Development of a method for evaluating the risk to New Zealand's indigenous fauna from the introduction of exotic diseases and pests—including a case study on native parrots

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ABSTRACT

The report comprises four Parts. Part 1 presents an overview of risk analysis and its general application to the management of New Zealand's indigenous fauna and sets out a framework for risk analysis for indigenous fauna with reference to the example analysis for indigenous parrots in Part 3 of the report. Part 2 lists the indigenous vertebrate fauna populations of interest and considers, in general terms, the range of disease agents that need to be covered. A semi-quantitative method for prioritising each population of interest so as to allow an orderly progression of successive risk analyses based on each population's priority ranking is presented. Part 3 is an example evaluation of risk analysis for managing the threat of exotic disease to indigenous parrots (psittacines). Part 4 recommends the use of risk analysis as a standard and appropriate tool for the management of risk of exotic disease to indigenous fauna in New Zealand. The report recommends a number of actions that the Department of Conservation could make to reduce risk of exotic disease to indigenous psittacines in particular and indigenous fauna in general.

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Part 1 An overview of risk analysis and its general application to the management of indigenous fauna of New Zealand

1.1 APPLICATION OF RISK ANALYSIS TO RISK OF EXPOSURE OF INDIGENOUS WILDLIFE TO EXOTIC DISEASE

Risk analysis has general application for assessing the risk of an adverse event occurring and as such presents a potentially valuable tool for examining risk of exotic disease to indigenous wildlife in New Zealand in a systematic and logical manner.

Over the last 50 years or so the procedure has been regularly used for assessing risks of introducing unwanted organisms associated with imports of animals and animal products. It recognises that importation of animals may involve a degree of risk of entry of one or more diseases and seeks to provide importing countries with an objective and defensible method of assessing the risk.

Risk analysis as applied to animal health and disease is a systematic approach to ranking the contribution that agent and management, host and environmental factors make to overall probability of an untoward event occurring and the severity of the impact of the event. Risk analysis uses a qualitative approach where relevant data is sparse or where there is poor understanding of disease pathways. Qualitative or quantitative methods or combinations of both may be used where data allows more precise estimates of probability of events occurring. There is not universal acceptance of all methods among risk analysts and the relative merits of different approaches are the subject of on-going debate. What does appear to be clear, however, is that quantitative analyses should not be considered superior to qualitative methods simply because they use more empirical data. Nor should estimates from quantitative analyses be regarded as absolutes since they tend to be very model dependent.

Risk analysis comprises hazard identification, risk assessment, risk management and risk communication. Hazard identification involves listing all the hazards, i.e. all the things that might go wrong. This part of the procedure needs to be very robust and include all possible hazards, even if the likelihood of their occurrence is very low. If a full accounting of all potential hazards is not done then the results may be flawed and proposed risk management strategies ineffectual.

Risk assessment attempts to estimate the likelihood that each hazard will occur and evaluate the implications should a hazard occur. Where that assessment is qualitative, hazards are generally ranked in terms such as very likely, possible and unlikely. The options available to avoid hazards or minimise risk are outlined in risk management where the question asked is ‘what can be done to minimise the risk?’.

The risk communication component should ideally be an integral part of hazard identification, risk assessment and risk management procedures and involve all affected parties throughout the analysis. This approach avoids the undesirable 'Decide, Announce, Defend' strategy where affected parties are presented with final decisions without having any opportunity to contribute to the analysis through earlier discussion.

1.2 INTERNATIONAL STANDARDS

The Uruguay round of the General Agreement on Tariffs and Trade (GATT) led to the formation of the World Trade Organisation (WTO). The Uruguay round formulated guidelines that came into effect in 1995 for the development of animal health policies affecting trade (The Agreement on the Application of Sanitary and Phytosanitary Measures or SPS Agreement). Risk assessment was adopted for justifying animal health standards on a science basis and countries were instructed to base their animal health import requirements on science justified by risk assessment. The GATT encouraged international harmonisation and recognised the Office International des Epizooties (OIE) as the agency responsible for global animal health standards. The OIE has developed a standardised general approach to conducting animal health risk analyses (Anon. 1999) that is being progressively developed in the light of new information and needs. Although the OIE guidelines refer specifically to List A and List B diseases, they are equally applicable to diseases outside those Lists.

Principles embodied in the SPS Agreement, and listed by Doyle (Doyle 1996), that are relevant to indigenous fauna include:

- **harmonisation** (basing national import quarantine measures on international standards)
- **scientific basis** (where international standards are not used, there is an obligation for quarantine measures to be scientifically based)
- **consistency** in risk management
- **equivalence** (using alternative measures to achieve an equivalent level of security)
- **transparency** (having an open decision making process for consulting on and documenting quarantine decisions)
- **regionalisation** (the acceptance for import of animals or products from declared disease-free zones within infected countries)
- **risk assessment** (evaluation of risk as a basis for import decisions rather than blanket exclusion based on the presence of a disease in the exporting country)

Apart from international treaty considerations, it is not surprising that veterinary regulatory authorities have increasingly used import risk analysis over the past 10 years. They have welcomed the transparency that accompanies the approach since analyses provide clear and documented decisions on the conditions imposed for importation, or refusal of importation. Documentation of the logic and data used in assessing risk also enables decision-makers and other interested parties to discuss any differences in conclusions among interested parties concerning potential risks. It also provides a way of dealing with the concerns of those who favour a zero-risk approach by providing a more objective decision.

With increased adoption and application of risk analyses, documentation of information on allied subjects, such as epidemiology of animal diseases, in standardised format, will continue to grow. This will provide a long-term community resource and aid to management that can be readily updated.

1.3 RESPONSIBILITIES AND ROLE OF THE DEPARTMENT OF CONSERVATION IN THE CARE OF INDIGENOUS SPECIES

The Department of Conservation is the government agency with primary responsibility for the conservation of New Zealand's unique indigenous flora and fauna. Process targets set during strategic planning in this area of responsibility included:

- completing by June 1998:
  —a scoping analysis of risks from new pests and unwanted organisms,

  —identification of appropriate risk management systems for their exclusion and/or early detection;
- developing, by 2002:
  —management systems for the exclusion or early detection of the most threatening new pests and unwanted organisms identified in the scoping analysis.

The outcome target from those processes is implementation of priority elements of management systems for new pests and unwanted organisms by 2002. Specifically, the Department's Objective 1.4.5 proposes to use provisions of the Biosecurity Act 1993 to effectively manage risks to natural heritage posed by pests and unwanted organisms.

1.4 LEGISLATIVE FRAMEWORK

The Conservation Act promotes the conservation of New Zealand's natural and historic resources and established the Department of Conservation. Conservation is defined as 'the preservation and protection of natural and historic resources for the purpose of maintaining their intrinsic values, providing for their appreciation and recreational enjoyment by the public, and safeguarding the options of future generations.'

The same emphasis on protection for indigenous fauna can be found in the other key statutes administered by the Department. These include: National Parks Act 1980, Reserves Act 1977, Wildlife Act 1953, Historic Places Act 1993, Marine Mammals Protection Act 1978, Marine Reserves Act 1971 and Wild Animal Control 1977.

In addition, the Department contributes to the sustainable management of New Zealand fauna through its roles under the following key Acts: Biosecurity Act 1993, Fisheries Act 1983 and Fisheries Act 1996, Forest and Rural Fires Act 1997, Land Act 1948 and Resource Management Act 1991.

1.5 CURRENT POLICIES AND PRACTICES FOR PREVENTING INTRODUCTION OF EXOTIC DISEASE INTO INDIGENOUS VERTEBRATES

The Biosecurity Act 1993 provides for the exclusion, eradication, and effective management of pest and unwanted organisms. Under Section 22 of the Act, the Director-General of Agriculture has statutory responsibility for issuing import health standards and permits for risk goods, which can be anything that could harbour organisms capable of causing unwanted harm to New Zealand's natural or physical resources. In preparing an import health standard, regard must be given to the likelihood that organisms may be brought into the country and their possible effect on people, the environment, and the economy.

Deliberate introductions of unwanted organisms are targeted by the Hazardous Substances and New Organisms (HSNO) Act 1996, and as with the Biosecurity Act, consideration is given to effects on the environment, animals and people. Applications to import new organisms now require their consideration under HSNO legislation in addition to their meeting the requirements of the Biosecurity Act. Some administrative confusion will be inevitable in the early stages of implementation of the HSNO Act since the Environmental Risk Management Authority (ERMA) has yet to develop methodology (to be approved through Orders in Council) and the legislation has yet to be tested. Current difficulties include precise interpretation of some terms in relation to organisms, such as 'separable' and 'inseparable', 'wanted' and 'unwanted', and 'acceptable' and 'unacceptable' in relation to risk.

A proposed importation may be processed under the Biosecurity Act if it does not involve the deliberate introduction of a new organism. If a new organism, e.g. a frog, was involved then ERMA would need to consider the application. Because that frog could carry an unwanted disease organism, it would need to be assessed as a risk good under the Biosecurity Act. Under HSNO legislation the applicant bears the burden of proof.

1.6 CURRENT THREATS

Current threats of exotic organisms to indigenous species come from illegal importation (both deliberate and careless), via intentionally introduced goods and via uncontrollable animal movement, including migration. Threats to indigenous species have always been taken into account in risk analyses, but in the past, full considerations of the risks, the likelihood of their occurring and the consequences of an unwanted introduction to indigenous species have probably been examined with less rigour than for established agricultural industries. In the same vein, there may have been a tendency to discount risk to indigenous species because of relatively poor knowledge of disease in those species and an apparent lack of effective modes of transmission to indigenous populations that may be sparse and relatively inaccessible.

On the other hand, current DOC initiatives, as embodied in their process targets and their biosecurity responsibilities under the Biosecurity Act, aim to give primary consideration to indigenous species.

1.7 LIMITATIONS OF RISK ANALYSIS

This document shall attempt to identify specific limitations of risk analysis applied to indigenous species. As an example, the Fish Department of West Australia noted its concern (Jones et al. 1997) with the OIE approach of identifying only 'significant disease' or 'diseases of concern'. It pointed out that for most wild fish populations, history has shown that the real danger has come from those agents not recognised at the time as diseases of concern. It considered there is a need to highlight diseases that have the potential to become pathogenic and a need to consider the consequences of an unforeseen introduction.

Thus while it is possible to apply risk analysis to known or suspected threats, a major challenge is to design generic response plans that enable an initial response to be made and allow data to be gathered for decision making about ongoing management responses.

1.8 PROCESSING A RISK ANALYSIS

After completing a risk analysis, it is submitted to the Ministry of Agriculture and Forestry (MAF) for peer review in conjunction with independent experts who recommend any modifications to be made before it is made available for public consultation. The document is normally available for consultation over a period of about 6–8 weeks. After any modifications from that process it is submitted in final form for approval by MAF. If approved, MAF then go on to draft import health standards. At that stage the WTO is notified and those standards are distributed to member countries for comment.

1.9 A FRAMEWORK FOR RISK ANALYSIS FOR INDIGENOUS FAUNA

There are three main parts to the whole process of a risk analysis for indigenous fauna:

- characterisation of the particular Order under consideration
- consideration of pathways for disease entry and transmission
- risk analysis procedure

No part can be developed independently of the other two parts and each part is progressively refined and modified from new information as the whole process proceeds.

1.9.1 Characterisation of the particular Order under consideration

All known species within the particular Order of concern are characterised with due consideration to ecological factors that might influence disease establishment and transmission. Thus available information is summarised for each species with respect to endangered status, population size, distribution and make-up, feeding habits and contact with other species, including humans

(see Part 3, *Characteristics of New Zealand parrots in the wild, New Zealand indigenous and introduced parrots,* and *Summary of characteristics of indigenous New Zealand parrots*).

1.9.2 consideration of pathways for disease entry and transmission

Pathways for disease entry and establishment are considered and preferably presented in diagrammatic form as in Part 3, *Figure 2, Likely transmission pathways for disease*, and explained as in Part 3 under *Pathways for establishment of exotic disease in indigenous parrots, Pathways for disease entry, Smuggling*, and *The effect of disease in free-living populations*. All legal and illegal means of disease entry are considered for the diagram and direct and indirect pathways constructed with weightings given to the efficacy of transmission for each section of the various pathways. Groups and individuals identified in the pathways should be consulted early on, and then later, to further refine the pathways diagram as hazards and risks of establishment are identified and better understood.

1.9.3 Risk analysis procedure

The risk analysis decision pathway of Sabirovic et al (1997) needed only slight modification to provide a generic risk analysis framework for procedures applicable to indigenous fauna. Figure 1 outlines the stepwise process for hazard identification, risk assessment and risk management that was followed in the case study for psittacines in this report.

Hazard identification (Step 1)

The first step in Hazard identification lists all infectious diseases and diseases suspected of being caused by an infectious agent reported for the Class or Order containing the species under consideration (Appendix 2.)

Hazard identification (Step 2)

In the second step the list is further refined by removing diseases from consideration if they meet criteria indicating they pose no threat because of their nature or particular requirements for transmission such as arthropod vectors that do not occur in New Zealand (see Part 3, *Step 2. Diseases for further consideration,* and Appendix 3). This step requires some judgmental decisions, and here, as elsewhere where such decisions are made, the reasons for exclusion should be documented.

Hazard identification (Step 3)

Further refinement of the list comes in the third step where diseases that are endemic in New Zealand are disregarded provided:

- strains of greater pathogenicity than those endemic to New Zealand (and which were of regulatory concern to New Zealand authorities) do not occur elsewhere
- the endemic disease is not subject to regulation for animal health reasons
- the risk to humans from any disease of public health concern in the list is not likely to be enhanced by an importation

Finally, recently recognised or emerging diseases for which the aetiology is poorly understood are examined and either discarded or retained for further consideration.

Risk assessment

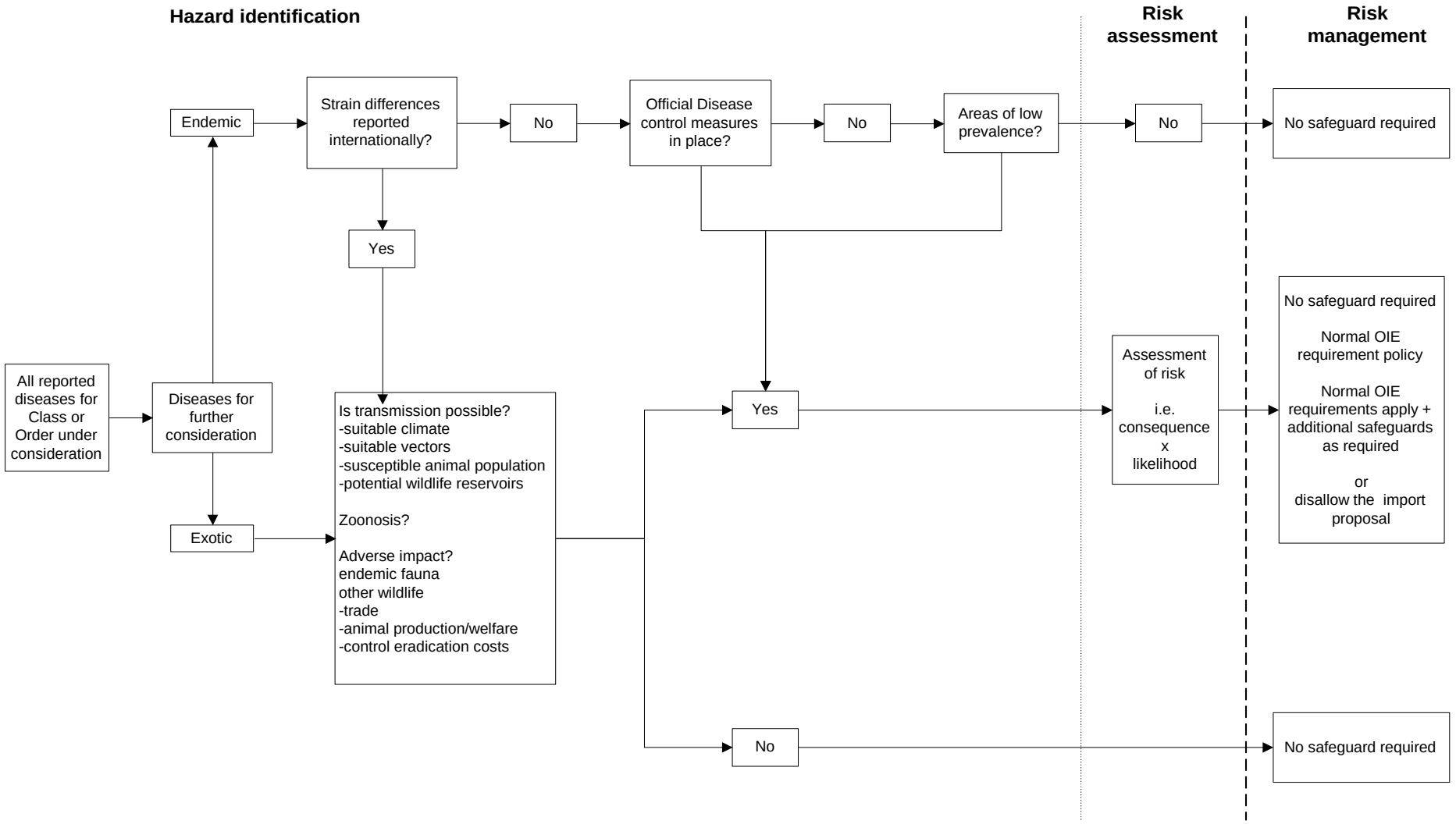
The risk of disease entry and the risk of disease establishment given entry are then assessed for each disease using a common format (see Part 3 *Risk Assessment*) that includes a section on risk management in which recommendations are made to limit risk.

Under that section heading for each disease, risk management options are outlined ranging from disallowing the import to following developed guidelines (as outlined in Part 3, *Planned introduction procedures* and *Recommended import health standards*) plus additional safeguards as required.

Summary statement

The psittacine risk analysis case study concluded with a summary statement setting out the limits of the analysis and briefly documenting the constraints from gaps in knowledge about the diseases of concern, the nature and behaviour of populations of concern and the effects of disease in those populations. In that section, *Summary of risk analysis for threat of exotic disease to indigenous psittacines*, recommendations were made for addressing gaps in knowledge and management procedures suggested for the important major and minor routes of entry.

Figure 1. Risk analysis decision pathway.



Part 2 Animals requiring protection, and the range of agents that must be considered

2.1 INDIGENOUS VERTEBRATE FAUNA OF NEW ZEALAND

Tables 1–4 list the indigenous vertebrate fauna of New Zealand by Class, Order and Family and common name representatives.

TABLE 1. ORDER, FAMILY AND COMMON NAMES OF INDIGENOUS CLASS AVES FAUNA OF NEW ZEALAND (BARNETT 1985).

ORDER	FAMILY	COMMON NAMES
APTERYGIFORMES	Apterygidae	Kiwis
SPHENISCIFORMES	Spheniscidae	Penguins
PODCIPEDIFORMES	Podicipedidiae	Grebes and dabchicks
PROCELLARIIFORMES	Diomedeidae	Albatross and Mollyhawks
PROCELLARIIDAE	Hydrobatidae	Storm petrels
	Pelecanoididae	Diving petrels
PELECANIFORMES	Phaehonidae	Tropicbirds
	Sulidae	Gannets and boobies
	Phalacrocoracidae	Shags and cormorants
CICONIFORMES	Ardeidae	Herons and bitterns
	Threskiornithidae	Ibises and spoonbills
ANSERIFORMES	Anatidae	Swans, geese and ducks
FALCONIFORMES	Accipitridae	Hawks and allies
	Falconidae	Falcons
GRUIFORMES	Rallidae	Rails, crakes, swamp hens, coots
CHARADRIIFORMES	Haematopodidae	Oystercatchers
	Charadriidae	Lapwings, plovers, dotterels
	Scolopacidae	Turnstones, curlews and allies
	Recurvirostridae	Stilts and avocets
	Stercorariidae	Skuas and jaegers
	Laridae	Gulls
	Sternidae	Terns
COLUMBIFORMES	Columbidae	Kereru, Parea
PSITTACIFORMES	Cacatuidae	Kakapo
	Nestoridae	Kaka, kea
	Platycercidae	Parakeets
CUCULIFORMES	Cuculidae	Cuckoos
STRIGIFORMES	Strigidae	Owls
CORACIIFORMES	Alcedinidae	Kingfishers
PASSERIFORMES	Xenicidae	Wrens
	Hirundinidae	Swallows and martins
	Motacillidae	Pipits and wagtails
	Muscicapidae	Fantails, fernbirds robins, tits, etc.
	Zosteropidae	Silvereyes
	Meliphagidae	Bellbird, stitchbird, tui
	Callaeidae	Kokako, saddleback

TABLE 2. ORDER, FAMILY AND COMMON NAMES OF INDIGENOUS CLASS MAMMALIA FAUNA OF NEW ZEALAND (KING 1990).

ORDER	FAMILY	COMMON NAMES
CHIROPTERA	Vespertilionidae	Long-tailed bats (localised)
	Mystacinidae	Short-tailed bats (localised)
	Pteropodidae	Fruit bats (1 vagrant record)
CARNIVORA	Otariidae	Fur seals and sea lions (localised)
	Phocidae	True seals (1 localised, 4 Antarctic only)
ODONTOCETI	Delphinidae	Spotted dolphin
		Hector's dolphin

TABLE 3. ORDER, FAMILY AND COMMON NAME OF INDIGENOUS CLASS AMPHIBIA FAUNA OF NEW ZEALAND.

ORDER	FAMILY	COMMON NAMES
ANURA	Leiopelmatidae	native frogs

TABLE 4. ORDER, FAMILY AND COMMON NAMES OF INDIGENOUS CLASS REPTILIA FAUNA OF NEW ZEALAND.

ORDER	FAMILY	COMMON NAMES
RHYNCHOECPHALIA	Sphenodontidae	Tuatara
SQUAMATA	Gekkonidae	Geckos
	Scincidae	Skinks

Finfish are not tabled here but should be included for consideration as indigenous vertebrate fauna. There are opportunities for importation of exotic disease along with fish commodity imports that include ornamental fish for the aquarium trade, fish meal, fish feed and fish biological products.

Aquatic fauna that are not endemic but spend part of their life cycle within New Zealand waters are not included here. The status of mammals such as whales that may range between Antarctic, New Zealand, Australian and Pacific Island territories should be clarified so that they are not neglected with no one country taking responsibility because they fail the criterion for endemic status.

