Method for Risk Assessment

David Buckley[1]

Risk assessment is defined in the OIE Code as:

" … *an evaluation of the likelihood and the biological and economic consequences of entry, establishment or spread of a pathogenic agent within the territory of an importing country*."

Risk assessment is undertaken in a number of distinct stages. The first of these is *release assessment.* This involves the elucidation of the pathway(s) by which a disease agent could enter Australia in the product in question, and the estimation of the likelihood of each step in the pathway being completed.

The second stage is *exposure assessment*, which involves the elucidation of the pathway(s) by which susceptible Australian animals may be exposed to the disease agent, and the estimation of the relevant likelihoods.

Consequence assessment involves the estimation of the expected consequences of establishment and spread of the disease in question. This is done using econometric methods, involving the consideration of potential outbreak scenarios, the likelihoods of these scenarios, and the biological and economic consequences arising from each.

The risk assessment for each identified agent concludes with the combination of likelihood of release, likelihood of exposure, and expected value of the consequences of each of the scenarios for establishment and spread, to give an *unrestricted risk estimate*, per imported bird, for each disease agent. The detailed method for each of the steps described above is given in the following sections.

Risk assessment may be done by either qualitative or quantitative means, with either method being considered valid by the OIE. Due to the low level of surveillance for psittacine diseases which veterinary authorities in Australia and overseas undertake, the data to allow a quantitative risk assessment to be undertaken in this case were unavailable. For this reason, qualitative methods were used throughout this risk assessment. Qualitative likelihoods were reported using the nomenclature outlined in Table 1.

This IRA was 'generic', in that the risks associated with the importation of psittacine birds or their hatching eggs from *any* exporting country were considered. To facilitate this, the risk assessment for each identified hazard was undertaken in two phases.

In the first phase, the release assessment did *not* include country-specific factors, or steps, in the chain of events leading to the importation of infected birds or eggs. Where the generic risk assessment led to an annual risk of establishment and spread that was lower than Australia's ALOP, and therefore considered acceptable (see *Risk Estimation*), further assessment was not required.

Where the generic risk assessment produced a risk that was higher than Australia's ALOP, a second country-specific release assessment for each of the countries from which access requests have been obtained, was carried out. The country-specific risk assessments gave rise to a second series of unrestricted risk estimates, which were again compared with Australia's ALOP. Those diseases for which the unrestricted risk was higher than Australia's ALOP required risk management.
This two-stage approach was chosen as it enabled the unrestricted risk of establishment and spread to be calculated for *each* exporting country. The approach was also considered an efficient means by which to investigate country factors, since hazards for which the generic risk of establishment and spread was acceptable did not need further country-specific assessment.

[1] Principal Veterinary Officer, Animal Quarantine Policy Branch, AQIS Canberra

Table 1: Nomenclature for qualitative likelihoods

Likelihood	Descriptive definition	Probability (P)
High	The event would be extremely likely to occur	P ≡ 0.85 Range = 0.7→1
Moderate	The event would occur with an even probability	P ≡ 0.5 Range = 0.3→0.7
Low	The event would be unlikely to occur	P ≡ 0.175 Range = 0.05→0.3
Very low	The event would be very unlikely to occur	P ≡ 0.0255 Range = 0.001→0.05
Extremely low	The event would be extremely unlikely to occur	P ≡ 0.0005 Range = 10^{-6}→0.001
Negligible	The event would almost certainly not occur	P ≡ 5X 10^{-7} Range = 0 ← 10^{-6}

Release assessment

The 'biological pathway', or ordered sequence of steps undertaken in sourcing, processing and exporting a commodity, is termed its *release scenario*. The end-point of a release scenario is the arrival in Australia of an infected or contaminated commodity. In this context, 'the arrival in Australia' is taken to imply the arrival of infected or contaminated commodity at the point of entry - whether this is an airport, a shipping port or an Australian quarantine station.

Figures 1 and 2 show, respectively, the steps in the release scenario for aviary bred psittacine birds and their hatching eggs. Each step in the pathway may occur with a particular likelihood, and these individual likelihoods are denoted in Figures 1 and 2 as R_1 to R_n. From Figure 1 it can be seen that there are two possible major pathways by which a disease agent could be imported into Australia in live psittacine birds. These correspond to:

1. Direct selection and importation of an infected bird; and
2. Selection of a non-infected bird which is subsequently infected during transport to Australia.

The likelihoods of each of these pathways are represented by the product of the likelihoods of the individual steps, and are represented as $R_1xR_2xR_4$, and $R_1xR_3xR_4$, respectively.

Similarly there are two pathways by which a disease agent could be imported into Australia in hatching eggs of psittacine birds. The likelihoods of each of these pathways are represented as $R_1xR_5xR_6xR_8$, and $R_1xR_7xR_8$ respectively. The individual steps are described qualitatively in Table 2. From the figures, it can be seen that the likelihood that the disease agent is present and unrecognised in an individual bird for export (R_2), is equal to the likelihood that the disease agent is present and unrecognised in an individual bird selected to provide eggs for export to Australia (R_5).

