



RISK ASSESSMENT METHODOLOGY FOR IMPORTING VERTEBRATE WILDLIFE IN TASMANIA

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1. PURPOSE

This risk assessment methodology is a companion document to the *Policy on Importing (and Keeping) Vertebrate Wildlife in Tasmania* (DPIPWE 2018) and *Procedures for Importing and Keeping Vertebrate Wildlife under the Nature Conservation Act 2002* (DPIPWE 2018). It sets out the methodology to assess the risk of a species to Tasmania and assign a risk rating of low, moderate, serious, or extreme for that species.

The Wildlife Management Branch is the primary point of contact for people wanting to import or keep wildlife in Tasmania. To ensure the animal sought for import can enter the State, both Biosecurity Tasmania and the Wildlife Management Branch must be contacted to determine the animal's import status and requirements under relevant legislation. A flow chart of the process for import applications, assessments and decisions is contained in Appendix 1.

2. THE BOMFORD MODEL

This methodology adopts the 'Bomford model' (Bomford 2008) which is applied by other Australian jurisdictions and other countries. The methodology was developed by the Bureau of Rural Sciences (Bomford 2003, 2006, 2008), is applied by several Australian jurisdictions (for example see Massam *et al.* 2010) and has been endorsed internationally (Simons and De Poorter 2009). The Bomford model is based on analyses of the historical outcome of biological introductions (Bomford 2008; Bomford *et al.* 2009).

The Bomford model assesses the risk of an exotic species to Australia as a whole and has been adapted to consider the risk of wildlife imports to Tasmania specifically. Importantly, it also enables the risk assessment of Australian native species present on the mainland being imported into Tasmania.

3. THE ASSESSMENT METHODOLOGY

This methodology considers three factors to assess the level of risk posed by a species (from Bomford 2008). They are:

A. danger posed by individual animals;
B. likelihood of establishment; and
C. consequence of establishment.

Risk assessment templates are provided in Appendix 2 (birds and mammals) and Appendix 3 (reptiles and amphibians).

A. DANGER POSED BY INDIVIDUAL ANIMALS

The public safety risk score and ranking is determined by two factors: the risk posed from individual escaped animals (see reference A1 on the risk assessment templates); and the risk posed to public safety from individual captive animals (A2), as outlined below.

A1. Risk posed from individual escapees to humans (0-2)

The species is assessed to determine whether individuals could harm people. Factors that are taken into consideration are aggressive behaviour, size, the possession of organs capable of inflicting harm such as sharp teeth, claws, spines, a sharp bill, or toxin-delivering apparatus (including toxic skin). Additionally, any known history of the species attacking, injuring, or killing people is considered. It should also assume that the species is not protecting a nest or young.

The species is put in one of the following categories:

- The animal sometimes attacks when unprovoked and/or is capable of causing serious injury (requiring hospitalisation) or fatality (**A1 = 2**).
- The animal can make unprovoked attacks causing moderate injury (requiring medical attention) or severe discomfort but is highly unlikely (few if any records) to cause serious injury (requiring hospitalisation) if unprovoked. Or the animal is unlikely to make an unprovoked attack but can cause serious injury (requiring hospitalisation) or fatality if cornered or handled (**A1 = 1**).
- All other animals posing a lower risk of harm to people (that will not make unprovoked attacks causing injury requiring medical attention, and which, even if cornered or handled, are unlikely to cause injury requiring hospitalisation) (**A1 = 0**).

Note: This section does not include impacts to native species. It is also assumed that animal health risks are managed under the *Animal Health Act 1995* prior to the species being imported into Tasmania and that human health disease risks are managed under the *Public Health Act 1997*.

A2. Risk to public safety from individual captive animals (0-2)

Potential for public safety issues arising from the irresponsible use of product obtained from captive individuals (such as toxins) is then assessed. This does not include the safety of anyone entering the animal's cage/enclosure or otherwise coming within reach of the captive animals. The risk that irresponsible use could pose a public safety issue is categorised in the following way:

- High risk (feasible and consequences could be fatal) (**A2 = 2**).

- Moderate risk (few records and consequences unlikely to be fatal) (**A2 = 1**).
- Nil or low risk (highly unlikely or not possible) (**A2 = 0**).

Public Safety Risk Score

A species' Public Safety Risk Score (A) is then determined as the sum of A1 and A2.