2.2 RANGE OF EXOTIC DISEASE AGENTS THAT MAY AFFECT INDIGENOUS WILDLIFE IN NEW ZEALAND

The range of diseases or conditions that may affect indigenous wildlife in New Zealand include infectious diseases and diseases for which the aetiology is still uncertain, but which have epidemiological features that suggest that they are likely to be caused by an infectious agent.

The range of exotic disease agents that may potentially affect indigenous wildlife in New Zealand can be broadly classified as bacteria, fungi, viruses, parasites and prions[1].

Any list of diseases for wildlife is likely to be incomplete since our understanding of diseases of wildlife falls well below the level now established for diseases of domestic animals. New wildlife diseases continue to be identified and, for many, epidemiological information about their behaviour and interactions between host species is poorly understood. Managed populations are better understood than wild populations but key information about the spectrum of susceptible hosts, routes of transmission, validity of serological tests and behaviour of diseases over a range of conditions is sometimes missing. While these gaps do not mean that risk analyses cannot be made, any deficiencies in available data transfers uncertainty into estimates of risk and consequences of entry and forces conservative decisions for risk management. Thus animals from wild populations generally will be considered more conservatively than animals from managed populations that have been closely observed over time.

Many diseases of wildlife are unexpected and only become noticeable when wildlife populations are studied closely over time. Equine paramyxovirus, porcine paramyxovirus and lyssavirus, all recently isolated from fruit bats in Australia, were all detected first in domestic animals or man, and only recognised in bats when that particular host species was targeted for special attention. Thus the risk of introduction of previously unrecognised agents is greater for wildlife imports than for domestic animals that have been intensively managed for long periods of time.

Risk analyses methodology is more robust for animals that have been intensively managed and investigated over long periods of time. A more conservative approach to importation of wild animals or animals from poorly studied populations is appropriate.

2.3 PRIORITY LIST

A range of factors needs to be taken into account when constructing a list of risk analyses for families of indigenous species, ranked in order of priority. It is beyond the scope of this report to produce such a list—that is best left to DOC. However, a semi-quantitative method that requires examination of each issue as part of the prioritising process is suggested.

The process involves listing all of the factors or issues that need to be taken into account for each family under consideration e.g.:

- endangered status of the population
- public perceptions of the population
- commercial demands for importation of species that may carry unwanted organisms
- prevalence of smuggling

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[1] Note that the term prion is used here for the proteinaceous agent that causes transmissible spongiform encephalopathies and in ornithology is used quite separately as Prion for a genus of small seabirds (*Pachyoptila* spp.)

- adequacy of border controls
- availability of resources
- International harmony considerations with legislation e.g. with Australia

Once a list is drawn up, each factor is ranked on a nominal scale of 1–3 corresponding to high, medium and low for the family concerned. The total sum establishes the scale on which the priority is established.

Part 3 A qualitative risk analysis of the threat of exotic disease to endemic psittacines

This section details a qualitative risk analysis for psittacines that was made as an illustration of the procedure as applied to indigenous species and to demonstrate how the problems of conducting such analyses may be resolved, and to make recommendations on how further analyses for other priority groups should be conducted.

3.1 HAZARD IDENTIFICATION AND REFINEMENT

For hazard identification, the formats used for risk analyses for importation of passerine birds to New Zealand from Australia and the United Kingdom (Christensen, 1997), and importation of live ratites and their products into New Zealand (Sabirovic et al. 1997) were used as a guide. The decision pathway (Sabirovic et al. 1997) shown in Fig. 1 was followed.

Step 1. Diseases reported to affect avian species

Preparation of a database of all diseases that have been reported in avian species. This database differed from those produced for ratites (Sabirovic et al. 1997) and passerines (Christensen 1997) by the addition of budgerigar herpesvirus as a separate disease agent, avian polyomavirus, tuberculosis caused by *M. tuberculosis*, and roundworms, bringing the total number of diseases for further consideration to 192 (see Appendix 2).

Sources of information used in this analysis included standard reference texts for avian diseases, scientific journals, risk analyses for passerines and ratites, reviews, commissioned reports, the Internet and personal communications. Where reference was made to cited information in texts, the text, rather than the original source of information, was acknowledged.

Step 2. Diseases for further consideration

Refinement of that list was effected by removal of diseases from consideration if they met the following conditions:

- isolated on a very small number of occasions or as incidental/opportunistic findings (Sabirovic et al. 1997): Actinobacillosis, Aerobacteriosis, Bacteroidosis, Brucellosis, Citrobacteriosis, Flavobacteriosis, Heartwater, Goose venereal disease, Klebsiellosis, Liver granulomas, *Moraxella* infection, *Shigella* infection, *Vibrio* infection, *Trichinella pseudospiralis.*
- ubiquitous environmental contaminants, often associated with water, soil and humid environments: *Proteus* infection, *Pseudomonas* infection, Nocardiosis.
- distributed wordwide: Bumblefoot, Clostridial infections, Colisepticaemia, *M. tuberculosis* (drug susceptible strains) *Streptobacillus* infection,

Streptococcosis, Candidiasis, Cryptococcosis, Fungal dermatitis, Histoplasmosis, Amoebiasis, Fowl mites, *Giardia* infection, Trichomoniasis

- manifested in young chicks only after experimental inoculation: Aujeszky's disease, Bovine ephemeral fever.
- transmitted mainly by arthropod vectors that do not occur in New Zealand: Cabassou virus, Cacipacore virus, Chickungunya virus, Flanders virus, Fort Morgan virus, Hantavirus infections, Hart Park virus, Hypr virus, Ilheus virus, Kumlinge virus, Kunjin virus, Kyasanur Forest Disease virus, Louping ill, Mossuril virus, Mucambovirus, Nairovirus infections, Navarro virus, Orbiviruses (Kemerovo serogroup), Phlebovirus infections, Rocio virus, Russian Spring Summer Encephalitis, Semliki Forest virus, St. Louis encephalitis virus, Tonate virus, Uganda S virus, Usutu virus, West Nile virus.

Step 2 reduced the number of diseases for further consideration to 132 (see Appendix 3).

Step 3. Diseases of regulatory concern for further consideration

Using decision criteria similar to those established by Sabirovic et al. (1997), the list was further refined to diseases of possible regulatory concern by discounting diseases known to be endemic in New Zealand, with the proviso that:

- strains of greater pathogenicity than those endemic to New Zealand (and which were of regulatory concern to New Zealand authorities) did not occur elsewhere,
- the endemic disease was not subject to regulation for animal health reasons,
- the risk to humans of psittacine diseases of public health concern was not likely to be enhanced by an importation

Avian diseases for which strains of greater pathogenicity than those endemic to New Zealand or for which multiple drug resistance has been reported included:

- Infectious bursal disease
- Infectious bronchitis
- Marek's disease
- Tuberculosis caused by *M. tuberculosis*

Endemic diseases that could pose an enhanced risk to humans through importation included:

- Avian chlamydiosis
- Tuberculosis caused by *M. tuberculosis*

Step 3 reduced the number of diseases for further consideration to 90.

Recently recognised or emerging avian diseases for which the aetiology is not understood were not included in the primary list and, as with the analysis conducted by Sabirovic et al. (1997), it was considered that imposing safeguards for these diseases could not be justified. The conditions are listed here since the list may need to be modified in the future in the light of new information.

Recently recognised or emerging avian diseases for which the aetiology is not understood

Multicausal respiratory disease, Enteric viral infections, Hydropericardium-hepatitis syndrome, Hypoglycemia-spiking syndrome, Poult Enteritis and Mortality Syndrome (PEMS), Fulminating disease in guinea fowl, Muscovy duck parvovirus, Transmissable viral proventriculitis, Dispharynxiasis, Hepatitis-splenomegaly syndrome, Hepatic lipidosis, squamous cell carcinoma, Multicentric histiocytosis, Gangliosidosis in emus and Pigeon circovirus infection.

3.2 HAZARD IDENTIFICATION AND FINAL REFINEMENT OF DISEASE LIST

The 90 diseases of regulatory concern identified at step 3 were further divided into two subgroups:

- those for which there is no evidence that parrots could be affected (Table 5). There are 65 diseases in this subgroup.
- those for which available evidence indicates that parrots can be affected (Table 6). There are 24 diseases in this subgroup.

TABLE 5. DISEASES OF REGULATORY CONCERN FOR WHICH THERE IS NO EVIDENCE THAT PARROTS COULD BE AFFECTED.

DISEASE NAME	GENUS	SPECIES
Aegyptianellosis	*Aegyptianella*	spp.
Anthrax	*Bacillus*	*anthracis*
Infectious coryza	*Haemophilus*	*paragallinarum*
Intracellular infection in ducks	*Haematoproteus*	spp.
Mycoplasmosis	*Mycoplasma*	*iowae*
Ornithobacterium rhinotracheale infection	*Ornithobacterium*	*rhinotracheale*
Q fever	*Coxiella*	*burnetti*
Salmonella enteritidis phage type 4	*Salmonella*	*enteritidis*
Tularaemia	*Francisella*	*tularensis*
Turkey coryza	*Bordetella*	*avium*
Zygomycosis	*Absidia/Rhizopus/Mucor*	spp.
Argasid tick infestation	*Argas*	various spp.
Balantidiasis	*Balantidium*	spp.
Cryptosporidium infections	*Cryptosporidium*	spp.
Hexamita	*Hexamita*	spp.
Ixodid tick infestation	*Ixodes*	various spp.
Libyostrongylus infestation	*Libyostrongylus*	various spp.
Sarcosporidiosis	*Sarcocystis*	spp.
Trypanosoma infection	*Trypanosoma*	spp.
Verminous encephalitis	*Baylisascaris*	spp.
Adenovirus infections of ostriches	Adenovirus	unclassified
Alfuy virus	Flavivirus	
Astrovirus infection of turkeys	Astrovirus	
Astroviruses in ducks	Astrovirus	
Avian infectious bronchitis (exotic strains)	Coronavirus	various strains
Big liver and spleen disease	Virus?	Unclassified
Borna disease	Virus	Unclassified
Bunyavirus infections	Bunyavirus	

DISEASE NAME	GENUS	SPECIES
Cholangio-hepatitis virus infection	Flavivirus?	not yet identified
Coronaviral enteritis	Coronavirus	
Crimean-Congo haemorrhagic fever	Nairovirus	
Derzsy's disease of geese	Parvovirus	GVP type 1
Duck hepatitis	Picomavirus	
Duck hepatitis B virus	Avihepadnavirus	
Duck virus enteritis	Herpesvirus	Alphaherpesvirus
Equine encephalomyelitis (Eastern & Western)	Alphavirus	
Transmissible spongiform encephalopathy	Prions	
Haemorrhagic nephritis and enteritis of geese	?	Unclassified
Heron hepatitis B virus	Avihepadnavirus	
Highlands J virus	Alphavirus	
Infectious bursal disease (exotic strains)	Birnavirus	
Japanese encephalitis virus	Flavivirus	
Lymphoproliferative disease	Retrovirus	
Marble spleen disease of pheasants	Adenovirus	Adeno 11 group
Marek's disease (exotic strains)	Herpesvirus	
Australian arboencephalitis virus	Flavivirus	
Myelocytomatosis	Retrovirus	
Ostrich fading syndrome	?	?
Papillomas in finches	Papillomavirus	
Paramyxovirus 7 infection	Paramyxovirus	PMV-7
Paramyxovirus 8 infection	Paramyxovirus	PMV-8
Paramyxovirus 9 infection	Paramyxovirus	PMV-9
Parvovirus infection of chicken	Parvovirus	
Pneumovirus (turkey rhinotracheitis)	Pneumovirus	
Quail bronchitis virus	Adenovirus	Group 1
Rabies	Rhabdovirus	
Reticuloendotheliosis ('turkey leukosis')	Retrovirus	
Rift Valley fever	Phlebovirus	
Ross River virus	Alphavirus	
Swollen head syndrome	Pneumovirus	
Turkey haemorrhagic enteritis	Adenovirus	Adeno II group
Turkey meningoencephalitis virus	Flavivirus	
Turkey viral hepatitis	Virus?	enterovirus-like
Vesicular stomatitis	Rhabdovirus	
Wesselsbron disease	Flavivirus	

TABLE 6. DISEASES OF REGULATORY CONCERN FOR WHICH AVAILABLE EVIDENCE INDICATES THAT PARROTS CAN BE AFFECTED.

DISEASE NAME	OIE LISTING	GENUS	SPECIES
Avian chlamydiosis	B	*Chlamydia*	*psittaci*
Avian spirochaetosis		*Borrelia*	*anserina*
Salmonella arizonae		*Salmonella*	*arizonae*
Salmonella gallinarum infection	B	*Salmonella*	*gallinarum*
Salmonella pullorum infection	B	*Salmonella*	*pullorum*
Tuberculosis (multiple drug resistant strains)		*Mycobacterium*	*tuberculosis*
Filariae		*Filariae*	various spp.
Haemoproteus infection		*Haemoproteus*	spp.
Leucocytozoonosis		*Leukocytoozon*	spp.
Plasmodium spp. infections		Plasmodium	various spp.
Amazon tracheitis		Herpesvirus	

DISEASE NAME	OIE LISTING	GENUS	SPECIES
Avipoxviruses		Poxviruses	
Avian polyomavirus		Polyomavirus	
Budgerigar herpesvirus		Herpesvirus	
Fowl plague	A	Influenza	H5 and H7
Inclusion body hepatitis in pigeons		Herpesvirus	pigeon herpesvirus 1
Internal papillomatous disease		?	?
Newcastle disease (PMV-1)	A	Paramyxovirus	PMV-1
Pacheco's disease		Herpesvirus	
Paramyxovirus 2 infection		Paramyxovirus	PMV-2
Paramyxovirus 3 infection		Paramyxovirus	PMV-3
Paramyxovirus 5 infection		Paramyxovirus	PMV-5
Psittacine Proventricular Dilatation Syndrome (Macaw Wasting Disease)		?	?
Reovirus infections		Reovirus	various strains

3.3 RISK ASSESSMENT

To determine the type of safeguards required for each disease (Table 6) an assessment was made to determine the likelihood of disease transmission and the consequences of introduction. For each disease, the following was considered[2].

1. Aetiology

Taxonomic classification of agent and OIE categorisation

2. The disease

Epidemiology of the disease. Where available the following information is provided:

- susceptibility to infection
- incubation period
- survival of agent
- transmission
- consequence of birds (animals) becoming infected
- pathogenic significance unknown or uncertain
- capable of inducing systemic infections with high mortality, high morbidity andor establishment of latent infections
- capable of inducing sub-acute to chronic disease with high to low morbidity, low mortality and/or establishment of latent infection
- capable of inducing sub-acute to chronic disease with high to low morbidity and low mortality
- capable of inducing low grade chronic disease with low morbidity and minimal or no mortality
- not reported to cause clinical disease in natural infection; experimentally may induce low grade disease with low mortality and low morbidity

[2] Developed from procedures established by Sabirovic et al. (1997) and recommendations by Doyle (1996).

Diagnostic tests. Where available the following information is provided:

- tests recommended by the OIE
- option available to determine the true disease status
- whether the tests has been validated in the species concerned

3. Effect of introduction

Consequence. Is the disease likely to have an adverse impact on:

- trade?
- animal production and welfare?
- other wildlife

Consequence of entry score:

Severe, major, Moderate, minor.

4. Risk of introduction

Likelihood of disease introduction via the proposed commodity, and then of disease transmission within New Zealand:

Risk of introduction score:

Extemely likely, moderately likely, moderately unlikely, extremely unlikely.

5. Risk management

The information presented for each disease is considered as a basis for determining risk management options. In general, a number of options are available to provide an appropriate degree of assurance. Possible safeguards include:

- OIE standards where available
- recommended safeguards including justification if they exceed OIE standards
- a range of options for diseases not listed by the OIE
- birds/commodity not imported

3.3.1 General considerations

While considering appropriate safeguards for each disease the following factors have been taken into account:

1. Live parrots

1.1 Availability of diagnostic procedures

The OIE Manual of Standards for Diagnostic Tests and Vaccines, 1996, recommends the use of the various laboratory techniques for diseases on List A and List B but does not specifically prescribe tests for psittacines.

Procedures for isolation of a number of pathogens from poultry and birds are well established and should be equally applicable to psittacines.

Few serological tests routinely used for diagnosis in poultry have been validated with respect to their operating characteristics for psittacines. Results extrapolated from tests developed for other species should be interpreted with caution and, where possible, serology should be complemented by other diagnostic aids including direct demonstration of the organism.

The use of sentinel chickens should be considered for psittacine diseases that affect poultry.

1.2 Effect of a disease introduction

For a number of diseases that might be introduced there could be costs associated with either control measures (e.g. agent identification, property quarantine, movement control, slaughter of affected birds or other animals and destruction of carcasses, cleaning and disinfecting and vector control), treatment, or active immunisation of parrots and other domestic livestock.

The transmission pathways diagram (Fig. 2) illustrates the risk to other species.

Figure 2. Likely transmission pathways for spread of disease.

2. Hatching eggs

Importation of hatching eggs would exclude the introduction of virtually all internal and external parasites as well as some bacterial and viral diseases. There is considerable uncertainty about the routes of transmission for many psittacine diseases and the procedure is likely to have limited application for practical reasons. Attempts at smuggling hatching eggs are occasionally detected by border control authorities.

3.4 CHARACTERISTICS OF NEW ZEALAND PARROTS IN THE WILD

New Zealand has 10 (Table 7) of the world's 335 or so known species of parrots. Of the five that have been introduced, only the Rainbow Lorikeet has been declared a pest.

TABLE 7. NEW ZEALAND PARROTS, COMMON AND SPECIFIC NAMES, DISTRIBUTION AND STATUS (HEATHER & ROBERTSON, 1996).

PARROT	DISTRIBUTION	STATUS
Kakapo (*Strigops habroptilus*)	Fiordland; Stewart, Codfish, Little Barrier, Maud Is; long-lived (up to 30–40 years); popn 63.	rare and critically endangered; endemic
Kea (*Nestor notabilis*)	Alps of South I.; about 200 in captivity; long-lived (up to 20 years)	protected rare endemic; uncommon, <5000 birds
Kaka (*Nestor meridionalis meridionalis*)	South I.	threatened endemic; locally common
Kaka (*Nestor meridionalis septentrionalis*)	North I.; long-lived (up to 20 years)	Endemic; locally common
Yellow-crowned parakeet (*Cyanoramphus auriceps auriceps*)	North I., South I., most offshore islands, Auckland Is.; Nominate mainland species; local and overseas aviaries; hybridises in captivity	Protected; locally common; endemic
Forbes' parakeet, (*Cyanoramphus auriceps forbesi*)	Mangere and Little Mangere in the Chatham group; critically endangered; shares range with *C. n. cyanurus*	threatened endemic
Red-crowned parakeet (*Cyanoramphus novaezelandiae novaezelandiae*)	widespread but rare over both Islands, offshore islands, Gt Barrier, Stewart, Auckland Is.; Nominate mainland species; aviaries world-wide; releases back into wild	protected native; locally common
Chatham Island red-crowned parakeet (*Cyanoramphus novaezelandiae chathamensis*)	Chatham Is. only	protected native
Kermadec parakeet (*Cyanoramphus novaezelandiae cyanurus*)	Kermadec Is. only	protected native
Red-crowned parakeet, (Reischek's Parakeet) (*Cyanoramphus novaezelandiae hochstetteri*)	Antipodes Is.; captivity	protected native

PARROT	DISTRIBUTION	STATUS
Antipodes Island parakeet (*Cyanoramphus unicolor*)	Antipodes Is; in captivity ; popn ~2000–3000 in the wild; long-lived (up to 10 years)	protected endemic; locally common
Galah (*Cacatua roseicapilla*)	South Auckland and northern Waikato; popn probably <100 birds; largest flock record ~35 birds	Introduced; rare
Sulphur-crested cockatoo (*Cacatua galerita*)	popns Western Waikato (~200); Turakina (~300); Wellington (~50)	Introduced; uncommon; probably <1000 birds; harvested
Crimson rosella (*Platycerus elegans*)	central Wellington; popn <20 in the wild	Introduced; rare
Eastern rosella (*Platycerus eximus*)	Northland, Auckland, Coromandel, eastern Wairarapa and Hutt valley	Introduced; locally common
Rainbow lorikeet (*Trichoglossus haemadotus*)	Auckland North Shore; reports of flocks of up to 50 birds.	Introduced; uncommon but rapidly increasing; pest status

3.5 NEW ZEALAND INDIGENOUS AND INTRODUCED PARROTS

Information in this section is from Heather & Robertson (1996).

Kakapo (*Strigops habroptilus*) The kakapo is a critically endangered ground-nesting flightless parrot. There are only 63 known birds in existence. They feed on a wide variety of seeds and fruits, leaves, stems and roots. Kakapo are long-lived, up to 30–40 years and breeding occurs at 3–5 year intervals from first breeding at about 6–8 years of age. They are solitary animals outside the breeding season.

Kea (*Nestor notabilis)* Kea are considered rare with an estimated total population size of about 5000 birds. They inhabit the South Island only, mostly at high altitudes, but do descend to valley floors. They are mainly herbivorous but occasionally scavenge carcasses and garbage, where they interface with humans, especially at resorts. They are polygamous and gregarious and form groups of 5–15 birds at times. They are long-lived, up to 20 years, and start to breed at about 3 years of age. They nest on the ground. There are about 200 birds in captivity.

Kaka (*Nestor meridionalis*) There are two subspecies: The North Island Kaka, *N. m. septentrionalis* and the South Island Kaka, *N. m meridionalis*. They are moderately common in the North Island in forest from the Coromandel Peninsula to the Aorangi Range in southern Wairarapa and in the Pureora and Whirinaki forests in the central part of the Island. They also frequent towns in those regions and interface with humans. They are most numerous on the offshore islands of Hen and Chickens, Great Barrier, Little Barrier, Mayor and Kapiti. The South Island species are nowhere common but occur in the forests of Westland, Fiordland, southwest Southland and on Stewart Island and some offshore islands. They are classed as threatened endemic with a total population of probably less than 10 000. They nest at the base or in hollows in mature and

dead trees and start breeding at about 4 years of age. They are gregarious and form small flocks and have a life span of up to 20 or more years. Their diet is mainly fruit, nectar and insects. There are probably about 50 birds in captivity.