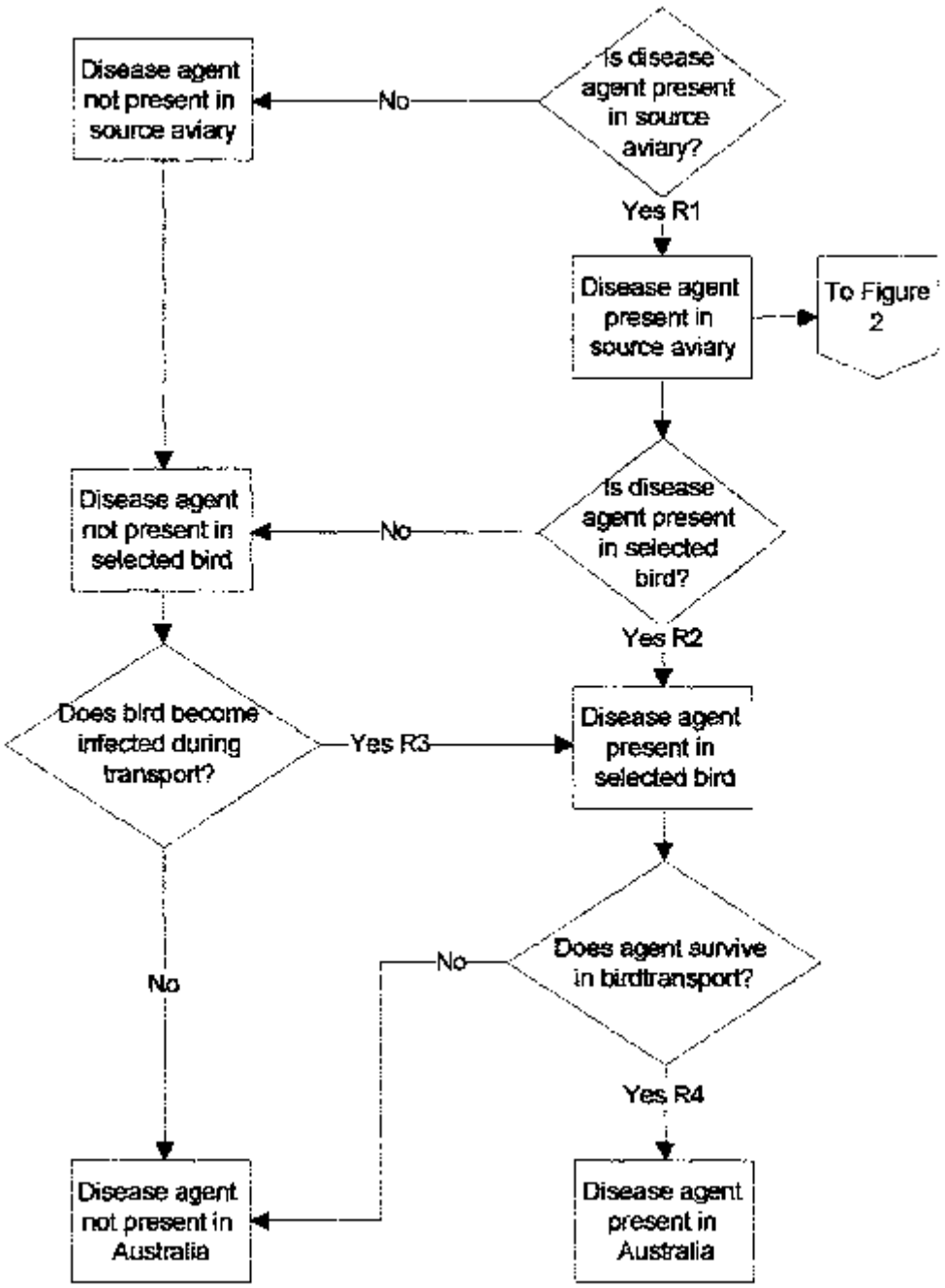

Figure 1: Scenario pathway diagram for the unrestricted release assessment for live psittacine birds

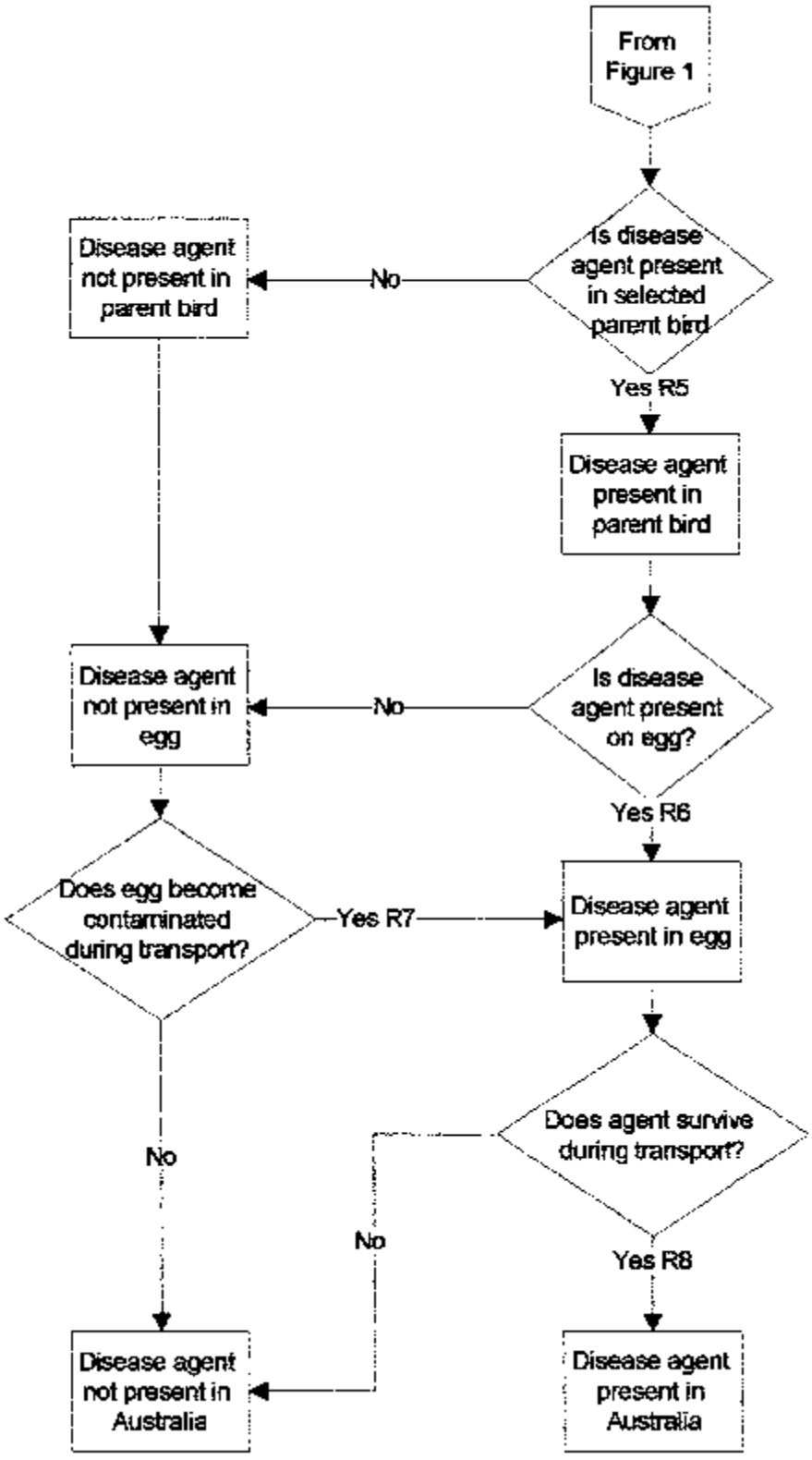
From Figure 1
Is disease agent present in selected parent bird
No
Disease agent not present in parent bird
Yes R5
Disease agent present in parent bird
Is disease agent present on egg?
No
Disease agent not present in egg
Yes R6
Disease agent present in egg
Does egg become contaminated during transport?
Yes R7
Does agent survive during transport?
No
Yes R8
No
Disease agent not present in Australia
Disease agent present in Australia

Figure 2: Scenario pathway diagram for the unrestricted release assessment for hatching eggs of psittacine birds

Table 2: **Steps in the 'release scenario' for psittacine birds.**

Step name	Description of step
Step R1:	This step describes the likelihood that the disease is present and unrecognised in the source aviary.
Step R2:	This step describes the likelihood that the disease agent is present and unrecognised in an individual bird selected for export to Australia.
Step R3:	This step describes the likelihood that an uninfected bird that is selected for export, becomes infected during transport to Australia, and the infection is not recognised.
Step R4:	This step describes the likelihood that infection is maintained unrecognised in an infected bird, during transport to Australia.
Step R5:	This step describes the likelihood that that the disease agent is present and unrecognised in an individual bird selected to provide eggs for export to Australia.
Step R6:	This step describes the likelihood that eggs produced by infected parent birds contain the infection.
Step R7:	This step describes the likelihood that an uninfected egg is contaminated with an infectious agent during storage/transport to Australia.
Step R8:	This step describes the likelihood that the disease agent survives in/on the egg, during storage and transport to Australia.

Sufficient data were not always available to allow estimates of the likelihood of each individual step in the various pathways. When this was the case, an estimate of the combined likelihood of the entire pathway was made, based on historical or other evidence. The identification of all steps in the pathway, including those for which data were not available, was of value in order to:

1. Guide future research needs; and
2. Guide decision on risk management options.

The results of the release assessment, for each disease agent of interest, will be a table of likelihood estimates, including, where possible, estimates of the individual likelihoods R1 - R8, and the overall pathway likelihoods $R_1 \times R_2 \times R_4$, and $R_3 \times R_4$ (for live birds), and $R_1 \times R_5 \times R_6 \times R_8$, and $R_1 \times R_7 \times R_8$ (for hatching eggs).