Yellow-crowned parakeet *Cyanoramphus auriceps auriceps* is the nominate subspecies and occurs throughout the North, South, Chatham, Stewart and Auckland Islands, favouring podocarp and beech forest on the mainland and forest and scrub on the islands. Their range in the North Island is limited mainly to the central forests but they are more widespread in the South Island. On offshore islands they share habitat with red-crowned parakeets which are generally more numerous in those locations. Forbes' parakeet, *C. a. forbesi*, is a threatened subspecies. Yellow-crowned kakariki feed on invertebrates, flowers and seeds for the most part in the canopy, and share feeding areas with Whiteheads in the North Island and Yellowheads in the South Island. They mostly nest in trees. They are usually solitary or in pairs but form small flocks in the winter. No information is available on life span or age at first breeding.

Red-crowned parakeet *Cyanoramphus novaezelandiae novaezelandiae* is the nominate subspecies but they are rare on the mainland. A few occur in forests in western Northland, central North Island and the Ruahine Range, but they are probably now absent from the South Island. They are common on northern offshore islands from the Three Kings, through the Hauraki Gulf to the Bay of Plenty and on Kapiti Island and on Stewart and the Auckland Islands in the south. Chatham Island parakeets are numerous and abundant on Mangere, Little Mangere and South-East Islands. Reischek's parakeets are found on Antipodes, Bollons and smaller islands in the Antipodes group. The Kermadec parakeet is abundant in the Kermadec Islands.

They tend to feed on the ground rather than in the canopy and are mainly herbivorous. Their diet includes seeds, fruits flowers, shoots, invertebrates and carrion. For the most part they nest in trees but also on the ground in burrows and heavy vegetation. They are usually solitary or in pairs but may form small flocks in autumn and winter. Breeding starts at about one year of age. Red-crowned parakeets are held in aviaries worldwide where they breed well.

Antipodes Island parakeet (*Cyanoramphus unicolor*) They are only found at Antipodes Island and associated islets, including Bollons Island and were estimated at 2000–3000 birds in 1978. They adapt readily to captivity and it is thought there are about 100 Antipodes parakeets in collections. They occur as solitary birds or as family groups. They nest in burrows or in the bases of tall tussocks. Breeding is thought to start at one year of age and clutches contain 1–3 fledglings. They are sedentary and prefer to walk and climb through vegetation when feeding. Their main food is tussock and sedge leaves but they also eat seeds, berries and flowers and are known to fossick for scraps of penguin and petrel carcasses and broken egg remains.

Galah (*Cacatua roseicapilla*) Introduced from Australia as a cage bird, but escapees have established in South Auckland and the northern Waikato and on some islands in the inner Hauraki Gulf. There are probably fewer than 100 birds in total. They are gregarious (a flock of 35 has been reported) and probably breed in the wild in New Zealand. Information about their diet and longevity in New Zealand is lacking but in Australia they feed mainly on the ground.

Crimson rosella (*Platycercus elegans*) Introduced from Australia as a cage bird and a few escapees have established in wooded parks and suburbs in central Wellington. There is probably less than 20 birds in total although there are occasional escapees reported elsewhere. They feed mainly on seeds of grasses, weeds and trees and fruit. Information about their breeding and longevity in New Zealand is lacking.

Eastern rosella (*Platycercus eximius*) They were introduced from Australia as cage birds but escapees have successfully established and become common in many parts of the North Island, especially, Northland, Auckland, Coromandel Peninsula, eastern Wairarapa and the Hutt valley. There are a few around Dunedin but that colony has declined over the years after becoming well established in about the 1940s. They are gregarious and form flocks of 5–25 birds. They feed on seeds, fruits, flowers and insects sometimes on the ground. Information about their breeding and longevity in New Zealand is lacking.

Sulphur-crested cockatoo (*Cacatua galerita*) Introduced from Australia in the 1900s, there are now probably fewer than 1000 birds in locations in western Waikato (c. 200), Turakina (c. 200), Wellington (c. 50) and Canterbury (c. 100). They nest high in trees but feed on the ground on seeds, fruit of podocarps, walnuts, orchard fruit and large insect larvae. They are harvested to an unknown extent for the cage-bird trade.

Rainbow lorikeet (*Trichoglossus haemadotus*) A brightly coloured gregarious parrot which feeds primarily on pollen, nectar and fruits, but will feed on grains. They are prolific, with pairs rearing up to three successive broods in a single season. Now established on the North Shore from deliberate releases of captive birds they now been recorded in flocks of up to 50 in the local vicinity and appear to have bred in the wild. The largest numbers appear to be on the North Shore with smaller concentrations in Mt Albert-Remuera, Glendowie and possible sightings of pairs from other locations including Clevedon, Howick, Henderson Valley, Waiheke Island. Because of their ability to travel they pose a threat to those species whose survival is only possible on Hauraki Gulf island sanctuaries which have been cleared of predators.

Lorikeets will compete with honeyeaters for food and also use the same nesting sites as kakariki, kaka and stitchbirds. Lorikeets could easily reach the sensitive offshore islands that are important sanctuaries for threatened species.

A co-operative venture between the Ministry of Agriculture and Forestry, the Auckland Regional Council and the Department of Conservation will attempt to recapture the birds which have been liberated and those that have bred in the wild. An initial group of birds will be screened to determine the presence of avian diseases.

3.5.1 Summary of characteristics of indigenous New Zealand parrots

There is little available information about species-specific physiological and anatomical characteristics that might be relevant to establishment of infectious disease in New Zealand parrots. It is necessary to extrapolate from other species of parrots with regard to their susceptibility to specific disease agents, since very limited information is available on that subject. Since they have evolved in relative isolation from other parrots it might be argued that they could be particularly susceptible to new disease agents, as has been seen in a range of other inter-species transfers of disease agents.

Kakapo, keas and kaka are long-lived and only start breeding at relatively advanced ages. Information about longevity in parakeets is lacking but breeding appears to start at an early age. Predation has probably caused some parrot population age distributions (kakapo and kaka in particular) to be negatively skewed, with older ages disproportionately represented, adding to the fragility of those populations.

Any disease entry, other than naturally through migratory bird movements, is most likely to be at mainland locations where existing populations are at their most fragile state with regard to overall survival. Populations on islands, with a few exceptions, are in a much better state and human interventions resulting in disease entry are less likely at those more remote locations. Poachers targeting populations on offshore islands also pose a risk if they carry diseases or use call birds for their illegal activities. However, should a disease be introduced by migratory birds or poachers, it could be detected late, due to remoteness of some island sites.

Most species are spatially fragmented with little contact between sub-populations of their own species and those of other genera due to distance and terrain.

3.6 PATHWAYS FOR ESTABLISHMENT OF EXOTIC DISEASE IN INDIGENOUS PARROTS

3.6.1 Pathways for disease entry

Exotic diseases of concern for indigenous parrots could conceivably be introduced to New Zealand via migratory bird movements, through alteration to virulence through mutation of existing agents, or directly or indirectly via legal or illegal importation of animals or animal products. Risk posed by migratory bird movements has been discussed by others (Sabirovic et al. 1997) and rather than cover those same issues separately at similar levels of detail here, that section of their report is included as Appendix 1. While conceding that migration presents an unavoidable natural risk for which the mechanism has been present for a very long period of time, it should not be wholly disregarded and the subject is therefore considered further in Section 4 under options for risk management.

The outbreak virus responsible for the 1999 outbreak of virulent Newcastle disease at Mangrove Mountain in New South Wales was almost certainly a mutation of a known Australian strain of low virulence for chickens, rather than from an imported strain of the virus. About 3 900 000 domestic poultry and birds were destroyed during the containment of this outbreak. Thus mutation of agents to virulent forms presents another unavoidable but very rare natural source of disease outbreaks.

Likely transmission pathways for the spread of disease from either legal or illegal importation of parrots or parrot material are proposed in Fig. 2. This diagram should be regarded as a working model containing some uncertainties, but which is nevertheless suitable for identifying and qualitatively ranking various possible pathways. The colour and line-width of the arrows are graded

to indicate relative strengths or importance of the various pathways. Pathways from imports of material other than parrots (such as poultry, ratites or passerines) can be identified in the diagram by assuming disease entry at the poultry and other-birds level. For reasons of simplicity, the diagram does not include pathways arising from unavoidable risks from a virus mutation or from migratory birds.

Escapees from aviculture, lack of effective barriers between caged and wild birds and fomites pose initial threats for spread of disease to wild bird populations. Escapees and shared aviculture and poultry enterprises constitute pathways for spread to backyard, free-range and intensive poultry operations in relative declining orders of risk. If disease established in wild birds or outdoor poultry enterprises, spread might then occur by direct contact at shared habitats to native parrot populations in the wild. Managed native parrot populations are less likely to be affected since the only available transmission pathway would be through ineffective barriers between wild birds and the managed caged birds. Transmission from managed populations would only be likely if undetected disease could pass to the wild parrots through rehabilitation, relocation or re-population programmes.

By considering pathways in the manner shown in Fig. 2, attention is drawn to the importance for aviculture enterprises involved with imports to prevent escapes, discourage shared enterprises, provide effective barriers between caged and wild birds and ensure sanitary disposal of fomites.

Direct and indirect transmission at common feeding areas in shared habitats would become important if disease established in poultry and/or free-living birds. At that stage, native parrot populations would be at dual risk; directly via escapees, and indirectly via free-living non-native parrots or other birds.

The pathways diagram indicates that only diseases of parrots with host ranges that include both poultry and birds other than parrots could be amplified and transmitted through poultry enterprises and other wild birds. That pathway is limited to those diseases with host ranges wider than parrots. On the other hand, the pathway of diseases that only affect parrots would be constrained by the efficiency of spread through direct contact with parrots in the wild via escaped parrots and through indirect contact at shared habitats. The limited distribution and relatively small sizes of most wild parrot populations in New Zealand would influence the efficacy of that particular pathway. The most abundant and widespread species are the indigenous yellow-crowned and red-crowned parakeets and the introduced eastern rosella (Table 7), making diseases of concern that affect those species of special interest.

3.7 SMUGGLING

There is a huge illegal international trade in birds and it is suspected that smuggling rings with links to Australia, Europe, South America and the United States have operated in recent times through New Zealand. The trade is lucrative and sentences are relatively light in most countries compared with those for other illegal activities such as smuggling drugs. The extent to which smuggling occurs to satisfy New Zealand bird collectors is not known but is likely to be small compared with the multi-national operations, where New Zealand is merely a convenient staging point.

Species most in demand are parrots, racing pigeons and raptors.

New Zealand is attractive because Australian species of parrots may be legally exported, whereas in Australia export of any Australian native fauna is banned. Because illegally imported Australian parrots cannot be distinguished from New Zealand resident parrots, smuggling via New Zealand is attractive to criminals. Live birds and eggs are smuggled into New Zealand and then exported, mainly to markets in the United States, Asia and Europe.

While it is in the interests of smugglers to trade in birds that remain healthy, at least until the time they reach their final destination, losses due to disease during smuggling are thought to be high. While the risk of importing disease through uncontrolled entry is higher than through regulated channels, examples of disease entry into domestic stock or native fauna in New Zealand or Australia by this means are difficult to find. However, serious diseases have undoubtedly been introduced (or at least the process of introduction has been hastened) into aviculture in North America and Europe through smuggling.

The direct air routes from Australia and Asia facilitate smuggling from those countries, whereas South America and Mexico, despite having sources of birds high in demand, are more difficult countries from which smugglers might bring birds to New Zealand because almost all flights are indirect.

On rare occasions pet birds enter on visiting yachts but risk of disease entry by that means is probably very low.

3.8 THE EFFECT OF DISEASE IN FREE-LIVING POPULATIONS

There is a dearth of knowledge about the effects of the parrot diseases considered in this analysis in free-living populations. This largely reflects the difficulties associated with studying diseases in wildlife. Intensive studies conducted over several years are needed to obtain robust data on incidence and effects of most wildlife diseases.

Outbreaks of highly pathogenic disease such as velogenic strains of Newcastle disease are spectacular due to high mortalities, but the effects of other diseases can be far subtler, with effects on the overall populations depending on particular mixes of disease epidemiology and population dynamics. Chronic diseases with incidence proportions up to 20% can easily go unrecognised in populations with high reproductive rates and short life spans, partly because there are other competing causes of death that mask the effect of disease. Thus some diseased birds will die from other causes of population regulation, such as predation and exposure during times of food shortages. On the other hand, populations with high reproductive ability are able to recover, sometimes over a period of years, from the effects of even very serious epidemics such as Newcastle disease.

Disease becomes far more important in populations in which individuals are normally long-lived because disease has proportionately greater impact if it changes population structure. A disease affecting say 10% of a kakapo population (long lived and low reproduction rate) would be of great concern, whereas a disease with that level of incidence in yellow-crowned parakeets (shorter lived and higher reproduction rate) could largely go unnoticed.

Similarly, the introduction of disease into populations that have been in decline for reasons other than disease is likely to have serious consequences since its effects will tend to be additive to the other causes of population decline. In critically endangered species such as kakapo, a disease introduction that affected reproductive ability or caused very low annual mortalities in the order of 1–2% of females would have serious consequences.

The amount of genetic diversity in a population is likely to have a strong influence on ability to withstand disease challenge, with responses in individuals ranging from fully susceptible to innately resistant. This variation in immune responsiveness is known to be related in part to the major histocompatibility complexes (MHC) genes and differences in MHC alleles between individuals. Reduced genetic diversity in vestigial populations may seriously limit the ability of those populations to mount an effective response to disease agents, and possibly to specific strains of agents.

A conservative approach to the effects of disease in indigenous parrots that are in decline, and in some cases critically endangered, can be justified from consideration of first principles of disease and population dynamics in free-living populations.

3.9 PLANNED INTRODUCTION PROCEDURES

New Zealand's membership in the World Trade Organisation requires that international standards (Anon. 1999) be used as the basis for developing specific safeguards whenever possible. This risk analysis follows established procedures (Sabirovic et al. 1997)and bases safeguards on the international standards, either individually or in combination, as follows:

3.9.1 Certification/verification of country freedom for specific disease

For diseases not on the OIE List A or List B there is no internationally accepted basis for certification/verification of country freedom.

3.9.2 Official flock of origin disease status, testing, treatment and/or vaccination history

For diseases not on the OIE lists there is no internationally recognised basis for certification/verification of the official flock of origin disease status, testing, treatment and / or vaccination history.

3.9.3 Season/time of year to avoid vector activity

The risk of introduction of some diseases (primarily insect borne) could be reduced by importing commodities during a season when insect activity is significantly reduced in the country of origin.

3.9.4 Pre-export/post-arrival quarantine requirements (disease status, testing or treatment requirements, sampling strategy, sentinel animal/birds)

Where applicable these are standard options available as specified by the OIE. Where there is no OIE standard, a range of options likely to be acceptable to New Zealand is offered.

3.10 RECOMMENDED IMPORT HEALTH STANDARDS FOR PARROTS

Currently there are no import health standards for the importation of psittacines into New Zealand, although up to July 1997 imports were allowed from Australia with quarantining carried out by the importer and from England via a high-security quarantine facility.

The following suggested import health standards for parrots follow the principles of the safeguards approved for importation of ratites and passerines and set appropriate guidelines for the purposes of this report:

- responsible supervision of isolation of imports from other birds and disease vectors, health of imports during the pre-export period, administration of treatment and collection of any samples required,
- quarantine premises for holding birds during pre-export period to be consistent with requirements of New Zealand with regard to security and welfare

A. Commodities—general

1. Live parrots

1.1 General

All birds must be subjected to veterinary inspection during quarantine and must be found to be fit to travel and free from clinical signs of infectious and contagious disease.

1.2 Specific

1.2.1 Establishment (flock of origin)

Modified OIE definition: 'Establishment means an aviculture establishment in which *birds for breeding or rearing* are raised'.

- As per OIE guidelines where appropriate.

1.2.2 Pre-export quarantine

- All birds will be subjected to veterinary inspection during quarantine and found fit to travel and free from clinical signs of infectious and contagious disease.
- Prescribed challenge of accompanying sentinel birds such as chickens if stipulated by the Chief Veterinary Officer of New Zealand.
- Level of quarantine security to be assessed on a country to country basis.
- Pre-export quarantine—30 days prior to export, all birds tested and treated as required on a disease by disease basis.
- Where testing is required in pre-export quarantine, any positive test results must be reported to the New Zealand Chief Veterinary Officer.

1.2.3 Post-arrival quarantine

- Minimum of 30 days post-arrival quarantine under security adequate to prevent direct and indirect transmission to birds outside the facility, all tests and treatments specified in recommended safeguards for each disease will be repeated in post arrival quarantine and all birds will be subjected to testing/ treatment.

2. Hatching eggs

2.1 General

- Hygiene and disease security procedures (follow poultry codes set out in OIE International Animal Health Code (IAHC) 1997, Appendix 4.2.4.1) (Anon. 1999).

2.2. Specific

2.2.1. Flock of origin

- Isolation and testing as required prior to and post-laying period, using OIE poultry guidelines where available and applicable.
- Where testing is required, any positive test results must be reported to the New Zealand Chief Veterinary Officer.

2.2.2 Pre-export quarantine

- Hygiene and disease security procedures (follow poultry codes set out in OIE IAHC 1997, Appendix 4.2.4.1).
- Level of quarantine security to be assessed on a country to country basis.

2.2.3 Post-arrival quarantine

- Minimum of 30 days after hatching, all tests specified in recommended safeguards for each disease will be repeated in post-arrival quarantine.

B. Laboratory testing

1. Serology

- No pooling of samples is permitted.

C. Bacteriology, virus isolation, parasitological examination

- Swabs used for bacteriological culture and virus isolation must be collected from each bird and must be individually tested.
- Blood smears for blood parasite detection must be collected from each individual bird and must be individually tested.
- Faecal samples used for virus isolation must be collected from each individual bird and must be individually tested.
- Faecal samples used for parasite detection must be collected from each individual bird.
- Pooling of samples will be permitted in accordance with applicable OIE guidelines, where appropriate.

D. Ecto- and endo-parasite treatment

- Were subjected to veterinary inspection during quarantine and found to be fit to travel and free from clinical signs of infectious disease.
- Treatment against parasites must be performed according to the protocol agreed with exporting country and based on the latest scientific information about the efficacy of treatment[3].

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[3] Ecto- and endo-parasiticide treatments should include two treatments, each of a wide spectrum parasiticide and each drug belonging to a different action family.

3.11 DISEASES OF CONCERN

In this section, diseases of regulatory concern for which available evidence indicates that Psittacines can be infected were examined using the principles outlined under Part 3.

Within each broad category of bacterial, parasitic, viral and unknown aetiology diseases, each disease was given a priority ranking according to the product of its consequence of entry and risk of introduction scores (Table 8.). Each disease was considered separately in alphabetical order within each broad category, except for the herpesvirus diseases that were considered together. The scoring system used to produce Table 8 was:

COE	SCORE
minor	1
moderate	2
major	3
severe	4

ROI	SCORE
extremely unlikely	1
moderately unlikely	2
moderately likely	3
extremely likely	4

PRODUCT SCORE	PRIORITY RANKING
1–3	★
4–6	★★
7–9	★★★
10–12	★★★★
>13	★★★★★

TABLE 8. DISEASE PRIORITY RANKING ACCORDING TO CONSEQUENCE OF ENTRY AND RISK OF INTRODUCTION SCORES.

DISEASE NAME	COE	ROI	SCORE	RANK
Avian chlamydiosis	minor	extremely likely	4	★★
Avian spirochetosis	minor	extremely unlikely	1	★
Salmonella arizonae	minor	moderately unlikely	2	★
Salmonella gallinarum infection	moderate	moderately likely	6	★★
Salmonella pullorum infection	major	moderately likely	9	★★★
Tuberculosis (MDR strains)	moderate	extremely unlikely	2	★
Filariae	minor	moderately unlikely	2	★
Haemoproteus infection	minor	moderately unlikely	2	★
Leucocytozoonosis	minor	extremely unlikely	1	★
Plasmodium spp. Infections	minor	moderately unlikely	2	★
Amazon tracheitis	major	moderately likely	9	★★★
Avipoxviruses	moderate	moderately likely	6	★★
Budgerigar fledgling disease	moderate	moderately likely	6	★★
Budgerigar herpesvirus	severe	moderately likely	12	★★★★
Fowl plague	major	moderately likely	9	★★★★
Inclusion body hepatitis in pigeons	moderate	moderately unlikely	4	★★
Internal papillomatous disease	minor	extremely likely	4	★★
Newcastle disease (PMV-1)	severe	moderately likely	12	★★★★
Pacheco's disease	moderate	extremely likely	8	★★★
Paramyxovirus 2 infection	severe	moderately likely	12	★★★★
Paramyxovirus 3 infection	severe	moderately likely	12	★★★★
Paramyxovirus 5 infection	severe	moderately likely	12	★★★★
Psittacine Proventricular Dilatation Syndrome (Macaw Wasting Disease)	moderate	extremely likely	4	★★★
Reovirus infections	minor	moderately unlikely	2	★

A. BACTERIAL DISEASES

Avian chlamydiosis ★★

1. Aetiology

Avian chlamydiosis is caused by *Chlamydia psittaci*, an obligate intracellular bacterium that survives in the environment for up to several weeks if protected by organic material. It is an OIE list B disease and is classified an unwanted organism in New Zealand under the provisions of the Biosecurity Act. The disease in humans is termed psittacosis (also parrot fever and ornithosis). *C. psittaci* strains from Psittaciformes are generally considered to cause relatively severe disease in humans.

2. The disease

Birds are considered the main vectors and reservoirs of avian chlamydiosis. The host ranges for the various *C. psittaci* strains are very wide and include most domestic and free-ranging birds and some mammals, including horses, cattle, sheep, dogs and cats, but the psittacine strain is not thought to cause disease in mammals other than humans. The disease is endemic in birds in New Zealand and is widespread throughout the world. Psittacosis was found at low to moderate levels of prevalence in feral pigeons at multiple sites in New Zealand but apart from some suspicious test results from kakas and wekas on Kapiti Island, there is no strong confirmatory evidence of its presence in indigenous birds in New Zealand (Motha et al. 1995). Clinical disease is generally considered to occur mainly in captive populations in Australia but can occur in wild populations as evidenced by being commonly reported in rosellas (*Platycercus* spp.) in Victoria (Vogelnest 1994). Relative susceptibility appears to be greatest for South American parrots, declining through South Asian and African to Australian parrots in that order (Ritchie et al. 1994).

Clinical signs are variable and may include weight loss, depression, anorexia, diarrhoea, ocular and nasal discharges (including sinusitis) and dyspnoea. With acute disease, birds may be found dead or comatose without any other signs. Making a definitive diagnosis may be difficult in single live birds, but findings of splenomegaly, hepatomegaly, air sacculitis, serositis and enteritis at post mortem are suggestive of chlamydiosis (Vogelnest 1994).

Laboratory diagnostic methods include isolation from cloacal swabs (not faecal samples), demonstration of Levinthal-Cole-Lillie (LCL) bodies (pathognomonic), PCR, antigen ELISA, several antigen capture tests, and BELISA (Ritchie et al. 1994).

A wide spectrum of manifestations of the disease has been reported from inapparent infection through to systemic infections with high mortality, high morbidity and/or establishment of latent infections. Cockatiels can shed the organism in faeces for more than one year following active infection. The minimum incubation period for naturally infected Psittaciformes is 42 days (Ritchie et al., 1994). The disease may be transmitted vertically and via respiratory and oral routes.

3. Effect of introduction

The disease already occurs in New Zealand and if introduced would have no further effect on trade or farm animal production. Strains that cause disease in mammals exhibit strain variation in DNA sequence to the psittacine strain. No information about its occurrence in native birds in the wild is available but *Chlamydia psittaci* is commonly isolated from faeces of Psittaciformes and is not uncommonly diagnosed at necropsy of previously sick birds in New Zealand (Johnstone et al. 1993).

Consequence of entry score: already occurs in New Zealand

4. Risk of introduction

Risk of introduction score: extremely likely in imports of live parrots

5. Risk management—recommended safeguards:

This disease does present a slight dilemma since it is present in New Zealand birds, it is an OIE list B disease and in New Zealand it is notifiable to both MAF and Ministry of Health. The question of interest is whether importation could increase the already present background risk of transmitting the disease. There is some evidence to suggest that parrot-derived strains produce relatively severe disease in humans. The International Animal Health Code 1996, Chapter 3.6.4 specifies requirements for birds of the *Psittacidae* family and states that Veterinary Administrations of countries free from psittacosis/ornithosis may prohibit importation or transit through their territory, directly or indirectly, from countries considered infected with psittacosis/ornithosis of birds of the *Psittacidae* family.

The recommended course of action for imports of susceptible species is to reduce exposure of imported birds to resident birds and personnel handling the birds. Consideration might be given to treatment of parrots with doxycycline (Doneley 1996) or chlortetracycline (Anon. 1997) for 45 days during a pre-export period although that course of action would need to be balanced against the possibility that it could interfere with diagnosis of other diseases of interest. During United States quarantine, psittacine birds receive a balanced, medicated feed ration containing 1% chlortetracycline with 0.7% calcium for the entire quarantine period as a precautionary measure against avian chlamydiosis (Virginia Dept. of Agriculture 1998). The USDA also recommends that importers continue prophylactic treatment of psittacine birds for an additional 15 days (i.e. for 45 continuous days).

More information is required about the epidemiology and pathogenicity of the disease in New Zealand birds in the wild. In particular, data on prevalence in a range of bird species would be helpful. It is possible that some populations of rare and endangered native psittacines have never been exposed to this agent, and would be highly susceptible if the agent was introduced. It would be appropriate to develop a specific protocol for monitoring the status of selected populations with respect to *C. psittaci*, and establishing biosecurity requirements for people who have to handle birds in any populations found to be free of the agent. It is recommended that DOC pursue this approach.

Avian spirochaetosis ★

1. Aetiology

Avian spirochaetosis is caused by *Borrelia anserina.* It is not listed by the OIE.

2. The disease (Calnek et al. 1995)

Chickens, turkeys, pheasants, ducks, geese and canaries have been naturally infected with *B. anserina* but one case has been reported overseas in an African grey parrot (*Psittacus erithacus*) imported from Ghana. The disease is distributed worldwide but occurs mainly in tropical and subtropical regions where fowl ticks are common. No information is available on the effects of the disease in indigenous parrots in New Zealand but mortality and morbidity rates in other species are variable and range from 1–2% to 100%. Confirmation of spirochaetosis depends on demonstration of *B. anserina* in stained blood smears or by dark-field microscopy.

The principal vectors of the disease are ticks of the genus *Argas* with *A. persicus* thought to be the principal host, but arthropods and fowl mites (*Dermanyssus*) are capable of transmitting the spirochaete. Transmission via excreta is thought to be of only minor importance. The disease is capable of inducing acute to chronic disease with high to low morbidity and mortality in a wide variety of avian species. Clinical signs include anorexia, diarrhoea and paralysis, and signs referable to anaemia. Recovered birds are not carriers.

3. Effect of introduction

Potentially a wide range of avian species could be affected but transmission of the disease would be limited by absence of *Argas* ticks on land birds in New Zealand. The only argasid tick established in New Zealand is *Ornithodoros capensis* whose host is the shag (McKenna 1996). Migratory egrets from Australia are potential sources of avian spirochaetosis (Appendix 1).

Consequence of entry score: minor

4. Risk of introduction

Risk of introduction score: extremely unlikely

5. Risk management—recommended safeguards:

Treatment of imported birds for ecto-parasites on arrival into and departure from pre-export quarantine.

Salmonellosis ★ to ★★★

1. Aetiology

The diseases of particular interest are pullorum disease caused by *Salmonella pullorum* ★★★, fowl typhoid caused by *S. gallinarum* ★★★ and Arizonosis caused by *S. arizonae* ★ . *Salmonella pullorum* and *S. gallinarum* are OIE list B diseases with requirements listed in the International Animal Health Code Chapter 3.6.5 for domestic poultry. *Salmonella arizonae* is not listed.

The International Animal Health Code 1996, Chapter 3.6.12, specifies requirements for domestic poultry, hatching eggs and commodities for *S. enteritidis* and *S. typhimurium*.

Because of the similarities among these *Salmonella* spp., they are considered together in this section. New Zealand actively monitors livestock and farm products for the presence of *S. pullorum, S. gallinarum, S. enteritidis* phage-type 4 and *typhimurium* phage-type 104 but they are not classified as unwanted organisms.

2. The disease

Salmonella pullorum is effectively non-existent in commercial poultry in New Zealand but may still be circulating in fancy flocks and hence in backyard and farm poultry. Infection is common in poultry worldwide and natural infection has been recorded in a wide range of other birds, including parrots (Calnek et al. 1995). Occasional cases in humans have been reported (Calnek et al. 1995) but not in New Zealand.

The epidemiology of *S. pullorum* is different from the other *Salmonellae*. Transmission is vertical and horizontal and high incidences of disease can occur under artificial incubation conditions where uninfected newly hatched chickens are exposed through extensive dissemination of the agent from vertically infected chickens. The disease can potentially cause very severe losses in chickens (up to 100%) when artificial incubation is used. The disease was controlled in commercial poultry flocks by a combination of blood testing and slaughter of affected birds and between batch sterilisation of incubators.

Salmonella gallinarum has not been recorded for many years in New Zealand in commercial poultry flocks but could still exist in some backyard enterprises (Manktelow et al. 1988). In other countries, infection has been reported in a wide range of domestic and wild birds but the disease occurs most frequently in managed flocks (Calnek et al. 1995). *Salmonella gallinarum* is not considered to be of public health importance.

The epidemiology of fowl typhoid is similar to pullorum disease with vertical and horizontal transmission causing severe losses in chickens under conditions of artificial incubation. The incidence of vertical transmission appears to be lower for *S. gallinarum* than for *S. pullorum*. Acute and chronic disease occurs in older birds but at lower incidences than in chickens.

Salmonella arizonae has a very wide host range and can cause enteric disease in humans. *Salmonella arizonae* has not been reported in New Zealand.

Salmonella pullorum, S. gallinarum and S. *arizonae* are distributed throughout most of the world. Clinical signs in poultry vary according to the species of

Salmonella and age at exposure. No information is available about the effects of these diseases in New Zealand indigenous parrots, but infections caused by *S. enteritidis* and *S. typhimurium* have been reported in Psittaciformes outside New Zealand. Both have public health significance. S. *enteritidis* phage-type 4 appears to be more pathogenic to poultry than other strains but has not been detected in New Zealand poultry. It has been reported on several occasions in ruminants and humans in New Zealand (Carmen et al. 1997).

Laboratory diagnosis is made by isolation of bacteria from cloacal swabs and the preferred test is culturing on selective media with serotyping and phage-typing where appropriate for further identification.

3. Effect of introduction

In addition to public health considerations, *S. pullorum* and *S. gallinarum* could cause serious disease in native Psittacines if introduced. Either agent could seriously affect chick production in Psittacines if they became established in populations. There is a serious risk of this occurring if infected eggs of affected species are incubated artificially with eggs of native psittacines, especially if no precautions are taken. This disease caused serious problems for the poultry industry when artificial incubation was introduced until eradication measures were developed. Precautions are therefore highly desirable, especially for species in which artificial incubation is used to increase breeding success. It is uncertain whether native psittacine populations are infected.

Salmonella arizonae has the potential to establish in a variety of avian mammalian and reptilian species (Calnek et al. 1995).

Consequence of entry score: major for *S. pullorum*
major for *S. gallinarum*
minor for *S. arizonae*

4. Risk of introduction

The risk of introduction of *S. pullorum* and *S. gallinarum* is moderately likely without safeguards for most endangered species and moderately unlikely for *S. arizonae*.

Risk of introduction score: moderately likely for *S. pullorum*
moderately likely for *S. gallinarum*
moderately unlikely for *S. arizonae*

5. Risk management—recommended safeguards:

The risks for *S. pullorum* and *S. gallinarum* are not so much of introduction from overseas as of introduction to native psittacines from other birds due to common incubation. It would be appropriate to develop protocols that ensure that only eggs from birds free from disease are introduced into hatching facilities and that thorough disinfection is practised between batches of hatching eggs. Horizontal transmission to native birds should also be controlled, with particular attention paid to managed population facilities where the consequences of transmission of infection to endangered species may be severe. It is recommended that DOC pursue this approach.

The OIE International Animal Health Code (1999) Articles 3.6.5.1 and 3.6.5.3 (Anon. 1999) are incorporated into New Zealand recommended safeguards for imports of ratites and those particular safeguards (Sabirovic et al. 1997) are

applicable to imports of parrots and hatching eggs. However, because of the public health and trade significance of *S. enteritidis* phage-type 4 and *S. typhimurium* phage type 104 and their rarity in New Zealand, it is recommended that they are included with *S. pullorum, S. gallinarum* and *S. arizonae* for border protection.

OIE standards. Article 3.6.5.1 (amended here for live parrots)

Safeguards would include:

- Were kept in an establishment which had been regularly monitored for the presence of *Salmonella* in accordance with Appendix 4.2.4.1 (Section 1).
- Were kept in a flock within the establishment in which no evidence of *S. pullorum, S. gallinarum, S. arizonae, S. enteritidis* phage-type 4 and *S. typhimurium* phage type 104 are detected and have had no contact with birds or other material from flocks which do not comply with this standard.
- Were kept in an establishment which complies with the hygiene and disease security procedures referred to in OIE Appendix 4.2.4.1.
- Were kept in a quarantine station for not less than 21 days prior to shipment and were subjected to a single test (culture) after 14 days in pre-export quarantine.

OIE standards. Article 3.6.5.3. Hatching eggs

Safeguards would include:

- Were kept in an establishment which had been regularly monitored for the presence of *Salmonella* in accordance with OIE Appendix 4.2.4.1 (Section 1).
- Were kept in a flock within the establishment in which no evidence of *S. pullorum, S. gallinarum*, *S. arizonae, S. enteritidis* phage-type 4 and *S. typhimurium* phage type 104 are detected and have had no contact with birds or other material from flocks which do no comply with this standard.
- Were kept in an establishment which complies with the hygiene and disease security procedures referred to in OIE Appendix 4.2.4.1.
- Were shipped in clean and unused packages.

Tuberculosis ⋆

1. Aetiology

The disease of interest is tuberculosis caused by *Mycobacterium tuberculosis*. The disease is notifiable to the New Zealand Department of Health. Avian tuberculosis caused by *Mycobacterium avium* is an OIE list B disease.

2. The disease (Ritchie et al. 1994)

Mycobacterium tuberculosis infections occur extremely rarely in Psittaciformes and are usually encountered in pets with very close human contact. Lesions are described as benign localised granulomas of the dermis, frequently around the cere or nares or retro-orbital tissue, where it causes exophthalmos. Diagnosis can be made by histology and culture of biopsies. Affected birds should be euthanased.

3. Effect of introduction

The disease has public health significance, particularly if multiple drug resistant strains are involved. The characteristics of the disease in parrots suggest that affected birds are not likely to be effective transmitters of the disease. The consequences of introduction of the disease for aviculture is likely to be minor with no effect on trade or farm animal production. However, given the worldwide importance of MDR strains, some attention should be given to preventative measures when psittacines are imported.

Consequence of entry score: minor

4. Risk of introduction

Risk of introduction score: extremely unlikely

5. Risk management—recommended safeguards

Safeguards would include:

- Require that birds exhibited no signs of disease during their stay in pre-export and post-export quarantine.
- Require that the history of imported birds is not consistent with exposure to *M. tuberculosis.*

B. PARASITIC DISEASES

Filariae ⋆

1. Aetiology

Species of *Pelecitus, Chandlerella, Cardiofilaria* and *Eulimdana* occur in psittacine birds (Ritchie et al. 1994).

2. The diseases

Filariid nematodes have indirect life cycles and are transmitted to birds by blood sucking insects. Apart from occasional problems associated with Pelectitus genera localising in joints and subcutaneous tissues, most infections are considered to be non-pathogenic.

3. Effect of introduction

The diseases are not likely to have an adverse impact on wildlife or aviculture.

Consequence of entry score: minor

4. Risk of introduction

Although the likelihood of disease introduction via importation of parrots is moderately likely, disease transmission within New Zealand is likely to be constrained by lack of suitable vectors.

Risk of introduction score: moderately unlikely

5. Risk management—recommended safeguards:

Safeguards would include:

- Some level of control may be expected from routine anthelmintic treatment in pre- and post-entry quarantine but it is not likely to be absolute.
- Control of any vectors during quarantine through ecto-parasiticide treatment in pre-entry quarantine.

Haemoproteus ⋆

1. Aetiology

Haemoproteus spp. are common protozoon blood parasites of birds and are unlisted by OIE.

2. The disease

Culicoides spp. and *Hippoboscid* biting flies transmit infection. Under normal circumstances *Haemoproteus* spp. are considered non-pathogenic and have only very rarely been implicated in disease states characterised by chronic anaemia.

Diagnosis is based on the demonstration of pigmented intra-erythrocyte halter-shaped gametocytes in blood smears together with the absence of schizonts (Petrak 1982).

3. Effect of introduction

Based on the ubiquitous nature of infections in a very wide host range, the parasite is not likely to have an adverse impact on trade, farm animal production and welfare or health of indigenous parrots. However, neither the current infection status of native birds nor the effects of infection in those birds is known.

Consequence of entry score: minor

4. Risk of introduction

The likelihood of introduction of the parasite via live parrots and for subsequent disease transmission within New Zealand is moderately likely.

Risk of introduction score: moderately unlikely

5. Risk management—recommended safeguards

No particular safeguards required.

Leucocytozoon ⋆

1. Aetiology

Leucocytozoon spp. are protozoon blood parasites of birds and are unlisted by the OIE.

2. The disease

The status of psittacines in New Zealand with regard to *Leucocytozoon* infections is not clear. Protozoal organisms occur in New Zealand birds (Smits 1997), but diseases associated with them are not commonly diagnosed in birds, especially psittacines, perhaps because suitable insect vectors are not present, or infections are subclinical. *Leucocytozoon* spp. are distributed worldwide and are recorded incidentally in birds in Australia. In general, *Leucocytozoon* spp. are host-specific.

Transmission may be effected by biting *Simuliid* flies in which sporogony occurs, and by *Culicoides* midges. Infections have a seasonal incidence in the wild with parasitaemia being highest in the spring. The disease produces anaemia, and fatal infections have been described in budgerigars (Ritchie et al. 1994).

Diagnosis is by demonstration of gametocytes in leukocytes and sometimes in erythrocytes.

3. Effect of introduction

The effect of infection in native parrots has not been determined but circumstantial evidence (Sabirovic et al. 1997) indicates that suitable vectors are not present in New Zealand. The disease is not likely to have adverse impact on trade, animal production and welfare or wildlife.

Consequence of entry score: minor

4. Risk of introduction

Risk of introduction score: extremely unlikely

5. Risk management—recommended safeguards

No specific safeguards required.

Plasmodium spp. ★

1. Aetiology

Plasmodium spp. are protozoon blood parasites of birds and are unlisted by the OIE. Of about 50 species of Plasmodium so far described, six have been reported from Psittaciformes (Ritchie et al. 1994). Other species in the genus affect mammalian hosts and are important, especially human malaria. However, there is no interchange of infection between avian and mammalian host species.

Some species of Plasmodium have been reported in New Zealand viz. *P. relictum* in the songthrush (*Turdus philomelos)* and other introduced songbirds (Dore 1921, Dore 1920a, b), in endemic Rockhopper penguins (*Eudyptes crestatus*) (Fantham et al. 1944), yellow-eyed penguins (*Megadyptes antipodes*) (Fantham et al. 1944, Graczyk et al. 1995a), little blue penguins (*Eudyptula minor*) (Graczyk et al. 1995b) and *P. relictum* and *P. elongatum* in captive New Zealand dotterel (Reed pers. comm.).

2. The disease

Clinical disease is most likely to occur in avicultural settings and although Plasmodia are generally regarded as non-pathogenic in most hosts, they can cause fatal anaemia in canaries. Juveniles in small populations, as in captive dotterels, may be clinically affected (C. Reed pers. comm.). Transmission is by *Aedes, Culex* and *Anopheles* mosquitoes. For the most part, they are not strongly host specific and mixed *Plasmodium* species infections also occur.

Diagnosis is by demonstration of intra-erythrocytic schizonts and gametocytes in blood smears.

3. Effect of introduction

The effect of infection in native parrots has not been determined. *Aedes* mosquitoes are endemic in New Zealand, giving some potential for disease to occur in unprotected aviaries in some regions. The disease is not likely to have adverse impact on trade, animal production and welfare or wildlife.

Consequence of entry score: minor

4. Risk of introduction

Risk of introduction score: moderately unlikely

5. Risk management—recommended safeguards

No specific safeguards required.

C. VIRAL DISEASES

Amazon tracheitis ★★★

1. Aetiology

Amazon tracheitis is caused by a herpesvirus and is not listed by the OIE.

2. The disease

The agent has a very limited host range with natural infections confined to Amazon parrots (*Amazona* spp.) and possibly also Bourke's parrot. Chickens and pheasants have been experimentally infected.

The incubation period is very short with clinical signs occurring within three to four days. Deaths may commence several days later after experimental infection.

The respiratory route is probably the main route of infection and infection spreads quickly through a flock. The disease range includes acute to chronic states with high mortality and high morbidity.

Signs in diseased birds include serous, mucoid or fibrinous to pseudomembranous rhinitis, pharyngitis, laryngitis and tracheitis. The disease is similar to infectious laryngo-tracheitis histopathologically and intra-nuclear inclusion bodies may be seen early in the course of the disease. Pharyngeal or laryngeal swabs are suitable for confirming a diagnosis (Ritchie et al. 1994).

3. Effect of introduction

The effect of the disease on indigenous parrots is not known but overseas experience has not implicated parakeets or introduced species of Australian parrots in the epidemiology of the disease. Given the endangered and threatened status of several New Zealand parrots, a conservative stance in regard to their susceptibility would seem justified. If introduced, the disease is likely to have a serious adverse impact on Amazon parrots in captivity and the international perceived high health status of parrots in New Zealand would be damaged.

Consequence of entry score: major to aviculture concerned with Amazon parrots. Unknown consequence to indigenous parrots, but must be treated as serious.

4. Risk of introduction

The commodity of particular concern would be *Amazona* parrots. Conditions in New Zealand would not favour spread of infection outside of aviculture and there are no high risk pathways for infection to spread to indigenous parrots in the wild.

Risk of introduction score: moderately likely for *Amazona* spp. in captivity but extremely unlikely for indigenous parrots in the wild.

5. Risk management—recommended safeguards

Safeguards would include:

- prohibit imports of *Amazona* spp. or confine imports of that species to flocks from countries or regions that can demonstrate freedom from the disease.
- Border controls for smuggling.

Consideration should be given to active surveillance and declaration of the disease as notifiable under the terms of the Biosecurity Act 1993.

Budgerigar herpesvirus (BHV) disease ⋆

1. Aetiology

Caused by a herpesvirus. It is not listed by the OIE.

2. The disease (Ritchie et al. 1994)

Budgerigar herpesvirus has a limited host range and is associated with decreased hatchability in budgerigars (*Melopsittacus undulatus*). A herpes-like virus was reported from a yellow-crowned Amazon parrot that died suddenly soon after exposure to budgerigars but there is no evidence that BHV causes disease in birds other than budgerigars. Infection can be transmitted vertically but information about other routes of transmission is lacking. The virus is related to the pigeon herpesvirus causing Inclusion Body Hepatitis in pigeons (Infectious Oesophagitis).

A recommended strategy for dealing with infected flocks is to interrupt breeding to allow hens to develop immunity, and perhaps provide some protection for chicks

For diagnosis, virus isolated in cell culture can be identified using antibodies in virus-neutralisation or immuno-diffusion tests.

3. Effect of introduction

Apart from some effect on reproduction in caged budgerigar flocks if introduced, the disease is not likely to have an adverse impact on other wildlife or affect trade.

Consequence of entry score: minor

4. Risk of introduction

The disease is moderately likely to be introduced with imports of budgerigars but is unlikely to establish in indigenous parrots because of poor pathways of transmission and the apparent very restricted host specificity of the virus.

Risk of introduction score: moderately unlikely

5. Risk management—recommended safeguards

No safeguards required.

Pacheco's disease ★★★

1. Aetiology

Pacheco's disease is caused by a herpesvirus. It is not listed by the OIE.

2. The disease (Snowdon 1995)

New Zealand's status with regard to Pacheco's disease is unclear. Avian herpesviruses were isolated from two separate parrot disease incidents (one in imported parrots) in the South Island in 1977 (Durham et al. 1977) in which the clinical and pathological findings strongly suggested Pacheco's disease. Unfortunately the diagnoses were not definitive and the only cases reported since that time were in quarantined parrots in 1997.