Primary exposure assessment

The exposure of susceptible animals in Australia may occur as a result of one or more discrete pathways, or *exposure scenarios*. Exposure scenarios comprise an ordered series of steps, each of which represents a stage in the distribution and disposal of psittacine birds. The exposure assessment was based on the identification of the groups of animals that may be directly exposed to disease carried in or on imported birds or hatching eggs, and on the sequence of discrete steps which must occur for these groups to be exposed. It was considered that the only group of animals likely to be directly exposed to imported birds or eggs, are other aviary birds. The discrete steps involved in the exposure pathways for psittacine birds and their eggs are shown in Figure 3. The likelihoods associated with these discrete steps are termed E_1 and E_2 and are described in Table 3. Again, qualitative estimates for these likelihoods will be assigned using the nomenclature described in Table1. For each disease agent, the results of the exposure assessment will be described, where possible, as the individual estimates for each of the likelihoods E_1 and E_2, and for the combined likelihood $E_1 x E_2$.

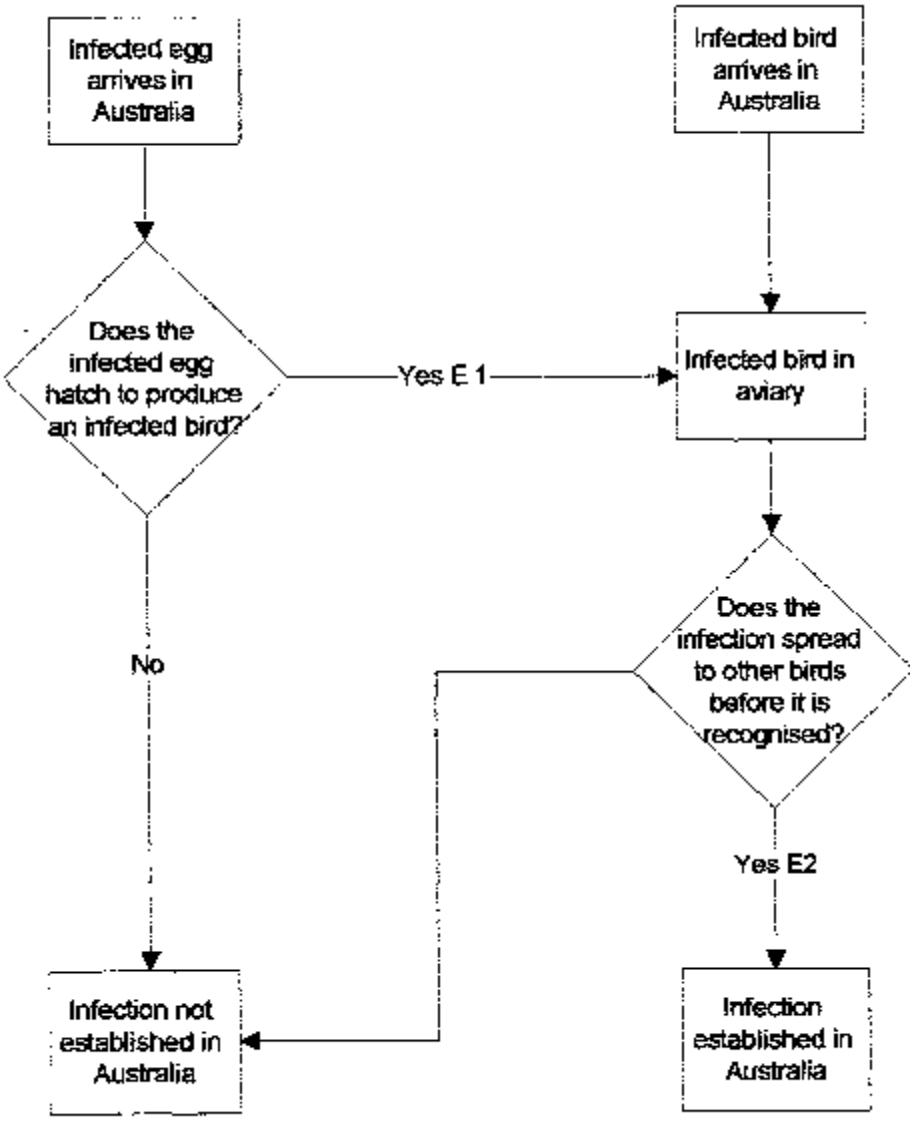

Figure 3: Exposure pathway for psittacine birds and their eggs

Table 3: Steps in the exposure scenarios for psittacine birds.

Step name	Description of step
Step E1:	This step describes the likelihood that an infected egg will be incubated and hatched to produce an infected bird in Australia.
Step E2:	This step describes the likelihood that the disease spreads from one infected bird to other birds in the aviary. It depends on the infectiousness of the disease agent and the immune status of the other birds.
E_1xE_2	Describes the combined likelihood that an infected egg hatches to produce an infected bird, which then infects other birds in the aviary.

Consequence assessment

The objective of the consequence assessment was to assess the likely impact, or 'expected consequence', associated with the exposure of Australian birds to exotic diseases imported through psittacine birds or their eggs. In addition to the direct exposure of aviary birds, there are a number of other groups that may be affected by diseases imported into Australia with psittacine bird or eggs. These are considered to be secondary exposures, associated with the establishment and spread of the disease in this country. The groups considered to be at risk of secondary exposure are:

1. Wild birds
2. Backyard/free range flocks (less biosecure)
3. Large commercial poultry operations (more biosecure)
4. Humans

The distinction between large commercial flocks and backyard/free range flocks is made on the likely level of biosecurity associated with these operations, and not on any assessment of economic value. The likelihoods of the various steps in the exposure pathways for these secondary exposures will be considered further in later sections.

The level of consequence will clearly be affected by the degree to which the exotic disease is able to spread from the primary exposure groups to any secondary groups of susceptible animals, and the nature of any spread to the secondary exposure groups described above. The "expected consequence" of the exposure of a secondary group is therefore a combination of the likelihood of the various establishment and spread scenarios within the secondary group, and the consequences that arise from such secondary exposure.

Given the above discussion of possible secondary exposures, there are a number of plausible outbreak scenarios that must be considered. These can be described as follows.

Outbreak Scenario 1: No further spread beyond the local aviary bird population, except to humans for zoonotic diseases.

Outbreak Scenario 2: Spread to aviary birds generally across the country, with spread to humans of zoonotic diseases

Outbreak Scenario 3: Spread from the aviary bird population to local wild birds, with spread to humans of zoonotic diseases.

Outbreak Scenario 4: Spread from local wild birds to wild birds generally, with spread to humans of zoonotic diseases.

Outbreak Scenario 5: Spread from aviary birds to local backyard/free range poultry, with spread to humans of zoonotic diseases.

Outbreak Scenario 6: Spread from local backyard/free range poultry to backyard/free range poultry generally, with spread to humans of zoonotic diseases.

Outbreak Scenario 7: Spread to local commercial poultry

Outbreak Scenario 8: Spread from local commercial poultry to commercial poultry generally, with spread to humans of zoonotic diseases.

Figure 4 shows the most likely pathways by which an exotic disease could spread from aviary birds to other birds in Australia. Likelihoods of the various steps in the exposure and spread scenarios are shown as ES_1 to ES_8 respectively. However, it is clear that once an outbreak had commenced, it would be possible for there to be spread between the various exposure groups which, for simplicity, has not been shown in the figure.

For the purposes of the discussion, it is assumed that zoonotic diseases will spread to humans from aviary birds, commercial poultry, and backyard poultry with equal likelihood, due to the close association between these groups of birds and their human caretakers. This likelihood is denoted ES_9. As before, the results of the exposure assessment will be described, where possible, as the individual estimates for each of the individual steps, and for the combined pathways.