Although susceptibility appears to vary among different species of parrots, most are susceptible to infection. Disease has not been reported in parrots in the wild but there has been speculation that wild conures are unaffected carriers of the virus. The sulphur-crested cockatoo (*C. galerita*), the red-crowned parakeet (*C. novaezelandiae*) and a wide array of Australian parrots have been involved in outbreaks outside New Zealand and Australia. Apart from reports of the disease in parakeets, no information is available about the susceptibility of other New Zealand indigenous parrots, but the wide parrot host range strongly suggests that they could also be susceptible. The incubation period for natural infection is not known, nor is it known how well the agent survives outside a host.

Transmission is thought to occur horizontally via oral and respiratory routes with no evidence of vertical transmission. Morbidity and mortality can be high, depending on the species involved. Stress seems to act as a disease promoter and outbreaks commonly occur at the onset of the breeding season or following a change in environment.

The agent is capable of inducing systemic infections with high mortality, high morbidity and/or inapparent carrier states.

Diagnostic tests rely on isolation of virus from diseased organs in chick embryo tissue cultures and identification in serum neutralisation tests using antiserum specific for Pacheco's virus (Snowdon 1995). An indirect immuno-peroxidase test for the detection of virus in the liver and digestive tract of affected birds has also been described (Snowdon 1995).

3. Effect of introduction

If introduced, the disease is not likely to have an adverse impact on farm animal production but is likely to have a significant affect on susceptible species of parrots in aviculture and affect international trade in that commodity.

The disease is also likely to have an adverse impact on indigenous species if it became established in New Zealand since the susceptible host range is wide. Any disease transmission to and within New Zealand introduced and indigenous parrots in the wild is likely to be slow because of the fragmented and isolated characteristics of those populations. However, if the agent were introduced to populations of rare and endangered species, the impact could be very serious for local populations.

Consequence of entry score: moderate

4. Risk of introduction

Risk of introduction score: extremely likely

5. Risk management—recommended safeguards

Because there are no satisfactory tests for asymptomatic carriers, Psittaciformes should not be imported from countries that do not have robust surveillance programmes in place, or are unable to demonstrate regional or country freedom from the disease. Over 100 exotic psittacine birds imported into New Zealand in 1997 were destroyed when Pacheco's disease was diagnosed in birds dying in a private quarantine station.

Because the risk of illegal importation may be high, risk management should not only rely on border controls but should incorporate active surveillance for the disease in New Zealand aviculture.

The pros and cons of making Pacheco's disease notifiable in New Zealand under the terms of the Biosecurity Act 1993 should be explored[4].

A commercial vaccine is available, but there is evidence that it only protects against Psittacid Herpesvirus type 1 and not against type 2 infections (Magnino et al. 1996).

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[4] Pacheco's disease is a notifiable disease in Australia.

Inclusion body hepatitis in pigeons ★★

1. Aetiology

Inclusion body hepatitis in pigeons is caused by a herpesvirus, Columbid herpesvirus I. It is not listed by the OIE and has not been reported in New Zealand.

2. The disease (Ritchie et al. 1994)

The herpesvirus that causes inclusion body hepatitis in pigeons is distributed worldwide and exhibits between-strain variation in pathogenicity. The full host spectrum is uncertain but pigeons, budgerigars and cockatiels (*Nymphiscus hollandiscus*) (Wolff 1996) are known to be susceptible and falcons and owls might possibly also be susceptible. The disease attacks all ages of pigeons but young birds are the most susceptible. The upper respiratory tract is first affected with rhinitis, conjunctivitis and dyspnoea, progressing to more general signs of anorexia, polydipsia and diarrhea. Morbidity is typically 50% and mortality 10–15% with annual epidemics reported in some flocks. Transmission can occur pseudo-vertically and horizontally via contaminated feed and water and direct contact between mates.

No information is available about the susceptibility of free-living indigenous or introduced parrots in New Zealand or whether the disease can persist in wild populations. Similarly, no information is available about the susceptibility of other Columbidae in New Zealand but a conservative view is warranted, especially with regard to the common endemic New Zealand pigeon (*Hemiphaga novaeseelandiae*), kereru or kukupa on the North, South and Stewart Islands, and parea (*Hemiphaga chatamensis*) on the Chatham Islands.

Diagnosis is made on histopathology and presence of intranuclear eosinophilic and basophilic inclusion bodies in cells about lesions and virus isolation. The virus may be identified by immuno-diffusion techniques with strain differentiation by virus neutralisation, ELISA or electrophoresis.

3. Effect of introduction

If introduced, the disease is not likely to have an adverse impact on trade or farm animal production. Its effect in the wild and on New Zealand wildlife is uncertain but it does appear to have a restricted host range. The disease is likely to adversely affect domestic pigeon flocks and introduced Columbidae (Barbary dove *Streptopelia roseogrisea* and spotted dove *Strepopela chinensis*) if it can persist in wild populations. Feral pigeons (*Columbia livia*) are commonly distributed throughout both main islands. If feral pigeons became reservoir hosts, there would possibly be consequences for raptor species that prey on them. Any effect on the New Zealand falcon (*Falco novaeseelandiae*) might further compromise its already threatened status. Opportunity for the disease to infect endemic pigeons would hopefully be restricted by the different feeding pattern of New Zealand pigeons to those of introduced Columbidae and limited habitat overlap, although that is by no means certain. Shared habitats include farmlands, parks and gardens.

Consequence of entry score: moderate

4. Risk of introduction

Smuggling of racing pigeons into New Zealand is thought to occur, with risk of introduction by that means.

Risk of introduction score: moderately unlikely

5. Risk management—recommended safeguards

Safeguards would include:

- Restriction of imports of budgerigars and pigeons to source flocks that can demonstrate historical freedom from the disease.
- Use of susceptible species as sentinels during quarantine.
- Monitoring the disease status of pigeon flocks.
- Surveillance at rehabilitation facilities.

Avipoxviruses (poxviruses of parrots) ★★

1. Aetiology (Snowdon 1995)

Three poxviruses are known to cause disease in parrots: agapornis pox (lovebird pox), psittacine pox (Amazon pox) and budgerigar pox. They are not listed by the OIE although fowl pox, another avipoxvirus, is an OIE list B disease.

2. The disease (Snowdon 1995)

Most avipoxviruses are species-specific although experimental infections have been successful in a range of avian host species. Avipoxviruses are distributed worldwide but have not been reported in parrots in New Zealand and information is unclear about their occurrence in parrots in Australia. Avipoxviruses have been demonstrated in New Zealand in a wild wood pigeon (*Hemiphaga novaeseelandiae*), an oystercatcher (*Haemotopus leucocephalus*), in black robin, banded dotterel and New Zealand dotterel and in lesions in albatross chicks.

Psittacine pox is common in Amazon parrots (*Amazona* spp.) and macaws (*Ara* spp.) and causes devastating losses, particularly in blue-fronted Amazons (*Amazona aestiva*) and pionus parrots (*Pionus* spp.), with coryza and ocular lesions predominating.

Budgerigar pox does not produce cutaneous lesions or cause deaths in infected budgerigars.

Transmission is via biting arthropods such as mosquitoes or through wounds to the skin, particularly around the head. Latent poxvirus infections persist in chickens for long periods of time and vertical transmission may also occur in chickens but information about latency and vertical transmission is lacking for parrots.

Avipoxviruses are thus capable of inducing acute to chronic disease with high mortality, high morbidity and probably (on circumstantial evidence) establishment of latent infections.

A definitive diagnosis can be made by the histologic demonstration of Bollinger bodies in biopsy samples (Ritchie et al. 1994) and clinical and necropsy findings.

3. Effect of introduction

The relatively high species specificity shown by poxviruses suggests that an introduction is not likely to have an adverse effect on trade for farm animal production. If introduced, the parrot pox is likely to have an adverse impact on susceptible parrots in aviculture. The effect on indigenous parrots is unknown, but the relatively high specificity of viral strains suggests that birds other than parrots are unlikely to be affected.

Consequence of entry score: moderate

4. Risk of introduction

Commodities of particular concern would be African and Central and South American species of parrots, lovebirds and budgerigars. Introduction of pox viruses would be moderately likely for those varieties of parrots.

Risk of introduction score: moderately likely

5. Risk management—recommended safeguards

Safeguards would include:

- Restrict imports of parrot species in which infection has been demonstrated (Snowdon, 1995) to countries or regions that can demonstrate freedom from the disease. Prohibit imports of all parrots from Africa and Central and South America. Similar restrictions to apply to hatching eggs. Vaccination with Psittacine pox vaccine may be used to mitigate risk if the disease became established post-quarantine.

Consideration should be given to making Psittacine poxvirus notifiable to MAF in New Zealand[5].

[5] Psitticine poxvirus disease is notifiable to AQIS in Australia.

Avian polyomavirus (APV Budgerigar fledgling disease) ★★

1. Aetiology

Avian polyomavirus (APV) is caused by a polyomavirus. The disease is not listed by the OIE.

2. The disease (Ritchie et al. 1994, Phalen 1998)

Avian polyomavirus affects Fringillidae, Psittaciformes, Galliformes[6] and Passeriformes (Wolff, 1996) but APV strains affecting budgerigars may be different to strains affecting other species. There are differences between the clinical manifestations of APV in budgerigars in Europe, where a chronic form predominates, and in North America, where a more acute form with high mortality is common. These differences are thought to be due to strain variation within the APV polyomavirus (Ritchie et al. 1994).

The form of disease in budgerigars appears to depend on body condition and age at exposure to infection. In infected flocks, deaths may be sudden with mortality rates ranging from 30–100%. Survivors often exhibit feather abnormalities that are grossly indistinguishable from those produced by Psittacine Beak and Feather Disease (PBFD).

Manifestations in the larger psittacines range from peracute deaths to chronic disease with weight loss, anorexia, polyuria, concurrent infections, poor feather development and death.

Polyomavirus virions survive well in the environment and are resistant to many disinfectants. The disease is transmitted horizontally by the respiratory and oral routes and probably also vertically. Carrier states occur since sub-clinical infection is common. Outbreaks are common in budgerigar aviaries where breeding cycles are continuous and less common in aviaries with large Psittacines where breeding is less regular.

The disease has not been reported in parrots in New Zealand and there is no information available about the susceptibility of free-living introduced or indigenous parrots in New Zealand. Given the amount of trade in parrots and budgerigars in the past, in particular between New Zealand and Australia where it has been reported, it seems unlikely that the disease does not occur in avicultural settings in New Zealand.

To establish a diagnosis of APV, the disease has first to be differentiated from PBFD, with the realisation that concurrent infection of APV and PBFD may occur. Histologic findings of large clear basophilic or amphlophilic intranuclear inclusion bodies is considered suggestive. Viral specific DNA probes may be used on organ tissues collected at necropsy and on cloacal swabs in live birds. Serology may be used as a screening test (Phalen 1998).

3. Effect of introduction

If introduced the disease is likely to have an adverse impact on aviculture. Suggested controls for aviculturalists overseas include checking of introductions during quarantine to determine whether the bird is shedding polyomavirus. The effect on birds other than parrots is not known.

Consequence of entry score: moderate

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[6] Galliformes includes grouse, pheasant, quail, peafowl, partridge and any other of the 'fowl type' birds.

4. Risk of introduction

The disease does not appear to have established or become a serious disease in New Zealand. If that scenario is true and if the disease requires confinement and constant breeding cycles, as exhibited by budgerigars in captivity, then if introduced, it would probably be unlikely to pose a serious threat to indigenous parrots. However, a conservative stance is warranted in view of the limited information available about the effects of the disease in parrots native to New Zealand.

Risk of introduction score: moderately likely

5. Risk management—recommended safeguards

Safeguards would include:

- Pre- and post-entry quarantine checks of cloacal swabs with viral-specific DNA probes plus screening with serological tests.
- Prohibition of hatching eggs except from flocks that can demonstrate freedom from the disease.

Monitoring the health of parrots in aviculture would help to determine the true status of the disease in New Zealand.

More information about the behaviour of the disease in Australia with particular reference to free-living populations would be useful.

Fowl plague (FP, Highly pathogenic avian influenza, HPAI, Avian flu) ★★★★

1. Aetiology (Alexander 1995)

Avian influenza is caused by group A influenzaviruses belonging to the Orthomyxoviridae family. Highly pathogenic avian influenza is an OIE list A disease and is notifiable in New Zealand.

2. The disease

Avian influenza viruses (AIV) have been identified in apparently healthy wild ducks in New Zealand (Hooper et al. 1995) but HPAI has never been recorded here. AIV serotypes are distributed worldwide and have a very wide host spectrum that includes domestic ducks and poultry, migratory waterfowl and seabirds, passeriformes and psittacines. Only a few specific strains cause HPAI. Anatiformes are relatively resistant to AIV and are thought to be a natural reservoir host, with young birds becoming infected at water habitats contaminated by faeces from carrier birds. In Australia, avian influenza viruses have been isolated from a wide range of wild waterfowl species (some migratory) in well-separated locations throughout Australia. It is thought that there may be continual re-introduction of virus subtypes with the potential for a virulent strain to emerge at any time (Geering & Forman 1987).

HPAI causes serious losses of up to 100% in poultry, usually with per-acute deaths. All ages are susceptible, but older birds appear more so. Latent-infected and carrier birds occur and control of outbreaks is effected by slaughter of all affected and in-contact birds and quarantine. In Australia, outbreaks have occurred at the rate of 2 or 3 incidents per decade. It is somewhat surprising that the disease has not occurred in poultry in New Zealand. It is unclear whether this is due to chance or whether carrier birds do not occur in New Zealand for some reason.

The majority of viruses isolated from psittacines have H5- or H7-related haemaglutinnins. Mortality rates may reach 30% with virulent strains and affected birds show lethargy and central nervous system signs during a disease course of about two weeks. A range of parrot species are known to be susceptible to HPAI in captivity, including suphur-crested cockatoos, yellow-crowned Amazons, plum-headed parakeeets, rose-ringed parakeets and African grey parrots (Ritchie et al. 1994). No information is available about the susceptibility of indigenous New Zealand parrots, but given the known wide host range, they should be considered vulnerable.

The incubation period is very short (from a few hours to days), but for the purposes of the OIE code, the incubation period for HPAI is set at 21 days (Article 2.1.14.1), since the Code deals in maximum values, not typical ones.

Virus is shed in faeces and in respiratory aerosols and horizontal transmission is effected directly and indirectly by the oral and respiratory routes. The role of vertical transmission is not clear but eggs may act as mechanical carriers of the virus. Waterfowl have been implicated in the spread of the disease in recent outbreaks in Australia and large quantities of virus are excreted in the faeces of infected waterfowl. A wide range of species of migratory birds that visit New Zealand can carry AIV and annually migrate from countries where HPAI regularly occurs (Appendix 1).

The disease may be diagnosed by isolation and identification of the influenza virus strain.

3. Effect of introduction

If introduced, the disease is likely to have an adverse impact on trade, poultry production and birds in the wild.

Consequence of entry score: major

4. Risk of introduction

HPAI is moderately unlikely to be introduced via imports of birds but much more likely to enter via migratory birds, although past experience indicates that HPAI has never established in New Zealand. Unusual ecological conditions that encourage closer than usual contact between wild carriers and susceptible birds may be required for an epidemic to occur.

Risk of introduction score: moderately likely

5. Risk management—recommended safeguards

Smuggling and migration

The risk for HPAI is probably greatest through migratory birds carrying pathogenic strains coming into contact with native birds. If the relatively resistant native Anatiformes were to become infected through this means then the likelihood of HPAI infecting indigenous parrots would be increased. The likelihood of parrots being infected from waterfowl carrying HPAI would depend on the extent of habitat overlap between those species. For the most part it is fairly limited. Nevertheless, it is probably worthwhile taking migratory bird movements and Anatiformes habitats into consideration when deciding on new island sites for relocation of native endangered and threatened species.

There has been an irregular vagrant introduction of Anatiformes into New Zealand and some have probably carried non-pathogenic strains. However, apart from a multiple grey teal (*Anas gracilis*) introduction in 1957, most are single birds and the likelihood of their carrying pathogenic subtypes is probably low.

Risk management for HPAI depends to a large extent on surveillance of wild and domestic birds.

Import requirements

The OIE International Animal Health Code for mammals birds and bees (Anon. 1999) recommends standards for poultry that are readily adaptable to imports of psittacines, viz:

Part II. List A diseases OIE Chapter 2.1.14

HPAI free country

- A country may be considered free from HPAI when it has been shown that HPAI has not been present for at least the past three years.
- This period shall be six months after the occurrence of the last case for countries in which a stamping-out policy is practised, with or without vaccination against HPAI.

HPAI infected zone:

- An HPAI infected zone shall be considered as such until at least 21 days have elapsed after the last case has been reported and following the completion of a stamping-out policy and disinfection procedures, or six months after the clinical recovery or death of the last affected animal if a stamping-out policy is not practised.

The OIE code (Article 2.1.15.3) states that arrangements similar to those applying to Newcastle disease should apply for HPAI.

Article 2.1.15.4 for live birds from HPAI free countries:

When importing from HPAI free countries, Veterinary Administrations should require for birds the presentation of an international animal health certificate attesting that the birds:

- showed no clinical sign of HPAI on the day of shipment;
- were kept in a HPAI free country since they were hatched or for at least the past 21 days;
- have not been vaccinated against HPAI.

Article 2.1.15.5 for wild birds from HPAI free countries:

When importing from HPAI free countries, Veterinary Administrations should require for wild birds the presentation of an international animal health certificate attesting that the birds:

- showed no clinical sign of HPAI on the day of shipment;
- come from a HPAI free country;
- were kept in a quarantine station since capture and for at least the 21 days prior to shipment.

Article 2.1.15.6 live birds from countries considered infected with HPAI:

When importing from countries considered infected with HPAI, Veterinary Administrations should require for domestic birds the presentation of an international animal health certificate attesting that the birds:

- showed no clinical sign of HPAI on the day of shipment;
- come from an establishment which is regularly inspected by the Veterinary Authority;
- come from an establishment free from HPAI and not situated in a HPAI infected zone; or
- were kept in a quarantine station for the 21 days prior to shipment or since hatching and were subjected to a diagnostic test for HPAI with negative results;
- have not been vaccinated against HPAI.

Article 2.1.15.7 wild birds from countries considered infected with HPAI:

When importing from countries considered infected with HPAI, Veterinary Administrations should require for wild birds the presentation of an international animal health certificate attesting that the birds:

- showed no clinical sign of HPAI on the day of shipment;
- were kept in a quarantine station since capture and for at least the 21 days prior to shipment;
- were subjected to a diagnostic test for HPAI with negative results before entry into quarantine.

Article 2.1.15.10 hatching eggs from HPAI free countries:

When importing from HPAI free countries, Veterinary Administrations should require for hatching eggs:

- the presentation of an international animal health certificate attesting that the eggs come from establishments situated in a HPAI free country and which are regularly inspected by the Veterinary Authority.

Article 2.1.15.11 hatching egg from countries considered infected with HPAI:

When importing from *countries considered infected* with HPAI, Veterinary Administrations should require for hatching eggs the presentation of an international animal health certificate attesting that the hatching eggs:

- have been disinfected in accordance with the OIE standards referred to in Appendix 4.2.4.1;
- come from establishments which are regularly inspected by the Veterinary Authority;
- come from establishments free from HPAI and not situated in a HPAI infected zone;
- come from establishments in which birds were not vaccinated against HPAI.

Newcastle disease (PMV-1) and other Paramyxoviruses affecting parrots (PMV-2, PMV-3, PMV-5) ★★★★

1. Aetiology

Newcastle disease (ND) or avian pneumoencephalitis is caused by specific viruses of the avian paramyxovirus type 1 (PMV-1) and is an OIE List A disease. Newcastle disease is notifiable in New Zealand. Infection with PMV-1 can produce severe conjunctivitis in humans but recovery is usually uneventful.

The other Paramyxoviruses that affect parrots (PMV-2, PMV-3, and PMV-5) are collectively dealt with here since risk management methods are applicable to the full range of strains.

2. The disease

Newcastle disease virus (NDV) is the type strain for avian paramyxoviruses. There are nine serotypes (PMV-1 to PMV-9). Lentogenic strains of Newcastle Disease (ND) have been isolated from domestic fowls and wild duck and serological evidence indicates that PMV-4 and PMV-6 are endemic in New Zealand.

Horizontal transmission of ND probably occurs most commonly through direct and indirect contact with infected birds, faeces and secretions of affected birds. Airborne transmission may occur on occasions and movement of live birds and fomites are important risk factors for the spread of the disease among flocks. The roles of airborne spread and vertical transmission are controversial and not fully understood. Latent and carrier states occur in a range of avian host species. The incubation period varies from 5–6 days to up to 28 days. The OIE code (Article 2.1.15.1) considers the incubation period for ND to be 21 days for the purposes of the code. Vaccination is generally not recommended for control of exotic ND since it does not eliminate carrier states, but is widely used in countries where ND is endemic.

Survival of the agent is enhanced by a lipoprotein envelope but the virus shows heat lability that rapidly increases at temperature above 40 C.

The OIE Manual recommends diagnostic techniques for ND as follows:

- Isolation (9–11 day old chicken embryos) and identification of the virus (pathogenicity tests and monoclonal antibodies tests).
- Serological tests (haemagglutination inhibition test).

By virus strain: (Ritchie et al. 1994) (McFerran et al. 1993)

PMV-1 is generally distributed worldwide with the exception of some islands of Oceania. The host spectrum is particularly wide and includes hundreds of species from at least 27 orders. PMV-1 consists of ND and related strains that are serologically, molecular biologically and pathogenically unique. Isolates are divided based on their virulence and epidemiological importance (velogenic, mesogenic or lentogenic[7]).

Lentogenic strains of ND are endemic in poultry in New Zealand and Australia. Mortality is high in epidemics of velogenic and mesogenic strains in poultry and ND is a serious threat to the poultry industry in New Zealand and Australia.

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[7] Strains of NDV are conveniently grouped as velogenic, mesogenic or lentogenic based on chicken embryo at <60 hr, 60–90 hr, and >90 hr respectively after allantoic inoculation. These terms have come to be applied to high-virulence, moderate-virulence and low-virulence viruses.

The disease in poultry varies considerably depending on the virulence of the strain of the agent with velogenic strains usually producing peracute infections associated with sudden death and very high mortality rates, up to 100%. Clinical signs include depression, prostration, diarrhoea and nervous signs and a sudden cessation of egg laying in mature flocks. The mesogenic strains tend to produce respiratory disease and nervous signs with mortality up to 50%. Lentogenic strains produce mild to inapparent infections for the most part but may promote clinical disease under conditions of poor husbandry or concurrent disease.

Cockatiels and cockatoos are highly susceptible, Amazon parrots and conures less so, with macaws, lories and African grey parrots relatively resistant to ND. In Amazon parrots and conures, where the disease is less acute, neurological signs predominate. Infected parrots and cage birds were the principal source of infection in the USA pandemic of 1970–72. Migratory birds are commonly implicated as sources of infection in epidemics in poultry.

There is an obvious potential for disease to be introduced to New Zealand by birds migrating from countries where the disease is endemic or occurs occasionally (Appendix 1).

PMV-2 strains are endemic in Passeriformes and poultry in many countries and may cause serious disease in Psittaciformes, particularly in African grey parrots. PMV-2 has not been isolated in New Zealand. Both PMV-2 and PMV-3 have caused respiratory disease and egg production problems in turkeys. They have both been isolated from apparently healthy Psittaciformes in quarantine situations overseas.

PMV-3 causes a range of disease states depending on the host species infected and the virus strain. It has also been found in Passeriformes and may cause encephalitis in parrots. PMV-3 has not been isolated in New Zealand.

PMV-5. Budgerigars are considered the host species for PMV-5 (also known as the Kunitachi virus). It was associated with disease and mortalities in free-living Rainbow lories and budgerigars in the Gold Coast region of southern Queensland in 1974. PMV-5 strains cannot be isolated via all the same methods as other PMV strains (Ritchie et al. 1994).

3. Effect of introduction

The effect of an introduction would depend on the strain involved. If lentogenic strains were introduced, ND would be likely to have a major adverse impact on trade and animal production and welfare. If it became endemic in wildlife populations it would have the potential to cause further epidemics and vaccination may be required. PMV-1, PMV-2, PMV-3 and PMV-5 all have the potential to cause serious losses to aviculture.

Consequence of entry score: severe

4. Risk of introduction

Like avian influenza, ND is moderately likely to be introduced via imports of birds or via migratory birds. The risk associated with illegal importation via smuggling is high and is a major cause of concern to border protection agencies. Past experience indicates that ND has never established in New Zealand and unusual ecological conditions that encourage close contact between wild

carriers and susceptible birds may be required for an epidemic to occur. Lentogenic strains of ND have been isolated from domestic fowls and wild ducks and antibodies detected in poultry pheasants and pea fowl (Sabirovic et al. 1997).

Risk of introduction score: moderately likely

5. Risk management—recommended safeguards

The recommended safeguards set out in Part II Chapter 2.1.15. of the OIE Code (Anonymous, 1999) for PMV-1 are applicable to the strains and avian species under consideration here.

These are as follows:

Article 2.1.15.2 ND free country:

- A country may be considered free from ND when it has been shown that ND has not been present for at least the past three years.
- This period shall be six months after the occurrence of the last case for countries in which a stamping-out policy is practised with or without vaccination against ND.

ND infected zone:

- An ND-infected zone shall be considered as such until at least 21 days have elapsed after the last case has been reported and following the completion of a stamping-out policy and disinfection procedures, or six months after the clinical recovery or death of the last affected bird if a stamping-out policy is not practised.

Article 2.1.15.4 for live birds from ND free countries:

When importing from ND free countries, Veterinary Administrations should require for domestic birds the presentation of an international animal health certificate attesting that the birds:

- showed no clinical sign of ND on the day of shipment;
- were kept in a ND free country since they were hatched or for at least the past 21 days;
- have not been vaccinated against ND; or
- were vaccinated against ND using a vaccine complying with the OIE standards (the nature of the vaccine used and the date of vaccination shall also be stated in the certificate).

Article 2.1.15.5 for wild birds from ND free countries:

When importing from ND free countries, Veterinary Administrations should require: for wild birds the presentation of an international animal health certificate attesting that the birds:

- showed no clinical sign of ND on the day of shipment;
- come from an ND free country;
- were kept in a quarantine station since capture and for at least the 21 days prior to shipment.

Article 2.1.15.6 live birds from countries considered infected with ND:

When importing from countries considered infected with ND, Veterinary Administrations should require for domestic birds the presentation of an international animal health certificate attesting that the birds:

- showed no clinical sign of ND on the day of shipment;

- come from an establishment which is regularly inspected by the Veterinary Authority;
- come from an establishment free from ND and not situated in an ND-infected zone; or
- were kept in a quarantine station for the 21 days prior to shipment or since hatching and were subjected to a diagnostic test for ND with negative results;
- have not been vaccinated against ND; or
- were vaccinated against ND using a vaccine complying with the OIE standards (the nature of the vaccine used and the date of vaccination shall also be stated in the certificate).

Article 2.1.15.7 importing from countries considered infected with ND:
When importing from countries considered infected with ND, Veterinary Administrations should require for wild birds the presentation of an international animal health certificate attesting that the birds:

- showed no clinical sign of ND on the day of shipment;
- were kept in a quarantine station since capture and for at least the 21 days prior to shipment;
- were subjected to a diagnostic test for ND with negative results before entry into quarantine.

Article 2.1.15.10 hatching eggs from ND free countries:
When importing from ND free countries, Veterinary Administrations should require: for hatching eggs the presentation of an international animal health certificate attesting that the eggs come from establishments or hatcheries situated in a ND free country and which are regularly inspected by the Veterinary Authority:

Article 2.1.15.11 hatching eggs from countries considered infected with ND:
When importing from countries considered infected with ND, Veterinary Administrations should require: for hatching eggs the presentation of an international animal health certificate attesting that the hatching eggs:

- have been disinfected in accordance with the OIE standards referred to in Appendix 4.2.4.1;
- come from establishments or hatcheries which are regularly inspected by the Veterinary Authority;
- come from establishments or hatcheries free from ND and not situated in a ND infected zone;
- come from establishments or hatcheries in which birds were not vaccinated against ND; or
- come from establishments or hatcheries in which birds were vaccinated against ND (the nature of the vaccine used and the date of vaccination shall also be stated in the certificate).

Reovirus infection of parrots ★

1. Aetiology

Reovirus infection of parrots is caused by a reovirus. The disease is not listed by the OIE.

2. The disease (Ritchie et al. 1994, Snowdon 1995)

Reovirus associated disease has been mainly reported in parrots captured from the wild during or post-quarantine, suggesting that stress from captivity is a predisposing factor. The disease appears to be endemic in many European countries, Africa and South America. Disease had been reported in a wide range of parrot species but not in any free-living populations. Mortality rates can be very high with non-specific signs including emaciation, incoordination, laboured breathing and diarrhoea. Carrier states and latent infections are thought to occur.

Transmission is thought to be predominantly via the oral route through faeces with some contribution via the respiratory route early in the course of an outbreak. The role of vertical transmission is not clear but is thought to be possible since it occurs at a low rate in reovirus infections in chickens.

No outbreaks of disease have been reported in free-living populations of parrots.

Diagnosis is by isolation of the infective agent from faeces or tissues of infected birds. There is no effective treatment.

3. Effect of introduction

Introduction of the disease would have no effect on farm animal production and welfare or trade. The effect of the disease on free-living populations of parrots is unknown.

Consequence of entry score: minor

4. Risk of introduction

Risk of introduction score: moderately unlikely

5. Risk management—recommended safeguards

Safeguards would include:

- Prohibit imports of birds captured from the wild in countries where available evidence suggests that the disease is endemic.

Detection of clinical disease during quarantine would mean rejection of the total importation.

Internal papillomatous disease (IPD) ★★

1. Aetiology

Internal papillomatous disease has features that suggest it is an infectious disease but no agents have been identified. The disease is not listed by the OIE and has not been reported in New Zealand parrots.

2. The disease (Snowdon 1995, Ritchie et al. 1994, Roe 1997)

Internal papillomatous disease is associated with papillomatous lesions that may occur at numerous locations along the gastrointestinal tract of parrots with the highest prevalence at the transition between mucosa and cutaneous epithelium in the cloaca. The lesions may interfere with normal physiological activities such as breeding and may cause prolapses. However, in many cases no signs of dysfunction are seen.

Snowdon listed the species of parrots in which IPD has been reported (Snowdon 1995). It includes two species of Australian parrots (a budgerigar and a cockatiel) but the disease has not been reported in captive or wild psittacine populations in Australia or in wild populations elsewhere. Internal papillomatous disease has not been reported in any of the species of parrots found in the wild in New Zealand and their susceptibility to IPD is unknown. The disease appears to mainly affect macaws (*Ara* spp.) and Amazon parrots (*Amazona* spp.).

Diagnosis is made on the appearance of gross lesions and histopathology of biopsy or necropsy material. Lesions are often not clinically apparent and the induction period may be years long.

Since no infectious agent has been found for IPD, methods of transmission are unknown. However, close contact, possibly mucosal surface to mucosal surface, such as occurs with mutual preening, courtship, parenting or mating, is thought to be a risk factor (Macwhirter et al. 1997).

Control measures reported to have given satisfactory results have been described (Van der Heyden 1988). Control measures that have been successful in excluding IPD from avicultural collections overseas involved holding new birds in closed quarantine for a minimum of six months and then examining the birds' cloacas, under general anaesthesia, for the presence of papillomas. If no lesions were identified the birds were allowed to be introduced to the collection.

The dilemma faced by regulatory authorities was demonstrated recently when cloacal lesions resembling IPD were found in 1997 post-quarantine in Australia in two Green Winged Macaws (*Ara chloroptera*) imported in 1993 (Gallagher et al. 1997). Quarantine restrictions imposed at the time of diagnosis by the Australian Quarantine and Inspection Service (AQIS) were later lifted and responsibility for dealing with the condition was devolved to the aviculture industry and veterinarians.

2. Effect of introduction

If introduced the disease is not likely to have an adverse impact on farm animal trade but may affect international trade in psittacines. The disease appears to be restricted to psittacines and its effect on psittacines in the wild in New Zealand is uncertain. It has not been reported in free-living populations.

Consequence of entry score: moderate

3. Risk of introduction

The disease is extremely likely to be introduced in imports of macaws or Amazon parrots from countries where IPD occurs.

Risk of introduction score: extremely likely

4. Risk management—recommended safeguards

Given that the disease appears to have a long incubation period and may often be clinically inapparent, the most conservative approach would be to prohibit imports of parrot species known to be susceptible to the condition and restrict imports to countries that can give assurances of freedom from IPD.

A less restrictive approach would be to restrict imports of parrot species known to be susceptible to the condition to flocks that can give assurances acceptable to New Zealand regulatory authorities of freedom from the disease and historical evidence of no introductions for several years.

Special procedures would be needed to reduce the probability of exposure of at-risk species if the disease established in New Zealand. It would therefore be advisable to put in place a surveillance system for early detection of IPD. This process would require declaration by the Chief Veterinary Officer of IPD as a notifiable disease. It is recommended that DOC pursue this approach.

Psittacine proventricular dilatation syndrome (PPDS, Macaw wasting disease, neuropathic gastric dilatation, infiltrative splanchnic neuropathy, myenteric ganglioneuritis, proventricular and ventricular myositis) ★★★

1. Aetiology

Psittacine proventricular dilatation syndrome has features that suggest it is an infectious disease but no agents have been identified. The disease is not listed by the OIE and has not been reported in New Zealand parrots.

2. The disease (Ritchie et al. 1994, Snowdon 1995)

The disease is characterised by progressive weight loss and death. The condition affects birds of all ages but is most common in young birds. Clinical signs of depression and weight loss, vomiting and passing of undigested feed in the faeces are generally referable to some degree of intestinal malfunction. These manifestations are due to reduced peristalsis caused by the pathognomonic features of the disease, viz. destruction of the intramural ganglia of the proventriculus, ventriculus, and to a lesser extent, the descending loop of the duodenum (Ritchie et al. 1994).

The wide range of parrot species in which PPDS has been reported was listed by Snowdon (Snowdon 1995). Of that list, only the suphur-crested cockatoo occurs in the wild in New Zealand. The effect of the disease on indigenous and introduced species of parrots in New Zealand is unknown, but given the wide host range, it would be prudent to expect a high probability of occurrence and serious effects in those species if exposed.

Following its first description in South America, the disease spread to North America and Europe. It has also been reported post-quarantine in Australia in one of a consignment of 102 macaws in 1993 (Sullivan et al. 1997). The condition may have a long induction period.

A presumptive diagnosis may be made on clinical signs but a more definitive ante-mortem diagnosis requires histopathological examination of biopsies of the ventriculus, although the site of selection of the biopsy material affects the sensitivity of ante-mortem histopathology.

The condition appears to be specific to parrots and is most commonly seen in macaws, conures, African grey parrots and cockatoos. It has not been reported in wild populations of parrots.

3. Effect of introduction

If introduced, the disease is not likely to have an adverse impact on farm animal production but is likely to have an adverse affect on susceptible species of parrots in aviculture and affect international trade in that commodity.

Consequence of entry score: minor

4. Risk of introduction

The disease is considered to be extremely likely to be imported into New Zealand with shipments of susceptible species of parrots such as macaws and conures from countries where the disease is endemic.

Risk of introduction score: extremely likely

5. Risk management—recommended safeguards

The state of knowledge of PPDS and its epidemiology are similar to those same features of IPD and similar precautions are applicable. Given that the disease appears to have a long induction period and may be clinically inapparent, the most conservative approach would be to prohibit imports of parrot species known to be susceptible to the condition, or restrict imports to countries that can give assurances of freedom from PPDS.

A less restrictive but more risky approach would be to restrict imports of parrot species known to be susceptible to the condition to flocks that can give assurances acceptable to New Zealand regulatory authorities of freedom from the disease and historical evidence of no introductions for several years.

Special procedures would be needed to reduce the probability of exposure of at-risk species if the disease established in New Zealand. It would therefore be advisable to put in place a surveillance system for early detection of PPDS. Currently PPDS is classed as an exotic organism but that classification does not guarantee notification to or any response from authorities. That would require declaration by the Chief Veterinary Officer of PPDS as a notifiable disease. It is recommended that DOC pursue this approach.

3.12 SUMMARY OF RISK ANALYSIS FOR THREAT OF EXOTIC DISEASE TO INDIGENOUS PSITTACINES

Populations of concern

This analysis considered a list of known exotic diseases that could threaten the health of indigenous psittacines in New Zealand. The psittacine population of particular concern comprised four endemic and one native species located mostly in the wild but also in managed populations. The analysis applies equally well to the five species of introduced parrots that have established in the wild in New Zealand.

Routes of entry

Three major and one minor routes of entry were considered:

- Major routes:
  —legal importation of birds or eggs
  —illegal entry of birds or eggs via smuggling
  —natural entry via migratory birds
- Minor route:
  —through contact between people and indigenous birds

Commodities of concern

Only live birds or hatching eggs were considered as commodities of concern. Poultry meats and other poultry products were not considered since adequate controls are already in place.

Diseases of concern

Hazard refinement produced a list of 24 diseases for which there was evidence that the parrot species under consideration could be affected. Two serious diseases of parrots of uncertain aetiology—psittacine proventricular dilatation syndrome (PPDS) and internal papillomatous disease (IPD)—were included because of likely involvement of an infectious agent in their aetiology. Avian chlamydiosis and drug resistant strains of *M. tuberculosis* are not exotic to New Zealand but were included because they are reportable zoonoses to health authorities and notifiable to MAF.

3.12.1 Analysis constraints

The analysis revealed gaps in knowledge of the epidemiology of the diseases of concern, the nature and behaviour of managed and wild populations and the effects of disease in those populations. Assumptions based on first principles were sometimes necessary, particularly with regard to establishment and effect of disease in populations of concern.

The analysis identified gaps in knowledge in the following areas:

1. Establishment and effect of disease

a) Transmission pathways for likely spread of disease to parrot populations of concern.
b) Susceptibility to infection for diseases of concern.
c) Effect of infection on populations of concern.

d) Epidemiology of diseases of concern in free-living populations—persistence, spread etc.
e) Efficacy of diagnostic tests established primarily for other species.

2. Ecology and health of parrot species of concern

a) Geographic distribution and size.
b) Interaction and movement between sub-populations of particular species.
c) Level and type of contact between bird families.
d) Occurrence and effect of endemic diseases.
e) Special considerations for birds subject to artificial rearing practices.

3. Aviculture

a) Types of enterprises, their value and husbandry systems employed.
b) Census data for species.
c) Geographic distribution of enterprises.
d) Buying-in and replacement practices.
e) Systems of disease control and sanitary standards.
f) Efficacy and level of surveillance for infectious diseases within aviculture.
g) Demand for imports.
h) Trading practices and value of trade.
i) Links with smuggling.

4. Smuggling

a) Prevalence of smuggling.
b) Nature of smuggling operation—husbandry etc.
c) Destination of smuggled birds.
d) Species targeted for smuggling.

3.12.2 Risk management:

Risk management procedures are best considered separately for the three major and one minor routes of entry.

1. Importation by legal means

Reasonable and adequate safeguards could be proposed for most diseases. A range of conservative and highly restrictive measures were recommended for Amazon tracheitis (AT), Pacheco's disease, Inclusion body hepatitis of pigeons (IBH), Psittacine poxvirus (PPV), Avian polyomavirus (APV), Internal papillomatous disease (IPD) and Psittacine proventricular dilatation syndrome (PPDS). The susceptibility to infection and effect of infection for virtually all of these diseases on indigenous species is unknown.

Amazon tracheitis The known host range is very limited. Infection cannot be confidently detected in carrier states and the recommended strategy is to prohibit imports of *Amazon* spp., or confine imports of those species to flocks from countries or regions that can demonstrate freedom from the disease to the satisfaction of MAF regulatory authorities. The latter course of action would rule out North and South America and European countries but might include Australia where there is no evidence of disease occurrence. A further recommendation is to request the Chief Veterinary Officer to declare the disease notifiable (it is currently only classed as exotic) under the terms of the Biosecurity Act 1993.

Pacheco's disease The status of this disease in New Zealand should be investigated since there is some doubt as to whether it already occurs here. Unlike Amazon tracheitis, this disease has a wide host range and is known to affect parakeets and sulphur crested cockatoos. Similar recommendations for management as for Amazon tracheitis including notifiable status.

Inclusion body hepatitis of pigeons The host range of this disease is limited but includes some parrots, pigeons and raptors. The recommended strategy is to restrict imports of parrots and pigeons to source flocks that can demonstrate historical freedom from the disease and the use of susceptible species as sentinel birds during quarantine.

Psittacine poxvirus Most parrot species are susceptible to infection. The recommended management is to restrict imports of parrot species in which infection has been demonstrated to countries or regions that can demonstrate freedom from the disease. Imports of all parrots from Africa and Central and South America should be prohibited. Similar restrictions to apply to hatching eggs. Psittacine poxvirus is a notifiable disease in Australia and the same status in New Zealand is recommended.

Avian polyomavirus The status of this disease in New Zealand should be investigated since it seems odd that the disease has not been reported, especially since it occurs widely in Australia in aviculture and the wild. Otherwise, standard diagnostic tests applied during quarantine should be adequate to prevent entry of the agent. Importation of hatching eggs should be prohibited, except for flocks that can demonstrate freedom from the disease.

Internal papillomatous disease Similar restrictions as for Amazon tracheitis, including notifiable status.

Psittacine proventricular dilatation syndrome Similar restrictions as for Amazon tracheitis, including notifiable status.

Summary statement for management of legal importation

- Notifiable status is recommended for Amazon tracheitis, Pacheco's disease, Psittacine poxvirus, IPD and PPDS.
- Investigations to check the true status of disease occurrence of Pacheco's disease, APV and PBFD should be carried out.

Very few countries, apart from Australia, are likely to be able to comply with the criteria for imports for the diseases listed above.

2. Illegal entry of hatching eggs or live birds through smuggling

Priority should be given to obtaining more information about the prevalence and nature of smuggling operations and the level of integration and/or collusion between smuggling and established aviculture. Cross-checks of rumours circulating within the aviculture industry taken in conjunction with considered opinions of experienced police and border control personnel could be used to construct a description of the smuggling industry sufficiently accurate for control planning.

Smuggled hatching eggs pose less risk than smuggled live birds since disease agents can only be transmitted vertically or pseudo-vertically from outside contamination of the shell. Smuggling operations that only involve short-term

stopovers in New Zealand may carry relatively low risks of disease establishment. Important pieces of information needed are estimates of the degree of contact between illegal operations and established aviculture and the species of birds most commonly involved.

3. Disease entry via migratory birds

A better appreciation of the risk via migration and identification of high-risk disease entry sites could be developed from data on migratory bird population sizes, geographic distribution, times of arrival and extent of habitat sharing with resident New Zealand birds, if considered in conjunction with OIE disease reporting. Diseases with the greatest potential for harm are highly pathogenic avian influenza and pathogenic strains of paramyxoviruses. Both are subject to OIE reporting from participating countries, but are likely to be under-reported in some of the countries from which birds migrate to New Zealand.

Combining ecological data and disease reporting would enable a better appreciation of likely high-risk entry pathways and establishment sites, and allow priorities to be set for targeted surveillance in key locations. Surveillance is the only currently available risk management tool for risks from migration but integrated strategies could be developed for disease containment if a better appreciation of risk indicated that course of action.

4. Disease entry through contact between people and birds (minor route)

Risk of disease entry by this means is considered very low since the most likely route of infection for such scenarios is the oral route. The combined probabilities of a tourist carrying infected material and a bird then ingesting that material are considered to be extremely low. Nevertheless there are numerous contacts with people for at least one particular species—keas—and DOC should continue to discourage public feeding of birds at locations where they interact.

Although more relevant to spread of disease rather than risk of entry of exotic disease, some practices may increase the risk of disease transmission after entry. Feeding stations tend to encourage a mix of species and provide opportunities for disease transmission through direct and indirect contact between birds that normally avoid one another. Risk of disease should be taken into consideration at the design stage of procedures such as relocation and rehabilitation where the level of contact between humans and birds is likely to be abnormally high.

Part 4 Preliminary advice on appropriate risk management systems for indigenous species

4.1 BORDER CONTROLS AND POPULATION PROTECTION METHODS CURRENTLY APPLIED TO INDIGENOUS WILD POPULATIONS

Science-based border control protection methods are applied to legal importations of animals or animal products into New Zealand. Although import health requirements are, for the most part, designed for entry of domestic species, consideration is always given to the full range of animals, including native fauna, that could be placed at risk from exotic disease. There is no evidence to suggest that new diseases have been introduced to native species via legal importations, although lack of evidence should not be taken as evidence that procedures have been fully effective in that regard.