Consequence criteria

The consequences that result from the introduction, establishment and spread of a pest or disease agent largely arise from the *direct* and *indirect* effects they have on biological systems.

Direct effects

Direct effects of a pest or disease on:

- Animal or plant life and health, including animal and plant production losses
- Human life or health
- The environment, including biodiversity, endangered species and the integrity of ecosystems

Indirect effects

Costs resulting from activities associated with incursion of a pest or disease:

- New or modified eradication, control, surveillance/monitoring and compensation strategies/programs
- Domestic trade or industry effects, including changes in consumer demand and effects on other industries supplying inputs to or utilising outputs from directly affected industries
- International trade effects, including loss of markets, meeting new technical requirements to enter/maintain market, changes in international consumer demand
- Changes to natural and built environment, including reduced tourism, reduced rural and regional economic viability, 'side effects' of control measures, loss of social amenity

Describing direct and indirect disease effects

The nature of the introduced agent, and the species that it affects, are important factors in determining the consequences that will result from its introduction. Some effects, such as change in commercial production, are relatively easy to measure. Others, such as changes in social amenity or an effect on biodiversity, are more difficult.

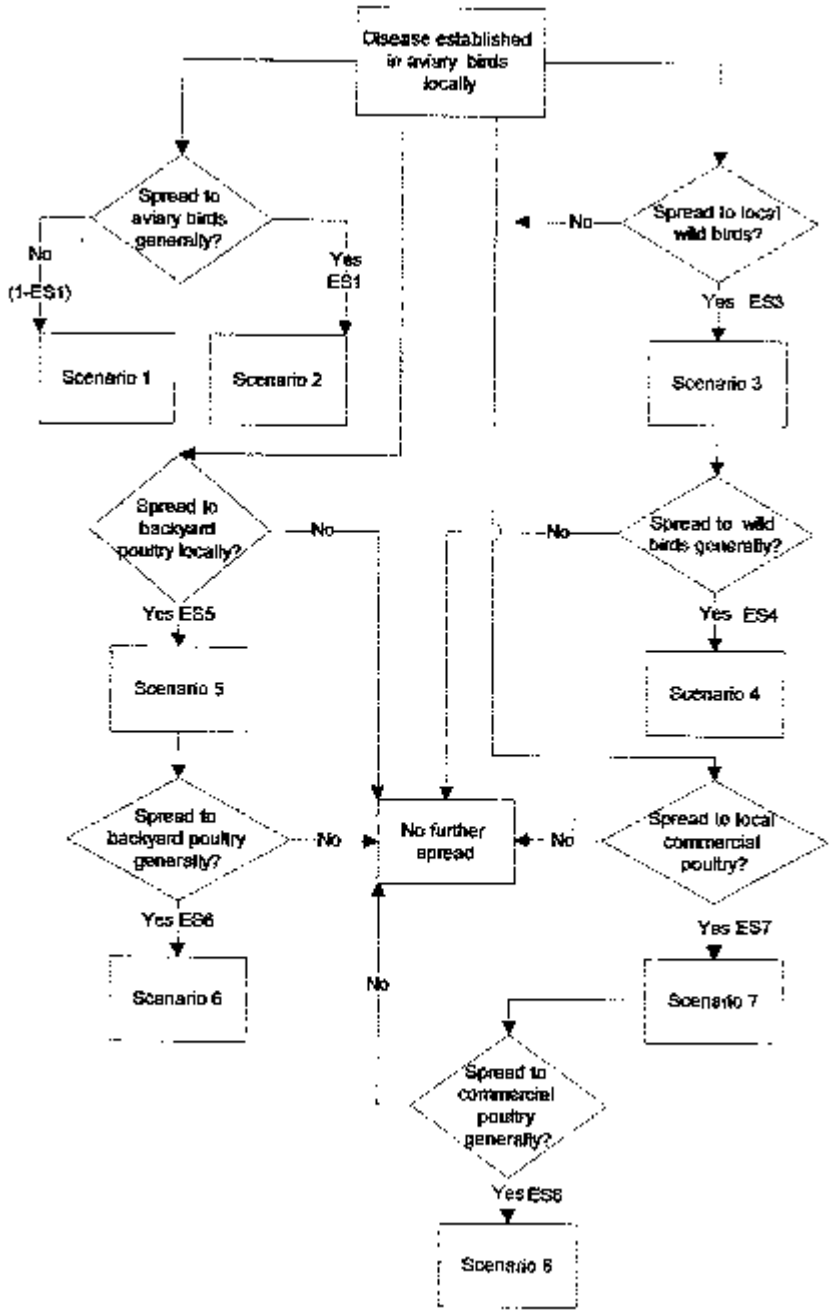

Figure 4: Pathways by which an exotic disease might spread from aviary to wild birds

The impact of each consequence criterion was considered in relation to its consequences at each of four levels[2]:

- a local production / environment level
- a district production / environment level
- a regional production / environment level
- the national level

At each level, the quantum of impact was described in terms of being 'unlikely to be discernible' (UD), of 'minor significance' (MS), 'significant' (S) and 'highly significant' (HS). These are defined as follows:

An 'unlikely to be discernible' impact is not distinguishable from normal day-to-day variation in the criterion.

An impact of 'minor significance' is not expected to threaten economic viability, but would lead to a minor increase in mortality/morbidity or a minor decrease in production. For non-commercial factors, which cannot be easily measured in economic terms, the impact is not expected to threaten the intrinsic 'value' of the criterion - though the value of the criterion would be considered as 'disturbed'. Effects would generally be reversible.

A 'significant' impact would threaten economic viability through a moderate increase in mortality/morbidity, or a moderate decrease in production. For non-commercial factors, which cannot be easily measured in economic terms, the intrinsic 'value' of the criterion would be considered as significantly diminished/threatened. Effects may not be reversible.

A 'highly significant' impact would threaten economic viability through a large increase in mortality/morbidity, or a large decrease in production. For non-commercial factors, which cannot be easily measured in economic terms, the intrinsic 'value' of the criterion would be considered as severely or irreversibly damaged.

A related consideration is the *persistence* of an effect. In general, where the effect was prolonged, as was the case if it was thought to persist for several production cycles or if regeneration would take several generations, the consequences were considered to be greater. If an effect was not prolonged, then consequences were likely to be less serious. In either case, it was at times necessary to place a disease in the next higher or lower category for that consequence criterion.

The consequences of the introduction, establishment and spread of a pest or disease were considered for each consequence criterion at the local, district, regional and national level. These four values were then translated to a range (denoted A-F) using the table below[3].

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[2] In the case of local, district or regional areas, the size of the area will depend on a number of factors including the epidemiology of the disease and the biological factors affecting the distribution of the disease/pest. Other important considerations include relevant cadastral information, political boundaries and geographical features.

[3] The categories 'unlikely to be discernible' and 'not applicable' were not included

Table 4: The assessment of local, district, regional and national consequences

Range	Local	District	Regional	National
A	Not applicable	Not applicable	Not applicable	Highly significant
B	Not applicable	Not applicable	Highly significant	Significant
C	Not applicable	Highly significant	Significant	Minor
D	Highly significant	Significant	Minor	Unlikely to be discernible
E	Significant	Minor	Unlikely to be discernible	Unlikely to be discernible
F	Minor	Unlikely to be discernible	Unlikely to be discernible	Unlikely to be discernible

Estimating the impact on each direct and indirect criterion

The impact of each identified disease agent on direct and indirect criteria was evaluated and reported using the qualitative method described at the start of this section (see *Describing Direct and Indirect Disease Effects*).