The risk analysis for indigenous psittacines illustrates the appropriateness of risk analysis for defining import conditions and quarantine requirements for protection of indigenous species from exotic disease. Once recommended risk management procedures for import of particular species have been prepared, as with the psittacines case study in this report, they can be fairly and openly presented for comment and modification. This transparent course of action is more acceptable to interested parties than the interim complete ban on parrot imports that currently applies.

No particular difficulties were encountered with the psittacine risk analysis that would suggest that risk analysis could not be applied equally well to evaluate the risk of exotic disease to other Orders or Families of native fauna. A method for prioritising the sequence for further native species risk analyses was suggested in Part 2.

All native species risk analyses are likely to present their own special problems, such as the effect the complex make-up of particular groups, e.g. passerines, may have on the construction of disease pathway diagrams. Lack of information about known disease conditions and their epidemiology, uncertainty about the full range of diseases to which they are susceptible and the possible consequence of particular diseases in native species will pose problems for all native species risk analyses.

4.2 RECOMMENDED RISK MANAGEMENT PROCEDURES

Risk management systems for indigenous species can be conveniently addressed by separate consideration of: (a) appropriate risk management procedures for the probability of agent entry into the country, and (b) probability of at risk-species exposure following entry.

For agent entry, risk analysis proposes quarantine requirements to reduce the risk of entry through legal channels to negligible levels and suggests ways of obtaining better insights into risks associated with illegal or uncontrolled entry of animals or commodities.

The four means of entry considered in the psittacine risk analysis were via legal imports, illegal imports (smuggling), migration and through contact between people and native fauna at sites in New Zealand. In that analysis, major roles were proposed for the first three routes and a minor role for the fourth route. In risk analyses conducted for other native fauna, the mix and relative importance of the various routes will vary depending on the particular group of native species under consideration. Legal and illegal imports will not be an issue for some groups, while migration, uncontrolled entry, and contact between people and native fauna will be more important for others.

4.2.1 Legal imports

Experience with the psittacine risk analysis indicated that risk analysis could be applied equally well to evaluate the risk of exotic disease to all other Orders or Families of native fauna. Massey University is currently well advanced in the development of a software product HandiRisk that can document both qualitative and quantitative risk analyses. This programme will be available in 1999 and could be useful as an ongoing tool for developing and maintaining currency of risk analyses for DOC. **It is recommended that risk analysis be used to devise risk management procedures for protection of indigenous species from exotic disease.**

4.2.2 Migration

The psittacine risk analysis highlighted the need for a measured response strategy to be developed for uncontrolled agent entry via normal migratory movements of birds. The risk of entry of serious diseases such as Newcastle disease or avian influenza by migratory birds is high and **it is recommended that DOC develops structured protocols that allow rapid investigation of sudden bird die-offs that could indicate entry of either of those diseases. As part of that process, consideration should be given to appropriate responses aimed at containing or eradicating disease agents in any such epidemic, and ensuring that national biosecurity is not compromised through exposure of disease agents to wider populations, including humans. The protocol should ensure biosecurity for other species and provide a standard structured approach equally applicable to epidemics in any Order of native fauna.**

Migratory species are highly predictable for countries of origin and stopover, time of arrival and locations during their stay in New Zealand. This data, if taken in conjunction with OIE disease reports for countries of origin and stopover, would give a better appreciation of risk of disease entry via migration and help to identify high-risk entry sites in New Zealand. Priorities to detect unusual disease occurrences could be set on the basis of presence and diversity of other bird populations at high-risk entry sites and the degree of contact between migrating and New Zealand-resident birds. **It is recommended that DOC assesses the risk of exotic disease entry via migratory birds and identifies high-risk entry sites associated with migration. The**

assessment should provide a standard approach applicable to identification of high-risk sites for other species of native fauna for which migration is an issue.

Routine broad-based serological surveillance is considered to be of lower priority at this stage. Its best application would be as part of investigations of disease outbreaks and perhaps at high-risk locations where there is an unnatural mix of species and genera such as occurs at tourist sites where native fauna are either displayed or occur naturally, as, for example, at Mount Bruce Wildlife Centre.

4.2.3 Smuggling

The psittacine risk analysis identified a need to obtain more information about the prevalence and nature of smuggling operations and the level of integration and / or collusion between smuggling and established aviculture. Crosschecks of rumours circulating within the aviculture industry taken in conjunction with considered opinions of experienced police and border control personnel could be used to construct a description of the smuggling industry sufficiently accurate for control planning. **It is recommended that DOC obtain information about the prevalence and nature of smuggling operations and the level of integration and/or collusion between smuggling and aviculture, and use that experience to extend those enquiries to other native species with links to illegal trade.**

Important pieces of information needed are estimates of the degree of contact between illegal operations and established enterprises and the species of fauna most commonly involved. Hazard identification for psittacine diseases suggested lower risk for smuggled hatching eggs than smuggled live birds, since disease agents associated with eggs can only be transmitted vertically, or pseudo-vertically from external contamination of the shell. Smuggling operations that are limited to short-term stopovers in New Zealand may carry relatively low risks of disease establishment.

4.2.4 Contact between people and fauna at high-risk contact sites

Risk of disease entry by this means is considered very low since the most likely route of infection for such scenarios is the oral route. The combined probabilities of a tourist carrying infected material and a bird then ingesting that material are considered to be extremely low. Nevertheless there are numerous contacts with people for at least one particular species—keas—and DOC should continue to discourage public feeding of birds at locations where birds and people interact. Routine examinations of sick or dead native fauna and in-contact species, plus serological surveillance, are the most effective methods for detecting disease entry at such locations. **It is recommended that DOC develops a standard protocol for disease surveillance and control at sites where people and native fauna interact.**

4.2.5 Exposure following entry

The potential for at-risk species to be exposed to disease agents is enhanced at managed population facilities where certain management procedures may increase the risk of disease. This was well illustrated in past years when *Salmonella pullorum* and *S. gallinarum* infections caused serious losses in poultry due to artificial incubation procedures producing favourable conditions

for dissemination of those diseases. Comparable development could occur in managed populations. Standard protocols already developed for farm animals such as pigs and poultry could be readily modified and adapted to address the needs for managed populations of native species. **It is recommended that standard structured disease security protocols be developed for managed populations of native species.**

4.2.6 Miscellaneous risk management recommendations

A recommendation that came from the psittacine risk analysis was that the advisability of having several specific diseases made notifiable under the Biosecurity Act 1993 should be explored with MAF. It is likely that risk analyses for other Orders of native fauna will recommend similar treatment for other diseases of particular concern in those Orders.

4.3 SUMMARY

Risk analysis is an appropriate tool for management of risk of introduction of exotic disease into indigenous fauna in New Zealand.

It is recommended that:

- a standard protocol be developed for investigation and containment of disease outbreaks at high-risk sites. Such sites should include remote areas such as offshore islands where migratory movements of birds are common. Locations such as tourist sites where there is abnormal mixing of native and introduced species and man are another category of high-risk sites.
- standard internal security protocols be developed to lessen the risk of disease entry at sites where native species are managed for reasons such as population recovery, rehabilitation and relocation.

Other important issues that require more detailed investigation listed in order of priority are:

- The nature and structure of fauna smuggling enterprises and the risks of introduction of exotic disease by that route.
- Migration and risk of exotic disease.
- The structure of industries involving native fauna or with links to native fauna such as aviculture, and their methods of disease control.
- Schedule exotic diseases identified by risk analyses as posing high risk for native fauna as notifiable organisms under the Biosecurity Act 1993.
- Endemic disease status of key species likely to be involved in disease transmission pathways in both aviculture and the wild. A review of the New Zealand wildlife mortality database held at Massey University would form part of this task.

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Appendix 1

Background risk—taken from Ratite Risk Analysis by Sabirovic et al. (1997)

INTRODUCTION

In any assessment of the risk of disease introduction and establishment the risks should be put into context by considering the risk of disease introduction through other channels.

1. CHANNELS FOR INTRODUCTION OF BIRDS AND AVIAN DISEASES

Two possible channels for introduction of avian diseases are migratory and smuggled birds.

1.1 Migratory birds

A number of bird species migrate to New Zealand on a regular basis (S. Bartle, M. Tenison, National Museum of New Zealand, pers. comm. 1996). Wild birds could carry a number of disease agents (e.g. *Salmonella* spp., *Mycoplasma* spp., ticks, *Cryptosporidium* spp., *Leucocytozoon* spp., avian malaria, Borna disease, coronaviral enteritis, Eastern and Western equine encephalomyelitides. highly pathogenic avian influenza, Newcastle disease (PMV-1) and other paramyxoviruses (PMV-2 to PMV-9), infectious bursal disease, Wesselsbron disease, etc.

The risk of introduction of diseases by migratory birds is difficult to estimate. However, the following factors need to be considered:

1.1.1 Seabirds

Around 60 species arrive annually from the North and South Pacific in approximately the following numbers:

- 100 000 000 migratory birds that breed on islands around New Zealand and migrate to North America and, to a lesser extent, to South America;
- 100 000 birds that migrate to New Zealand from the west coast of South America (Chile);
- 50 000 birds that migrate to New Zealand from the east coast of South America (Argentina);
- There is a small interchange of tropical seabirds from the Seychelles.

Strains of Newcastle disease, highly pathogenic avian influenza and infectious bursal disease are present in these countries.

1.1.2 *Shorebirds*

Approximately 500 000 of 25 species of shorebirds migrate annually from their breeding grounds in Siberia. On the way to New Zealand they usually have 3–4 stops along the Western Pacific coast and Australia. These migratory birds may have contact with local birds and can form 'mixed flocks'.

1.1.3 *Landbirds*

Two species of cuckoo (shining and long-tailed) migrate to New Zealand on an annual basis. Both species breed here, during which time they have close contact with indigenous passerine species. Shining cuckoos migrate between New Zealand and Papua New Guinea, while longtailed cuckoos migrate to Polynesia (mainly Fiji). It is estimated that from 100 000 to 1 000 000 of these birds migrate annually.

There are 5–6 species of New Zealand birds that migrate to Australia on a regular basis. Some birds from Australia also come here on a regular basis. For instance, all young gannets spend about 3–4 years in Australia before returning to New Zealand.

It could take several weeks for birds from Siberia, North and South Pacific to arrive in New Zealand or just a few days to come from Papua New Guinea, Australia and Polynesia.

Worldwide, the viruses most commonly isolated from wild and migratory birds are avian influenza and Newcastle disease. However, isolation of these viruses from waterfowl, especially migratory birds, varies considerably. The factors that affect isolation rate are the age of the bird, geographical location relative to migration, time of the year, species of waterfowl and characteristics of particular viruses (D. Alexander, Central Veterinary Laboratory, Weybridge, UK, pers. comm. 1997).

Any potential background risk will also be affected by the extent of effective contact between native populations and migratory birds. Shorebirds that come to New Zealand on a regular basis from Siberia could pose a risk of introducing diseases because of their regular contact with waste-water originating from duck farms in China. Newcastle disease, highly pathogenic avian influenza and infectious bursal disease are present in China, and infectious bursal disease occurs in Australia. Outbreaks of highly pathogenic avian influenza have also been reported in Australia, apparently associated with migratory water birds.

Table A1.1 outlines which birds are recorded as arriving here and some of the diseases to which are known to be susceptible. Information is from Barrie & Robertson 1996; and World Animal Health in 1996, Part 2.

TABLE A1.1. BIRDS ARRIVING IN NEW ZEALAND AND SOME OF THE DISEASES TO WHICH THEY ARE KNOWN TO BE SUSCEPTIBLE.

SPECIES OF BIRD	ORIGIN OF BIRD	DISEASES OF CONCERN
Hoary-headed grebe	Australia	Avian influenza
Buller's shearwater	Pacific Ocean from Japan to west coast North America, Peru and Chile.	Avian influenza, infectious bursal disease
Flesh-footed shearwater	North Pacific Ocean, mainly cast coast Korea and Japan. Some birds winter off western North America.	Avian influenza, infectious bursal disease

SPECIES OF BIRD	ORIGIN OF BIRD	DISEASES OF CONCERN
Fluttering shearwater	Australia. Stragglers reported in New Caledonia and Vanuatu.	Avian influenza, infectious bursal disease
Hutton's shearwater	Australia	Avian influenza, infectious bursal disease
Short-tailed shearwater	Australia. Migrate to north Pacific, commonly pass through New Zealand waters.	Avian influenza, infectious bursal disease
Sooty shearwater	Japan and west coast of North America and Alaska.	Avian influenza, infectious bursal disease
Adelie penguin	Circumpolar Antarctica	Infectious bursal disease, Newcastle disease
Chinstrap penguin	Circumpolar Antarctica	Newcastle disease
Emperor penguin	Circumpolar Antarctica	Infectious bursal disease, Newcastle disease.
Gentoo penguin	Circumpolar subantarctic and Antarctica.	Newcastle disease
King penguin	Circumpolar subantarctic	Newcastle disease
Macaroni penguin	Antarctica and subantarctic (south Atlantic / Indian Oceans).	Newcastle disease
Australasian gannet	Australia	Newcastle disease
Nankeen night heron	Australia	Avian influenza, Newcastle disease
White heron	Australia	Avian influenza, Newcastle disease
Australian wood duck	Australia	Avian influenza, duck hepatitis. infectious bursal disease, Newcastle disease, *Salmonella gallinarum, Salmonella pullorum*.
Grass whistling duck	Australia	Avian influenza, duck hepatitis. infectious bursal disease, Newcastle disease, *Salmonella gallinarum, Salmonella pullorum*.
Mallard duck	Australia	Avian influenza, duck hepatitis, infectious bursal disease, Newcastle disease, paramyxovirus 2, *Salmonella gallinarum. Salmonella pullorum*.
White-eyed duck	Australia	Avian influenza, duck hepatitis. infectious bursal disease, Newcastle disease, *Salmonella gallinarum, Salmonella pullorum*.
Chestnut teal	Australia	Avian influenza, duck hepatitis. infectious bursal disease, Newcastle disease, *Salmonella gallinarum, Salmonella pullorum*.
Grey teal	Australia	Avian influenza, duck hepatitis. infectious bursal disease, Newcastle disease, *Salmonella gallinarum, Salmonella pullorum*.
Northern shoveller	Europe, Asia and western North America. Migrate to southern Europe, Africa, central Asia, central America and are vagrants to Australasia.	Avian influenza, duck hepatitis. infectious bursal disease, Newcastle disease, *Salmonella gallinarum, Salmonella pullorum*.
Black kite	Australia	Newcastle disease
Black falcon	Australia	Newcastle disease

SPECIES OF BIRD	ORIGINOF BIRD	DISEASES OF CONCERN
Nankeen kestrel	Australia	Newcastle disease
Australian coot	Australia	Paramyxovirus 2
Cattle egret	Australia	Avian spirochaetosis, paramyxovirus 2
Intermediate egret	Australia	Avian spirochaetosis
Little egret	Australia	Avian spirochaetosis
Baird's sandpiper	Siberia, Alaska, Canada and Greenland. Migrate to South America. Rare vagrants to New Zealand.	Avian influenza
Broad-billed sandpiper	Arctic Eurasia (Scandinavia, Siberia). Migrate to Southeast Asia. Rare migrants to New Zealand.	Avian influenza
Common sandpiper	Eurasia (United Kingdom, Spain to Japan). A few reach New Zealand.	Avian influenza
Curlew sandpiper	Arctic Siberia. Winter in Africa, Asia and Australasia.	Avian influenza
Least sandpiper	Alaska, Canada. Migrate to United States, Caribbean, Central / South America. A few reach New Zealand.	Avian influenza
Marsh sandpiper	Eastern Europe, central Asia to Mongolia. Uncommon migrant to New Zealand.	Avian influenza
Pectoral sandpiper	Siberia, Alaska, Canada. Migrate to South America via United States, Mexico. A few migrate to Australasia.	Avian influenza
Sharp-tailed sandpiper	Siberia	Avian influenza
Terek sandpiper	Eurasia (Finland, Siberia).	Avian influenza
Upland sandpiper	North America. Migrate to South America (Brazil, Argentina. Chile). Rare vagrant to New Zealand.	Avian influenza
Western sandpiper	Arctic North America (Alaska) and Siberia. Migrate to South America. Rare vagrants to New Zealand.	Avian influenza
White-rumped sandpiper	Arctic North America (Alaska, Canada). Migrate to South America. Rare vagrants to Australasia.	Avian influenza
Turnstone	Arctic (Greenland, Scandinavia, Siberia, Alaska and northern Canada).	Avian influenza
Sanderling	Arctic (Greenland, Siberia).	Avian influenza
Arctic tern	Arctic (Greenland, north Europe, Siberia, North America). Migrate to southern oceans. A few seen in New Zealand on their way to and from Arctic waters.	Avian influenza
Common tern	Subarctic (North America, Europe, Asia). Migrate to Avian influenza temperate oceans, a few reach NZ.	Avian influenza
Crested tern	South Pacific, Australia.	Avian influenza
Gull-billed tern	Tropics and subtropics, including Australia.	Avian influenza
Little tern	North America, Africa, Europe, Asia (Japan, Korea, China, Taiwan), Australia. Uncommon migrant to New Zealand.	Avian influenza
Whiskered tern	Europe, Asia, Australia. The few birds that reach New Zealand are thought to come from	Avian influenza

SPECIES OF BIRD	ORIGINOF BIRD	DISEASES OF CONCERN
White-fronted tern	Australia	Avian influenza
White-winged black tern	East Europe, Siberia, China, Mongolia, east Africa.	Avian influenza
Channel-billed cuckoo	Australia. Winters Indonesia, Papua New Guinea, Bismarck Archipelago. Rare visitor to New Zealand.	Newcastle disease
Fan-tailed cuckoo	Australia, Papua New Guinea, Solomon Islands, Vanuatu, New Caledonia and Fiji. Rare vagrants to New Zealand.	Newcastle disease
Long-tailed cuckoo	Pacific Islands, birds may pass through east Australia. Australia. Winters northern Australia, Papua New Guinea and Indonesia. A few reach New Zealand.	Newcastle disease
Pallid cuckoo	Australia. Winters northern Australia, Papua New Guinea and Indonesia. A few reach New Zealand	Newcastle disease
Oriental cuckoo	Asia. Migrate from southern India to Philippines, Papua New Guinea, Solomon Islands, Indonesia, Australia and New Zealand.	Newcastle disease
Shining cuckoo	Indonesia, Papua New Guinea, Solomon Islands and Bismark Archipelago. Many birds believed to migrate through eastern Australia to or from wintering grounds.	Newcastle disease
Barn owl	Australia	Newcastle disease
Australian tree martin	Australia	Newcastle disease
Fairy martin	Australia	Newcastle disease
Fork-tailed swift	Eastern Asia (Siberia, Korea, Japan, Taiwan, Burma, Himalayas). Migrate via China, Philippines to Australia and Papua New Guinea. A few reach New Zealand.	Newcastle disease
Spine-tailed swift	Eastern Asia (Siberia, Korea, Japan, Taiwan, Burma, Himalayas). Migrate via China, Philippines to Australia and Papua New Guinea. A few reach New Zealand.	Newcastle disease

Table A1.2 outlines countries or regions of origin of birds arriving naturally here and some of the diseases of concern which are present in these countries/ regions. Information is from Barrie & Robertson 1996; and World Animal Health in 1996, Part 2.

1.2 Smuggled birds

It has been estimated that the total worldwide legal trade in wild birds is between 2 and 5 million birds each year, and the total illegal trade at a minimum of tens of thousands of birds per year (Hoiden 1997). In general, wild parrots are considered to be the birds most commonly taken from the wild for commercial markets. Many die before, during, and after export, although actual figures are difficult to obtain. Parrots may be infected with avian influenza, Newcastle disease and some other paramyxoviruses.

TABLE A1.2. COUNTRIES/REGIONS OF ORIGIN OF BIRDS ARRIVING NATURALLY IN NEW ZEALAND AND THE DISEASES OF CONCERN WHICH ARE PRESENT.

COUNTRIES/REGIONS OF ORIGIN	DISEASE STATUS
Africa	Newcastle disease, highly pathogenic avian influenza, infectious bursal disease, *Salmonella gallinarum, Salmonella pullorum* present.
Antarctica	Infectious bursal disease present.
Argentina	Newcastle disease, infectious bursal disease, *Salmonella gallinarum, Salmonella pullorum* present.
Asia	Newcastle disease, highly pathogenic avian influenza, infectious bursal disease, duck hepatitis, *Salmonella gallinarum. Salmonella pullorum* present.
Australia	Highly pathogenic avian influenza occurred in 1994, infectious bursal disease and *Salmonella pullorum* present.
Brazil	Newcastle disease, infectious bursal disease, *Salmonella gallinarum, Salmonella pullorum* present.
Canada	Infectious bursal disease present.
Chile	Infectious bursal disease present.
China	Newcastle disease, highly pathogenic avian influenza, infectious bursal disease, duck hepatitis, *Salmonella pullorum* present.
Europe	Newcastle disease, infectious bursal disease, duck hepatitis, *Salmonella gallinarum, Salmonella pullorum* present.
Fiji	Infectious bursal disease present.
India	Newcastle disease, infectious bursal disease, duck hepatitis, *Salmonella gallinarum, Salmonella pullorum* present.
Indonesia	Newcastle disease, infectious bursal disease present.
Japan	Newcastle disease and infectious bursal disease present.
Korea	Newcastle disease, infectious bursal disease, *Salmonella pullorum* present.
Mexico	Highly pathogenic avian influenza, infectious bursal disease, *Salmonella gallinarum* present.
New Caledonia	Infectious bursal disease present.
Papua New Guinea	Infectious bursal disease present.
Philippines	Newcastle disease. infectious bursal disease, *Salmonella gallinarum, Salmonella pullorum* present.
Scandinavia	Newcastle disease, infectious bursal disease, duck hepatitis, *Salmonella pullorum* present.
Siberia	Newcastle disease, infectious bursal disease, *Salmonella pullorum* present.
South America	Newcastle disease, highly pathogenic avian influenza, infectious bursal disease, *Salmonella gallinarum. Salmonella pullorum* present.
United States of America	Mesogenic strains of Newcastle disease, infectious bursal disease, duck hepatitis, *Salmonella pullorum* present. Highly pathogenic avian influenza occurred in 1997.
Vanuatu	Infectious bursal disease present.

There has been a steady stream of exotic CITES (Convention on International Trade in Endangered Species) listed birds intercepted at the border as their carriers attempts to smuggle them into New Zealand, primarily from Australia. Smuggling is facilitated by the close proximity of the two countries and methods includes light plane and body packing of eggs. The incentive lies in the very high prices that Australian native birds attract on the international market. Birds from Australia could possibly be infected with Pacheco's disease, other strains of avian influenza, and some paramyxoviruses.

There is growing body of evidence of smuggling of racing pigeons and show pigeons into New Zealand from North America and the UK via the mail system and body packing (F. Sheehan, MAF Enforcement Unit, Auckland; pers. comm. to S. MacDiarmid, 1997). Pigeons have been shown to spread Newcastle disease and may be also infected with some other diseases (avian influenza, other paramyxoviruses, herpesviruses).

Although smuggled birds are no more likely than legally imported birds to have effective contact with local birds, the risk they pose must be considered greater because of their unknown disease status.

When considering the disease risks posed by proposed imports decisions have to take into account the fact that 'zero risk' is unattainable, that an unquantifiable background risk always exists, and that risk management measures should not attempt to impose on trade a threshold of risk lower than what occurs from the natural movement of birds. The risks posed by illegal trade must also be recognised as part of the reality against which a proposed importation must be considered.

2. DISEASE INTRODUCTIONS WITH BIRD MOVEMENTS

Many diseases have been spread when domesticated or non-domesticated birds are moved from one locality to another. Theoretically, pathogens might establish themselves in released wild birds or spread from them to other species. There are very few substantiated accounts of disease problems associated with translocation or releases of wild birds. A study of the subject has been confined to Hawaii, Mauritius and a few other locations. Although such research has added weight to the thesis that infectious diseases may contribute to a decline in free-living populations, dissemination of organisms by released birds has generally not been confirmed. The paucity of sound data on this subject is probably attributable to the failure to adequately monitor disease in birds prior to and following release (Cooper 1993).

3. PLANNED INTRODUCTION AND RELEASE OF BIRDS

New Zealand's membership of the World Trade Organisation requires that international standards (International Animal Health Code, 1992) be used as the basis for developing specific safeguards wherever possible. Where such

standards do not exist, the safeguards developed should be technically sound and as least restrictive as possible.

The safeguards considered in this risk analysis are based on the international standards, either individually or in combination, and are as follows:

a) Certification/verification of country freedom for specific disease

For diseases not on the OIE List A or List B there is no internationally accepted basis for certification/verification of country freedom.

b) The official flock of origin disease status, testing, treatment and/or vaccination history

For diseases not on the OIE List A or List B there is no internationally recognised basis for certification/verification of the official flock of origin disease status, testing, treatment and/or vaccination history.

c) Season/time of the year to avoid vector activity

The risk of introduction of some diseases (primarily insect borne) could be reduced by importing commodities during a season when insect activity is significantly reduced (late autumn, winter, early spring). However, this has to be assessed on a country to country basis.

d) Pre-export/post arrival quarantine requirements (disease status, testing or treatment requirements, sampling strategy, sentinel animals/birds)

Where applicable these are standard options available as specified by the OIE. Where there is no OIE standard, a range of options considered acceptable to New Zealand are offered.

4. REFERENCES

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World Animal Health in 1996. Part 2. Tables on the animal health status and disease control measures. Office International des Epizooties, 1996.

Appendix 2

A LIST OF DISEASES THAT HAVE BEEN REPORTED IN ALL AVIAN SPECIES

DISEASE NAME	GENUS	SPECIES
Actinobacillosis	*Actinobacillus*	spp.
Aegyptianellosis	*Aegyptianella*	spp.
Aerobacteriosis	*Aerobacter*	spp.
Anthrax	*Bacillus*	*anthracis*
Avian chlamydiosis	*Chlamydia*	*psittaci*
Avian pseudotuberculosis	*Yersinia*	*pseudotuberculosis*
Avian spirochaetosis	*Borrelia*	*anserina*
Avian tuberculosis	*Mycobacterium*	*avium*
Bacteroidosis	*Bacteroides*	*fragilis*
Botulism	*Clostridium*	*botulinum*
Brucellosis	*Brucella*	spp.
Bumblefoot	*Staphylococcus*	*aureus*
Campylobacteriosis	*Campylobacter*	*jejuni*
Citrobacteriosis	*Citrobacter*	spp.
Clostridial infections	*Clostridium*	various spp. (*colinum* for ulcerative enteritis)
Colisepticaemia	*Escherichia*	*coli*
Corynebacteriosis	*Corynebacterium*	*pyogenes*
Flavobacteriosis	*Flavobacterium*	spp.
Fowl cholera	*Pasteurella*	*multocida*
Gangrenous dermatitis	*Clostridium*	*septicum*
Goose venereal disease	*NeisserialMycoplasma*	spp.
Heartwater	*Cowdria*	*ruminantium*
Infectious coryza	*Haemophilus*	*paragallinarum*
Intracellular infection in ducks	*Haematoproteus*	spp.
Klebsiellosis	*Klebsiella*	spp.
Listeriosis	*Listeria*	*monocytogenes*
Liver granulomas	*Eubacterium*	*tortuosum*
Megabacteriosis	*Megabacterium*	spp.
Moraxella infection	*Moraxella*	spp.
Mycoplasmosis	*Mycoplasma*	*gall1isepticum/synoviae/meleagridis*
Mycoplasmosis (M. iowae)	*Mycoplasma*	*iowae*
Nocardiosis	*Nocardia*	spp.
Ornithobacterium rhinotracheale infection	*Ornithobacterium*	*rhinotracheale*
Pasteurella anatipestifer infection	*Pasteurella*	*anatipestifer*
Proteus infection	*Proteus*	*vulgaris*
Pseudomonas infection	*Pseudomonas*	*aeruginosa*

DISEASE NAME	GENUS	SPECIES
Q fever	*Coxiella*	*burnetti*
Salmonella arizonae	*Salmonella*	*arizonae*
Salmonella enteritidis phage 4	*Salmonella*	*enteritidis*
Salmonella gallinarum infection	*Salmonella*	*gallinarum*
Salmonella pullorum infection	*Salmonella*	*pullorum*
Shigella infection	*Shigella*	*boydii*
Streptobacillus infection	*Streptobacillus*	*moniliformis*
Streptococcosis	*Streptococcus*	*various spp.*
Swine erysipelas	*Erysipelothrix*	*rhusiopathiae*
Tuberculosis (resistant strains)	*Mycobacterium*	*tuberculosis*
Tuberculosis (susceptible)	*Mycobacterium*	*tuberculosis* and *bovis*
Tularaemia	*Francisella*	*tularensis*
Turkey coryza	*Bordetella*	*avium*
Vibrio infection	*Vibrio*	*Non-01 cholerae*
Aspergillosis	*Aspergillus*	*furnigatus*
Candidiasis	*Candida*	*albicans*
Cryptococcosis	*Cryptococcus*	*neoformans*
Fungal dermatitis	*Trychophyton*	spp.
Histoplasmosis	*Histoplasma*	*capsulatum*
Zygomycosis	*Absidia/Rhizopus/Mucor*	spp.
Amoebiasis	*Amoeba*	spp.
Argasidae	*Argas*	various spp.
Ascarids		
Atoxoplasmosis	*Atoxoplasma*	spp.
Balantidiasis	*Balantidium*	spp.
Capillariasis	*Capillaria*	spp.
Coccidiosis	*Coccidia*	spp.
Cryptosporidium infections	*Cryptosporidium*	spp.
Filariae	*Filariae*	various spp.
Fowl mites	Mites	various spp.
Free-flying biting insects	Biting insects	various spp.
Giardia infection	*Giardia*	spp.
Haemoproteus infection	*Haemoproteus*	spp.
Heterakiasis	*Heterakis*	spp.
Hexamita	*Hexamita*	spp.
Hipoboscid flies	Flies	various spp.
Histomoniasis	*Histomonas*	*meleagridis*
Ixodidae	*Ixodes*	various spp.
Leucocytozoonosis	*Leucocytoozon*	spp.
Libyostrongylus infestation	*Libyostrongylus*	various spp.
Lice	Lice	various spp.
Plasmodium spp. Infections	*Plasmodium*	various spp.

DISEASE NAME	GENUS	SPECIES
Sarcosporidiosis	*Sarcocystis*	spp.
Syngarnosis	*Syngamus*	*trachea*
Tapeworms and flukes		
Toxoplasmosis	*Toxoplasma*	*gondii*
Trichinella pseudospiralis	*Trichinella*	*pseudosporalis*
Trichomoniasis	*Trichomonas*	spp.
Trypanosoma infection	*Trypanosoma*	spp.
Verminous encephalitis	*Baylisascaris*	spp.
Adenovirus infections of ostriches	Adenovirus	unclassified
Adenovirus type I	Adenovirus	Adeno 1 group
Alfuy virus	Flavivirus	
Amazon tracheitis	Herpesvirus	
Astrovirus infection of turkeys	Astrovirus	
Astroviruses in ducks	Astrovirus	
Aujeszky's disease	Herpesvirus	SVH 1
Avian encephalomyelitis	Picomavirus	various strains
Avian infectious bronchitis (endemic strains)	Coronavirus	various strains
Avian infectious bronchitis (exotic strains)	Coronavirus	various strains
Avian infectious laryngotracheitis	Herpesvirus	various strains
Avian leucosis	Retrovirus	various strains
Avian nephritis virus infection	Picornavirus	Avian nephritis vir.
Avipoxviruses	Poxviruses	
Big liver and spleen disease	Virus?	Unclassified
Borna disease	Virus	Unclassified
Bovine ephemeral fever virus	Rhabdovirus	
Budgerigar fledgling disease	Polyomavirus	
Budgerigar herpesvirus	Herpesvirus	
Bunyavirus infections	Bunyavirus	
Cabassou virus	Alphavirus	
Cacipacore virus	Flavivirus	
Chickungunya virus	Alphavirus	
Cholangio-hepatitis virus infection	Flavivirus?	not yet identified
Coronaviral enteritis	Coronavirus	
Crimean-Congo haemorrhagic fever	Nairovirus	
Derzsy's disease of geese	Parvovirus	GVP type 1
Duck hepatitis	Picomavirus	
Duck hepatitis B virus	Avihepadnavirus	
Duck virus enteritis	Herpesvirus	Alphaherpesvirus
Egg drop syndrome	Adenovirus	Group II (EDS 76)
Encephalopathy	Prions	
Equine encephalomyelitis (Eastern and Western)	Alphavirus	

DISEASE NAME	GENUS	SPECIES
Flanders virus	Rhabdovirus	
Fort Morgan virus	Alphavirus	
Fowl plague	Influenza	H5 and H7
Haemorrhagic nephritis and enteritis of geese	?	Unclassified
Hantavirus infections	Hantavirus	
Hart Park virus	Rhabdovirus	
Heron hepatitis B virus	Avihepadnavirus	
Highlands J virus	Alphavirus	
Hypr virus	Flavivirus	
Ilheus virus	1	Flavivirus
Inclusion body hepatitis	Adenovirus	Group I
Inclusion body hepatitis in pigeons	Herpesvirus	pigeon herpesvirus 1
Infectious anemia	Circovirus	
Infectious bursal disease (exotic strains)	Birnavirus	
Infectious bursal disease (low pathogen strains)	Birnavirus	
Internal papillomatous disease	?	?
Japanese encephalitis virus	Flavivirus	
Kumlinge virus	Flavivirus	
Kunjin virus	Flavivirus	
Kyasanur Forest Disease virus	Flavivirus	
Louping ill	Flavivirus	
Lymphoproliferative disease	Retrovirus	
Marble spleen disease of pheasants	Adenovirus	Adeno 11 group
Marek's disease	Herpesvirus	
Marek's disease (exotic strains)	Herpesvirus	
Mossuril virus	Rhabdovirus	
Mucambovirus	Alphavirus	
Murray valley encephalitis virus	Flavivirus	
Myelocytomatosis	Retrovirus	
Nairovirus infections	Nairovirus	
Navarro virus	Rhabdovirus	
Newcastle disease (PMV-1)	Paramyxovirus	PMV-1
Orbiviruses (Kemerovo serogroup)	Orbivirus	
Ostrich fading syndrome	?	?
Pacheco's disease	Herpesvirus	
Papillomas in finches	Papillomavirus	
Paramyxovirus 2 infection	Paramyxovirus	PMV-2
Paramyxovirus 3 infection	Paramyxovirus	PMV-3
Paramyxovirus 4 infection	Paramyxovirus	PMV-4
Paramyxovirus 5 infection	Paramyxovirus	PMV-5
Paramyxovirus 6 infection	Paramyxovirus	PMV-6

DISEASE NAME	GENUS	SPECIES
Paramyxovirus 7 infection	Paramyxovirus	PMV-7
Paramyxovirus 8 infection	Paramyxovirus	PMV-8
Paramyxovirus 9 infection	Paramyxovirus	PMV-9
Parvovirus infection of chicken	Parvovirus	
Phlebovirus infections	Phlebovirus	
Pneumovirus (turkey rhinotracheitis)	Pneumovirus	
PRRSV		
Psittacine beak and feather disease (PFBD)	Circovirus	
Psittacine Proventricular Dilatation Syndrome (Macaw Wasting Disease)	?	?
Quail bronchitis virus	Adenovirus	Group 1
Rabies	Rhabdovirus	
Reovirus infections	Reovirus	various strains
Reticuloendotheliosis ('turkey leukosis')	Retrovirus	
Rift Valley fever	Phlebovirus	
Rocio virus	Flavivirus	
Ross River virus	Alphavirus	
Rotavirus infections	Rotavirus	Group A, D, F
Runting & Stunting disease	not yet identified	reo/retrovirus?
Russian Spring Summer Encephalitis	Flavivirus	
Semliki Forest virus	Alphavirus	
Sindbis virus	Alphavirus	
St. Louis encephalitis virus	Flavivirus	
Swollen head syndrome	Pneumovirus	
Tonate virus	Alphavirus	
Turkey haemorrhagic enteritis	Adenovirus	Adeno II group
Turkey meningoencephalitis virus	Flavivirus	
Turkey viral hepatitis	Virus?	enterovirus-like
Uganda S virus	Flavivirus	
Usutu virus	Flavivirus	
Vesicular stomatitis	Rhabdovirus	
Wesselsbron disease	Flavivirus	
West Nile virus	Flavivirus	

Appendix 3

A LIST OF DISEASES FOR FURTHER CONSIDERATION

DISEASE NAME	GENUS	SPECIES
Aegyptianellosis	*Aegyptianella*	spp.
Anthrax	*Bacillus*	*anthracis*
Avian chlamydiosis	*Chlamydia*	*psittaci*
Avian pseudotuberculosis	*Yersinia*	*pseudotuberculosis*
Avian spirochaetosis	*Borrelia*	*anserina*
Avian tuberculosis	*Mycobacterium*	*avium*
Botulism	*Clostridium*	*botulinum*
Campylobacteriosis	*Campylobacter*	*jejuni*
Corynebacteriosis	*Corynebacterium*	*pyogenes*
Fowl cholera	*Pasteurella*	*multocida*
Gangrenous dermatitis	*Clostridium*	*septicum*
Infectious coryza	*Haemophilus*	*paragallinarum*
Intracellular infection in ducks	*Haematoproteus*	spp.
Listeriosis	*Listeria*	*monocytogenes*
Megabacteriosis	*Megabacterium*	spp.
Mycoplasmosis	*Mycoplasma*	*gall1isepticum/synoviae/meleagridis*
Mycoplasmosis	*Mycoplasma*	*iowae*
Ornithobacterium rhinotracheale infection	*Ornithobacterium*	*rhinotracheale*
Pasteurella anatipestifer infection	*Pasteurella*	*anatipestifer*
Q fever	*Coxiella*	*burnetti*
Salmonella arizonae	*Salmonella*	*arizonae*
Salmonella enteritidis phage 4	*Salmonella*	*enteritidis*
Salmonella gallinarum infection	*Salmonella*	*gallinarum*
Salmonella pullorum infection	*Salmonella*	*pullorum*
Swine erysipelas	*Erysipelothrix*	*rhusiopathiae*
Tuberculosis (resistant strains)	*Mycobacterium*	*tuberculosis*
Tuberculosis (susceptible)	*Mycobacterium*	*tuberculosis* and *bovis*
Tularaemia	*Francisella*	*tularensis*
Turkey coryza	*Bordetella*	*avium*
Aspergillosis	*Aspergillus*	*furnigatus*
Zygomycosis	*Absidia/Rhizopus/Mucor*	spp.
Argasidae	*Argas*	various spp.
Ascarids		
Atoxoplasmosis	*Atoxoplasma*	spp.
Balantidiasis	*Balantidium*	spp.
Capillariasis	*Capillaria*	spp.
Coccidiosis	*Coccidia*	spp.

DISEASE NAME	GENUS	SPECIES
Coccidiosis	*Coccidia*	spp.
Cryptosporidium infections	*Cryptosporidium*	spp.
Filariae	*Filariae*	various spp.
Free-flying biting insects	Biting insects	various spp.
Haemoproteus infection	*Haemoproteus*	spp.
Heterakiasis	*Heterakis*	spp.
Hexamita	*Hexamita*	spp.
Hipoboscid flies	Flies	various spp.
Histomoniasis	*Histomonas*	*meleagridis*
Ixodidae	*Ixodes*	various spp.
Leucocytozoonosis	*Leucocytoozon*	spp.
Libyostrongylus infestation	*Libyostrongylus*	various spp.
Lice	Lice	various spp.
Plasmodium spp. Infections	*Plasmodium*	various spp.
Sarcosporidiosis	*Sarcocystis*	spp.
Syngarnosis	*Syngamus*	*trachea*
Tapeworms and flukes		
Toxoplasmosis	Toxoplasma	gondii
Trypanosoma infection	Trypanosoma	spp.
Verminous encephalitis	Baylisascaris	spp.
Adenovirus infections of ostriches	Adenovirus	unclassified
Adenovirus type I	Adenovirus	Adeno 1 group
Alfuy virus	Flavivirus	
Amazon tracheitis	Herpesvirus	
Astrovirus infection of turkeys	Astrovirus	
Astroviruses in ducks	Astrovirus	
Avian encephalomyelitis	Picomavirus	various strains
Avian infectious bronchitis (endemic strains)	Coronavirus	various strains
Avian infectious bronchitis (exotic strains)	Coronavirus	various strains
Avian infectious laryngotracheitis	herpesvirus	various strains
Avian leucosis	Retrovirus	various strains
Avian nephritis virus infection	Picornavirus	Avian nephritis vir.
Avipoxviruses	Poxviruses	
Big liver and spleen disease	Virus?	Unclassified
Borna disease	Virus	Unclassified
Budgerigar fledgling disease	Polyomavirus	
Budgerigar herpesvirus	Herpesvirus	
Bunyavirus infections	Bunyavirus	
Cholangio-hepatitis virus infection	Flavivirus?	not yet identified
Coronaviral enteritis	Coronavirus	
Crimean-Congo haemorrhagic fever	Nairovirus	
Derzsy's disease of geese	Parvovirus	GVP type 1
Duck hepatitis	Picomavirus	

DISEASE NAME	GENUS	SPECIES
Duck virus enteritis	Herpesvirus	Alphaherpesvirus
Egg drop syndrome	Adenovirus	Group II (EDS 76)
Encephalopathy	Prions	
Equine encephalomyelitis (Eastern and Western)	Alphavirus	
Fowl plague	Influenza	H5 and H7
Haemorrhagic nephritis and enteritis of geese	?	Unclassified
Heron hepatitis B virus	Avihepadnavirus	
Highlands J virus	Alphavirus	
Inclusion body hepatitis	Adenovirus	Group I
Inclusion body hepatitis in pigeons	Herpesvirus	pigeon herpesvirus 1
Infectious anemia	Circovirus	
Infectious bursal disease (exotic strains)	Birnavirus	
Infectious bursal disease (low pathogen strains)	Birnavirus	
Internal papillomatous disease	?	?
Japanese encephalitis virus	Flavivirus	
Lymphoproliferative disease	Retrovirus	
Marble spleen disease of pheasants	Adenovirus	Adeno 11 group
Marek's disease	Herpesvirus	
Marek's disease (exotic strains)	Herpesvirus	
Murray valley encephalitis virus	Flavivirus	
Myelocytomatosis	Retrovirus	
Newcastle disease (PMV-1)	Paramyxovirus	PMV-1
Ostrich fading syndrome	?	?
Pacheco's disease	Herpesvirus	
Papillomas in finches	Papillomavirus	
Paramyxovirus 2 infection	Paramyxovirus	PMV-2
Paramyxovirus 3 infection	Paramyxovirus	PMV-3
Paramyxovirus 4 infection	Paramyxovirus	PMV-4
Paramyxovirus 5 infection	Paramyxovirus	PMV-5
Paramyxovirus 6 infection	Paramyxovirus	PMV-6
Paramyxovirus 7 infection	Paramyxovirus	PMV-7
Paramyxovirus 8 infection	Paramyxovirus	PMV-8
Paramyxovirus 9 infection	Paramyxovirus	PMV-9
Parvovirus infection of chicken	Parvovirus	
Pneumovirus (turkey rhinotracheitis)	Pneumovirus	
Psittacine beak and feather disease (PFBD)	Circovirus	
Psittacine Proventricular Dilatation Syndrome (Macaw Wasting Disease)	?	?
Quail bronchitis virus	Adenovirus	Group 1
Rabies	Rhabdovirus	

DISEASE NAME	GENUS	SPECIES
Reovirus infections	Reovirus	various strains
Reticuloendotheliosis ('turkey leukosis')	Retrovirus	
Rift Valley fever	Phlebovirus	
Ross River virus	Alphavirus	
Rotavirus infections	Rotavirus	Group A, D, F
Runting & Stunting disease	not yet identified.	reo, retrovirus?
Sindbis virus	Alphavirus	
Swollen head syndrome	Pneumovirus	
Turkey haemorrhagic enteritis	Adenovirus	Adeno II group
Turkey meningoencephalitis virus	Flavivirus	
Turkey viral hepatitis	Virus?	enterovirus-like
Vesicular stomatitis	Rhabdovirus	
Wesselsbron disease	Flavivirus	