Estimating the impact of each outbreak scenario

The estimates of impact on each (direct and indirect) criterion were combined to give an estimate of the impact associated with an outbreak scenario.

This was achieved by following the eleven rules outlined below. These rules are mutually exclusive, and were addressed in the order in which they appeared in the list. For example, *if the first set of conditions does not apply, the second set should be considered. If the second set does not apply, the third set should be considered* ..., and so forth until one of the rules applies.

- Where the impact on any direct or indirect criterion is 'A', the overall impact associated with the outbreak scenario is also considered to be 'extreme'
- Where the impact on more than one criterion is 'B', the overall impact associated with the outbreak scenario is considered to be 'extreme'
- Where the impact on a single criterion is 'B' and the impact on each remaining criterion is 'C', the overall impact associated with the outbreak scenario is considered to be 'extreme'
- Where the impact on a single criterion is 'B' and the impact on remaining criteria is not unanimously 'C', the overall impact associated with the outbreak scenario is considered to be 'high'
- Where the impact on all criteria is 'C', the overall impact associated with the outbreak scenario is considered to be 'high'
- Where the impact on one or more criteria is 'C', the overall impact associated with the outbreak scenario is considered to be 'moderate'
- Where the impact on all criteria is 'D', the overall impact associated with the outbreak scenario is considered to be 'moderate'
- Where the impact on one or more criteria is considered 'D', the overall impact associated with the outbreak scenario is considered 'low'
- Where the impact on all criteria is 'E', the overall impact associated with the outbreak scenario is considered 'low'
- Where the impact on one or more criteria is considered 'E', the overall impact associated with the outbreak scenario is considered 'very low'
- Where the impact on all criteria is 'F', the overall impact associated with the outbreak scenario is considered 'negligible'

Evaluating the 'expected consequence' of each outbreak scenario

In statistical or econometrics parlance an 'expected value' represents the product of the probability that an outcome will occur, and its impact. In the context of this IRA, the 'expected consequence' of an outbreak scenario represented the product of its likelihood and estimated impact. These measures were each derived using the approach described in the discussions above. Once obtained, the measures were combined using the matrix in Table 5, to give the 'expected consequence' associated with each outbreak scenario.

Table 5: Matrix for the estimation of 'expected consequence'

Probability of establishment and spread	High	*Negligible*	*Very low*	*Low*	*Moderate*	*High*	*Extreme*
	Moderate	*Negligible*	*Very low*	*Low*	*Moderate*	*High*	*Extreme*
	Low	*Negligible*	*Negligible*	*Very low*	*Low*	*Moderate*	*High*
	V. Low	*Negligible*	*Negligible*	*Negligible*	*Very low*	*Low*	*Moderate*
	E. Low	*Negligible*	*Negligible*	*Negligible*	*Negligible*	*Very low*	*Low*
	Negligible	*Negligible*	*Negligible*	*Negligible*	*Negligible*	*Negligible*	*Very low*
		Negligible	Very low	Low	Moderate	High	Extreme
		Consequence of establishment and spread					

Risk estimation

In the context of IRA, risk estimation denotes the integration of likelihood evaluation and consequence assessment, with the objective of deriving a unit to represent the overall expected loss, or 'risk', associated with each pathogenic agent. Given this, it can be seen that in addition to its role as the closing stage of a risk assessment, risk estimation was also undertaken during the second to last step of each consequence assessment, as described above[4].

When described as the closing step in a risk assessment, the method for risk estimation is very similar to the method used to derive the 'expected consequence' of each outbreak scenario, as outlined above. The difference is that in the context of overall risk, risk estimation will involve the amalgamation of the *release assessment*, the *exposure assessments* and the *consequence assessments*.

This process is undertaken in two steps. Firstly, the likelihoods derived from the release assessement, and the exposure assessment are combined. This can be done, for each possible pathway, in a stepwise fashion, using the matrix shown at Table 6 below. This purely qualitative process however, has one major failing, which becomes obvious when it is considered that the likelihoods are always less than 1 (except in the unusual case where an outcome is certain to occur). This is that, if combined stepwise as suggested, a series of (eg) 5 steps, each with an individual likelihood of "low" would have an overall likelihood of "low". Algebraically, this is inconsistent. Hence, where there are more than one individual terms in a likelihood expression, it is important to assess the outcomes from the matrix combination process to ensure that the final result is reasonable. In some cases, it may be necessary to revise the final outcome downwards by one or more risk categories. Where this is necessary, appropriate justification was given.

[4] That is, the *expected consequence of an outbreak scenario*, and the *expected consequence of exposing each group of susceptible animals to an exotic disease agent*, are each an example of 'risk'

Table 6: A matrix of 'rules' for combining descriptive likelihoods

	High	**Moderate**	**Low**	**V. low**	**E. low**	**Negligible**
High	High	Moderate	Low	V. Low	E. Low	Negligible
Moderate		Low	Low	V. Low	E. Low	Negligible
Low			V. low	V. Low	E. Low	Negligible
V. low				E. Low	E. Low	Negligible
E. low					Negligible	Negligible
Negligible						Negligible

Finally, the combined likelihood of release and exposure is combined with the consequence assessment, in a similar fashion to the above, by using the matrix shown below at Table 7.

Table 7: Risk estimation matrix

Probability of entry and exposure	High	*Negligible*	*Very low*	*Low*	*Moderate*	*High*	*Extreme*
	Moderate	*Negligible*	*Very low*	*Low*	*Moderate*	*High*	*Extreme*
	Low	*Negligible*	*Negligible*	*Very low*	*Low*	*Moderate*	*High*
	V. Low	*Negligible*	*Negligible*	*Negligible*	*Very low*	*Low*	*Moderate*
	E. Low	*Negligible*	*Negligible*	*Negligible*	*Negligible*	*Very low*	*Low*
	Negligible	*Negligible*	*Negligible*	*Negligible*	*Negligible*	*Negligible*	*Very low*
		Negligible	Very low	Low	Moderate	High	Extreme
		Expected consequence of entry and exposure					

The culmination of the procedure was a qualitative disease-specific estimate of the annual risk associated with each outbreak pathway.

Estimation of overall annual risk

The risk estimates obtained for each of the exposure pathways were derived using identical:

- Mathematical assumptions
- Qualitative probability definitions and probability ranges
- Qualitative consequence definitions
- Risk estimation matrices

Given this, risk estimates were essentially 'standardised' and could be 'summed' to give an overall estimate of risk. The set of eleven rules outlined below provided a pragmatic means by which qualitative risks could be summed. These rules were mutually exclusive, and were therefore addressed in the order that they appear in the list. For example, *if the first set of conditions does not apply, the second set should be considered. If the second set does not apply, the third set should be considered ...*, and so forth until one of the rules applies.

- Where any one partial risk is extreme, the overall risk is also considered extreme
- Where more than one partial risk is high, the overall risk is considered extreme
- Where any one partial risk high and each remaining partial risk is moderate, the overall risk is considered extreme
- Where a single partial risk is high and the remaining partial risks are not unanimously moderate, the overall risk is considered high
- Where all partial risks are moderate, the overall risk is considered high

- Where one or more partial risks are moderate, the overall risk is considered moderate
- Where all partial risks are low, the overall risk is considered moderate
- Where one or more partial risks are considered low, the overall risk is considered low
- Where all partial risks are very low, the overall risk is considered low
- Where one or more partial risks are very low, the overall risk is considered very low
- Where all partial risks are negligible, the overall risk is considered negligible

The result of this process was an estimate of the risk associated with introducing one bird to Australia. In order to convert this to an overall annual risk, it must be adjusted to allow for the expected annual number of birds imported. This will be done according to a process which is still under discussion. This was considered the final output of the risk assessment for each disease.

METHOD FOR RISK MANAGEMENT

Risk evaluation is described in the OIE Code as the process of comparing the estimated risk with a country's ALOP. ALOP was defined previously in this document as "… *the level of protection deemed appropriate by the WTO member country establishing a sanitary or phytosanitary measure to protect human, animal or plant life or health within its territory …*".

Australia has traditionally maintained a 'very conservative' attitude to quarantine risk. Given this, a risk that was either 'very low' or 'negligible', was considered sufficiently conservative to meet Australia's ALOP. The band of light grey cells in the risk estimation matrix (Table 7) illustrates a 'very low' risk, and provides a benchmark for the implementation of risk management.

The use of a benchmark for implementing risk management is illustrated in the rationale outlined below:

- For each potential hazard, the level of risk, or expected loss, associated with the *unrestricted* or unmitigated importation of psittacine birds or their hatching eggs was estimated [see *Guidelines for AQIS Import Risk Analysis* for an explanation of unrestricted risk].
- The unrestricted risk was then evaluated using the risk estimation matrix (Table7), so as to determine where it fell in relation to Australia's ALOP
- If the unrestricted risk was 'negligible' or 'very low', then it was considered acceptable and further risk management was not required
- If the unrestricted risk was 'low', 'moderate', 'high' or 'extreme', then alternative risk management strategies were identified and, for each, the risk was recalculated
- Where the subsequently restricted risk derived using a particular risk management strategy was 'very low', that strategy was considered acceptable
- Where the restricted risk derived using a particular risk management strategy was 'negligible', the strategy was considered unnecessarily restrictive. Where practical, overly restrictive risk management strategies were either rejected, or were manipulated to be less restrictive

This procedure led to the specification of a set of acceptable risk management strategies for each pathogenic agent for which the unrestricted risk was considered higher than Australia's ALOP[5]. The relative cost-effectiveness and practicality of acceptable risk management strategies were subsequently investigated. This process was described as *option evaluation*. Option evaluation enabled strategies considered *equivalent* to be identified.

[5] The SPS Agreement requires that risk management measures that fail to reduce the risk to the importing country's ALOP be re-evaluated in combination with other such measures. This may lead to a large number of combinations of risk management measures, each of which can be considered a 'strategy'

Internal papillomatous disease (IPD)

Technical issues
Agent taxonomy

The cause of IPD is not known. Observations by practitioners and aviculturalists suggest that an infectious agent may cause this disease. It has been suggested that the disease is associated with a papillomavirus, but attempts to demonstrate this using electron microscopy, low stringency southern blot techniques or immunocytochemical procedures have all failed. It has also been suggested that the disease is associated with a herpesvirus, possibly PDV. Herpes virus DNA has been detected in cloacal papillomas. However, herpesvirus infections are often ubiquitous and are not necessarily associated with disease. The author suggests that he has preliminary evidence of a papillomavirus-specific protein which may also be present in the tissues, suggesting the possibility that co-infection may be necessary for the disease to develop.

Attempts to transmit the disease experimentally by inoculations of partially purified IPD tissue homogenates in an Amazon parrot, a macaw, a sulphur crested cockatoo, and a Molluccan cockatoo have also failed.

World distribution
The disease was first reported in birds being imported from South America into the United States of America and is now widespread in Europe and North America. It has been reported in birds imported into Australia from Britain.

Disease characteristics
Host species: IPD is a disease of New World parrots and primarily affects macaws, conures, and Amazon and hawk-headed parrots. An IPD like disease has also been described in cockatoos and African grey parrots, but is extremely rare. The disease has not been reported from wild populations in South America, where the disease is thought to have originated. However, this may be due to the lack of appropriate disease surveillance and reporting in these populations.

Pathogenesis: IPD causes the lining of the digestive tract to develop into localised or more generalised papillomas. Birds with severe changes to the digestive tract will lose weight and eventually die. If left alone, papillomas will generally become smaller over a period of several months, but will then return. There appears to be an association between IPD and the development of cancer of the liver or pancreas, and sometimes both. The reasons for this observed association are as yet unknown. Death may result from suffocation due to lesions in the oropharyngeal region, or following progressive weight loss as a result of interference with the functioning of the digestive tract. It has also been suggested that cloacal lesions may interfere with fertility. However, Bond reported on a 7 year study (1988-1995) of a breeding facility in which papilloma positive pairs of blue and gold macaws were isolated from the rest of the population. Eggs from all psittacine birds at the facility are artificially incubated before hatching and the chicks are hand fed from day one. Papilloma negative pairs produced an average of 3.7 chicks annually, while papilloma negative pairs raised only 1.9 chicks annually on average.

Disease transmission in psittacine birds or their fertile eggs.
The transmission of IPD is not understood. It is thought that mutual preening, and possibly sexual contact may be methods of transmission.

Efforts to control the disease in affected aviaries have included isolation of pairs of birds where one or both is affected, and artificial rearing of all eggs, whether from affected parents or not. In the study reported by Bond, 24 offspring (ranging from 1 to 6 years of age) of papilloma positive macaws reside in various aviaries at the facility and all were papilloma free at the time of writing the report. This appears to confirm that prevention of close contact between birds will prevent spread of the disease.

Risk assessment
Tables summarising the various steps in the risk assessment are shown at Appendix 1.

Release assessment
The individual likelihoods of the various steps in the release scenario are extremely difficult to quantify in the case of IPD. Few, if any, veterinary authorities undertake routine surveillance of aviary birds, and therefore the likelihood that the disease agent will be present in an aviary (R_1) cannot be assessed with any accuracy. Further, there are no reliable tests to identify the presence of the disease agent in a particular bird, and therefore R_2 and R_5 cannot be assessed accurately. Similarly, there are no data to allow a direct assessment of the likelihood of the disease agent surviving in the bird during transport (R_4).

However, it can be demonstrated that IPD has spread widely throughout those countries of the world which allow trade in live aviary birds, since its recognition in birds of South American origin which had been imported into the United States. This spread appears to have been as a result of the unrestricted movement of aviary birds in international trade. Based on this information, it would appear reasonable to assume that the likelihood of release of the disease in Australia as a result of the unrestricted importation of live birds by the pathway denoted by $R_1 \times R_2 \times R_4$ is *high*.

The need for close contact, (either mutual preening or sexual contact) suggests that the likelihood of an uninfected bird becoming infected as a result of contact during transport (R_3) is unknown, but is probably very low. Therefore, the combined likelihood of the pathway $R_1 \times R_3 \times R_4$ is *extremely low.*

There is no evidence to suggest that the disease is able to be transmitted vertically through the egg, and in fact, control measures based on artificial incubation of eggs and hand rearing of chicks appears to be successful in breaking the disease cycle. Therefore it appears reasonable to assume that the likelihood of importation of IPD in hatching eggs of psittacine birds, by either of the pathways represented by $R_1 \times R_5 \times R_6 \times R_8$ or $R_1 \times R_7 \times R_8$ is *negligible*. From the work of Bond on control of the disease in aviaries, it seems reasonable to assume that this is because the likelihood of the agent being present in the egg (R_6) is *negligible.*

Exposure assessment
From the arguments presented above in relation to the likelihood of the disease agent being present in imported eggs, it is believed that, for this disease, the egg transmission pathway can be discounted. E_1 can therefore be considered to be *negligible.* However, given the current state of knowledge about the international spread of this disease, it has to be assumed that, without appropriate risk management efforts, the disease would become established in the aviary bird population as a result of the unrestricted import of psittacine birds into Australia. The likelihood that the infection spreads to establish in aviary birds (E_2) is therefore assessed as *high*.

Consequence assessment
Since this disease has not been shown to affect poultry, all outbreak scenarios which affect poultry (S_5-S_8) can be considered to have no direct or indirect adverse consequences.

Therefore, of the eight possible outbreak scenarios, only 4 need to be considered in relation to this disease. The relevant outbreak scenarios are:

- **Outbreak Scenario 1**: Spread to local aviary bird population only, with spread to humans for zoonotic diseases. (ES_1)

- **Outbreak Scenario 2**: Spread to aviary birds generally across the country, with spread to humans of zoonotic diseases.(ES_2)

- **Outbreak Scenario 3**: Spread from the aviary bird population to local wild birds, with spread to humans of zoonotic diseases. (ES_3)

- **Outbreak Scenario 8**: Spread from the aviary bird population to wild birds generally, with spread to humans of zoonotic diseases. (ES_3xES_4)

History has shown that, without some control measures in place, spread throughout the aviary populations is highly likely. This likelihood (ES_2) must be considered to be almost certain (*high*). Since Scenario 1 (no further spread in aviary birds) and Scenario 2 (spread to other aviary birds) are mutually exclusive, it can be seen that $ES_1 = (1 - ES_2)$. (ie *negligible*)

Whether the disease would become established in wild populations is less clear. The disease has not been reported in wild psittacines.[Snowdon] However, it is accepted that this may be as a result of the lack of on-going surveillance work in wild psittacine bird populations. There are two possible pathways by which the disease could become established in free-flying bird populations. These are that:

- Free flying birds may gain access to caged birds, or to aviary waste material; or
- An infected aviary bird may escape and mix with free-flying populations.

The information on the spread of this disease suggests that close contact is necessary for transmission to occur. Therefore, the likelihood of transmission following exposure to aviary wastes is *negligible*. Similarly, the likelihood of transmission between caged and wild birds during brief contact through the wire of cages is considered *negligible*. However, it is possible that escaped aviary birds could mingle with wild populations. Whether they would survive long enough in the wild to transmit infection, given the requirement for close contact, is difficult to assess. However, this likelihood (ES3) could be assessed as *low*. Once established in wild bird populations, however, the likelihood of further spread beyond the local area is considered *high*. Hence the combined likelihood of establishment in wild populations, followed by further spread to wild populations generally (ES3xES4) is *low*.

Consequence Criteria
Direct effects
Direct effects of a pest or disease on host species on:
Animal or plant life and health, including animal and plant production losses

Scenario 1: Costs due to infection, disease and production loss are associated with death of some infected birds, and with decreased reproduction. However, the actual level of adverse consequence is difficult to quantify, since there is conflicting evidence in the literature. Some affected birds die, while others appear to live long and productive lives, with adverse effects only arising in periods of severe stress. Clearly, in the worst case, the loss of one or more very expensive birds and their potential offspring could have a significant effect on an individual keeper of caged psittacine birds. However, in one study where appropriate control procedures were put in place, the reproductive performance of affected pairs was better than that of non-affected pairs. It is accepted that this may be an aberrant result due to the relatively small sample size, and that this result could not have been achieved without individual increased costs for disease control mechanisms, but these costs are assessed separately under indirect costs below. Overall, it is assessed that the direct costs due to losses of birds and potential offspring would be of Importance to the individual affected parties, but this effect is not likely to have more than a *minor* effect at the local level. The direct cost of these losses at higher levels is *unlikely to be discernible*.

Scenario 2: If the disease was to spread more widely through the entire caged bird population, more individuals would suffer. Again, local effects are likely to be no more than *minor*. There are no districts or regions that rely to a great extent on the avicultural community for economic viability. It is therefore considered that the district, regional and national effects are *unlikely to be discernible*.

Scenario 3 and Scenario 4: Direct costs in terms of animal production of an outbreak in wild birds, whether local or general are *unlikely to be discernible* at any level. They will be assessed under "The environment", below.

Human life or health

IPD does not cause disease in humans, and therefore the public health significance of this outcome scenario need not be considered.

The environment, including biodiversity, endangered species and the integrity of ecosystems

Scenario 1 &2: If the outcome scenario is restricted to caged aviary birds, the adverse consequences to the environment need not be considered. These consequences are assessed as *unlikely to be discernible* at any level.

Scenario 3 & 4: Since there are a number of species of Australian psittacine birds which are considered threatened, and these may occur in only local areas, the environmental consequences of an outbreak of IPD in Australian wild birds at any level are considered to be *highly significant*.

Indirect effects

Costs resulting from activities associated with incursion of a pest or disease:
New eradication, control, surveillance/monitoring and compensation strategies/programs

Indirect consequences of an outbreak include costs for surveillance and control, compensation, potential trade losses, social consequences, and adverse effects on other industries. Costs for surveillance and control due to an outbreak of IPD in caged birds are likely to be significant only at the level of directly affected parties. They are not likely to be noticeable at local, district, regional or national levels. For **Scenarios 1 & 2**, control costs of this disease would be expected to be similar to those direct costs under consequence category 1 (ie of minor significance locally, unlikely to be discernible at any other level).

For **Scenarios 3 & 4**, consequences under this category are more difficult to assess. National level surveillance and control programs for wildlife disease do not exist at present. However, should an exotic disease threaten an endangered species, resources would probably be made available. It is however, unlikely that this would be sufficient to threaten economic viability. It is therefore considered that the consequences of an outbreak of IPD in wild birds would be of minor significance at the local, district and regional levels, but would be unlikely to be discernible at national level. Because of the restricted distribution of some endangered species, this assessment is considered to apply for both local, and more generalised outbreaks. While this assessment does not necessarily fit the matrix for assessing the total impact on each criterion, (Table 4) it can be seen that the impact is more significant than the "E" range, and should therefore be considered to be equivalent to "D"

Domestic trade or industry effects, including changes in consumer demand and effects on other industries supplying inputs to or utilising outputs from directly affected industries

Scenarios 1 & 2: There may be adverse consequences for the trade in pet birds, bird feeds and other accessories for aviculture. However, given that these costs are likely to be less than those suffered by directly affected parties, since few pet industry traders restrict their activities to dealing solely in aviary birds, the consequences for this criterion are considered to be of *minor significance* locally, and *unlikely to be discernible* at any higher level, for both scenarios.

Scenarios 3 & 4: Effects due to an outbreak of IPD in wild birds would be unlikely to be discernible.

International trade effects, including loss of markets, meeting new technical requirements to enter/maintain market, changes in international consumer demand

Overseas countries do not at present place restriction on trade due to this disease. In any case, export trade in caged birds is not significant in the national economy. However, there may be some losses incurred by individual aviculturalists, as a result of reluctance on the part of some customers to purchase birds from an aviary where the disease is present. The consequences under **Scenarios 1, 2, 3 and 4** may therefore be likely to be important to individual affected parties, but unlikely to be discernible at any higher level, for any of the four scenarios under consideration.

Changes to natural and built environment, including reduced tourism, reduced rural and regional economic viability, 'side effects' of control measures, loss of social amenity

Scenarios 1 & 2: An outbreak of IPD in caged aviary birds is unlikely to cause serious adverse effects in the natural or built environment, or to reduce rural and regional economic viability. There may be some loss of social amenity, likely to be restricted to the individual affected parties whose enjoyment of the keeping of psittacine birds would be reduced. While this could be considered important for individuals, it is unlikely to be discernible at the local, district, regional or national levels.

Scenario 3 & 4: An outbreak of IPD in wild birds could lead to a reduction in the level of ecotourism in some local areas, which could cause significant effects at local level, and minor effects at district level. However, it is unlikely that this would be discernible at the regional or national levels.

Unrestricted risk estimate

Finally, the various release, exposure and consequence scenarios were combined, using the matrix approach given at Table 6 for combining probabilities, and at Table 7 for combining likelihoods and consequences. This gave an "expected overall risk" value for each pathway and scenario combination. These were subsequently summed using the decision rules shown in the section entitled "Estimation of overall annual risk". This "expected overall risk" represents the risk associated with the importation of one unit (ie one live bird, or one egg).

This expected overall risk will need to be adjusted for the expected volume of trade. Methods for doing this are still under consideration.

Risk Management
Internal Papillomatous disease

Risk Management strategy for live birds:

- Accept live birds and eggs only from countries or zones that are free of the disease of concern.

  If this could be achieved, it would reduce the likelihood of release to a negligible level, and hence no further risk management would be necessary. However, no veterinary authorities have surveillance measures in place for this disease, and therefore this option is not available for IPD

- Accept live birds only from aviaries shown by testing to have been free of the disease for a defined period.

  Appropriate testing methods are not available and hence this strategy will not have any effect on the risk.

- Accept live birds only from aviaries that are certified to have an appropriate disease control measure in place.

  Disease control measures have been shown to be capable of eliminating the disease from aviaries where it was present, over a period of time. Acceptable certification from the aviary veterinarian, countersigned by a representative of the competent veterinary authority in the country of export, that the aviary of origin had had a disease control program in place for a minimum of 2 years prior to export would therefore be considered to reduce the likelihood of release to "extremely low". This would have the effect of reducing the overall risk to "low".

- Require that transport of birds for export to the port of embarkation is done under secure conditions, sufficient to prevent contact with wild birds, or pathogens in the environment

For this disease the risk associated with this step is already very low, and hence this would not be expected to lessen the risk estimate.

- Require pre-export quarantine period with further disease testing, or demonstration of freedom from disease (eg quarantine period longer than any likely viraemic period) of individual birds intended for export to Australia.

  In the case of IPD, viraemic periods/incubation periods are unknown, but considered to be very long. Therefore, this option is considered to be impractical.

- Require post arrival quarantine period, with testing of birds for disease freedom prior to release

  Appropriate testing methods are not available and therefore this option is not suitable.

- Require long post-arrival quarantine period, to allow viraemia/bacteraemia to subside prior to release.

  In the case of IPD, viraemic periods/incubation periods are unknown, but considered to be very long. Therefore, this option is considered to be impractical.

- Impose post arrival restrictions on imported birds to minimise the risk of contact with other aviary birds.

  While this approach is unlikely to be appropriate for large commercial imports, it could easily be applied to the import of individual pet birds, not for breeding purposes. Similar restrictions to those currently applying for pet birds from NZ could be applied. This would have the effect of reducing the risk of exposure to a negligible level, and hence would reduce the overall risk estimate to a negligible level.

Risk Management strategy for hatching eggs:
Risks associated with the importation of hatching eggs are negligible and hence risk management measures are not required.

Internal papillomatous disease.

Release assessment	
Step	**Likelihood**
R1	No data
R2	No data
R3	V. low
R4	No data
R5	No data
R6	Negligible?
R7	No data
R8	No data
Pathway	
$R_1xR_2xR_4$	High
$R_1xR_3xR_4$	E. low
$R_1xR_5xR_6xR_8$	Negligible
$R_1xR_7xR_8$	Negligible

Exposure Assessment	
Step	**Likelihood**
E1	Negligible
E2	High
E1 x E2	Negligible
Establishment and Spread	
Step	**Likelihood**
ES1	(1-High) = Negligible
ES2	Extreme
ES3	Low
ES4	High
ES3xES4	Low
ES5	N/A
ES6	N/A
ES7	N/A
ES8	N/A

Consequence Assessment		**Direct effects**			**Indirect**				**Combined**
		1	**2**	**3**	**1**	**2**	**3**	**4**	
Scenario									
S1	**Local**	MS	N/A	UD	MS	MS	UD	UD	
	Dist	UD	N/A	UD	UD	UD	UD	UD	
	Reg	UD	N/A	UD	UD	UD	UD	UD	
	Nat	UD	N/A	UD	UD	UD	UD	UD	
		F			F	F	F		**NEG**
S2	**Local**	MS	N/A	UD	MS	MS	UD	UD	
	Dist	UD	N/A	UD	UD	UD	UD	UD	
	Reg	UD	N/A	UD	UD	UD	UD	UD	
	Nat	UD	N/A	UD	UD	UD	UD	UD	
		F			F	F	F		**NEG**
S3	**Local**	UD	N/A	HS	MS	UD	UD	S	
	Dist	UD	N/A	HS	MS	UD	UD	MS	
	Reg	UD	N/A	HS	MS	UD	UD	UD	
	Nat	UD	N/A	HS	UD	UD	UD	UD	
				A	D		F	E	**EXT**
S4	**Local**	UD	N/A	HS	MS	UD	UD	S	
	Dist	UD	N/A	HS	MS	UD	UD	MS	
	Reg	UD	N/A	HS	MS	UD	UD	UD	
	Nat	UD	N/A	HS	UD	UD	UD	UD	
				A	D		F	E	**EXT**

All scenarios involving disease in poultry have been deleted, since the disease does not occur in these species.

Combined consequence effects

Likelihood		**Consequence**		**Risk**
ES1	(1-High) = Negligible	**S1**	NEG	NEG
ES2	High	**S2**	NEG	NEG
ES3	Low	**S3**	EXT	HIGH
ES4	High	**S4**	EXT	EXTREME

Overall risk

Release		**Exposure**		**Cons**		**Overall risk**
For live birds						
$R_1xR_2xR_4$	High	E2	High	S1	NEG	**NEG**
$R_1xR_2xR_4$	High	E2	High	S2	NEG	**NEG**
$R_1xR_2xR_4$	High	E2	High	S3	HIGH	**HIGH**
$R_1xR_2xR_4$	High	E2	High	S4	EXTREME	**EXTREME**
$R_1xR_3xR_4$	V. low	E2	High	S1	NEG	**NEG**
$R_1xR_3xR_4$	V. low	E2	High	S2	NEG	**NEG**
$R_1xR_3xR_4$	V. low	E2	High	S3	HIGH	**LOW**
$R_1xR_3xR_4$	V. low	E2	High	S4	EXTREME	**MODERATE**
				Overall Risk for live birds		**EXTREME**
For eggs						
$R_1xR_5xR_6xR_8$	Negligible	E1 x E2	Negligible	S1	NEG	**NEG**
$R_1xR_5xR_6xR_8$	Negligible	E1 x E2	Negligible	S2	NEG	**NEG**
$R_1xR_5xR_6xR_8$	Negligible	E1 x E2	Negligible	S3	HIGH	**NEG**
$R_1xR_5xR_6xR_8$	Negligible	E1 x E2	Negligible	S4	EXTREME	**NEG**
$R_1xR_7xR_8$	Negligible	E1 x E2	Negligible	S1	NEG	**NEG**
$R_1xR_7xR_8$	Negligible	E1 x E2	Negligible	S2	NEG	**NEG**
$R_1xR_7xR_8$	Negligible	E1 x E2	Negligible	S3	HIGH	**NEG**
$R_1xR_7xR_8$	Negligible	E1 x E2	Negligible	S4	EXTREME	**NEG**
				Overall Risk for eggs		**NEGLIGIBLE**