Public Safety Risk Rank

Based on the Public Safety Risk Score, the species is assigned a public safety risk ranking according to the following rules:

Public Safety Risk Rank	Public Safety Risk Score
Highly dangerous	A ≥ 2
Moderately dangerous	A = 1
Not dangerous	A = 0

B. LIKELIHOOD OF ESTABLISHMENT

SECTION 1: LIKELIHOOD OF ESTABLISHMENT FOR BIRDS AND MAMMALS

The four-factor model developed by Bomford (2008) is used for estimating the likelihood of escaped or released birds and mammals establishing a population in Tasmania. The four-factors are calculated as outlined below**.** Note that Section 1 is for birds and mammals only. Section 2deals with the likelihood of establishment for reptiles and amphibians.

B1. Climate Match Score (1-6)

The Climatch tool is used to assess this risk factor. Climatch is a climate-matching tool developed and administered by the Commonwealth Department of Agriculture, Water and the Environment (DAWE). It uses long-term temperature and rainfall patterns of a species' existing distribution to determine its likely distribution and potential to become a pest if introduced to a new continent or region. The latest version (V2) was released in late 2020 and is freely accessed via https://climatch.cp1.agriculture.gov.au/.

Prior to using the Climatch tool, the species' distribution must be obtained through a literature review covering the entire native and exotic range over the past 1000 years. The references used to determine the species' distribution should be clearly referred to in the risk assessment.

There are three basic steps to running a Climatch model:

1) Once the species' distribution is obtained through a literature review, select the relevant sites which correspond with the species' range using the 'select stations' tool

found on the default 'Source Region' tab of the Control Panel. Zoom in/out as required using the map navigation tools. When all relevant sites are selected, screen shot the map and/or click the 'save map' icon and save as a .tif image.

2) Note the 'Approximate selected area' figure provided at the bottom right-hand corner of the screen. This figure will be useful in other areas of the risk assessment.

3) Now open the 'Target Region' tab on the left-hand side of the Control Panel. Run the match by clicking the 'run match' icon. A map of Australia will be produced. Zoom into Tasmania using the 'Australia 20k Grid' data set then screen shot the map and/or click the 'save map' icon and save as a .tif image.

Further information can be found in the Climatch V2 User Manual (accessed by clicking 'Manual' on the Control Panel.

To determine the Climate Euclidian Sum, count the total number of cells in Tasmania that are within the top five climate match classes. Specifically, cell scores 10 + 9 + 8 + 7 + 6 = Value X. The Climate Match Score can then be determined according to the total number of squares that are in these climate match classes as shown in the table below:

Climate Euclidian Sum Level 6 (Value X)	Climate Match Score (B1)
≥ 162	6 (Extreme)
102 – 161	5 (Very High)
54 – 101	4 (High)
26 – 53	3 (Moderate)
6 – 25	2 (Low)
<6	1 (Very Low)

B2. Exotic Population Established Overseas Score (0-4)

An assessment is then made on the number of exotic populations that the species has established. Establishment includes maintaining a viable population, even if these populations only persist in highly modified environments with no natural food supplies or shelter. If the species is only maintained via captive breeding populations or populations that are intentionally fed or sheltered, they are not considered established. If a species persisted for at least 20 years, before being eradicated, the event also counts as an establishment event. The exotic population establishment score is calculated on the following basis:

- Exotic populations have been established on a large island (> 50 000 km^2)[1] or anywhere on a continent, including the Australian mainland. This includes

[1] Tasmania's land area is 67 800 km^2.

populations that have been established due to human introduction on continents within the natural range of the animal, provided the population is geographically separate from the natural population (**B2 = 4**)

- Exotic populations have only established on small islands (<50 000 km^2) (**B2 = 2**)
- No exotic populations have been established (**B2 = 0**).

B3. Overseas Range Size Score (0-2)

The Bomford model then calculates the overseas range score. For the purposes of estimating the overseas range in Tasmanian risk assessments, populations of species on the Australian mainland are also included in the calculation. The overseas range size, including both natural and introduced populations, is categorised as follows:

Overseas Range Size (million km^2)	Overseas Range Size Score (B3)
> 70 million km^2	**2**
1 – 70 million km^2	**1**
< 1 million km^2	**0**

B4. Taxonomic Class Score (0-1)

This score is calculated on the following basis:

- Mammal (**B4 = 1**)
- Bird (**B4 = 0**)

Establishment Risk Score

A species' establishment risk score is then calculated as the sum of B1 to B4.

Establishment Risk Rank

The species' establishment risk score is then converted to an establishment risk ranking using the following rules:

Establishment Risk Rank	Establishment Risk Score
Extreme	11 – 13
High	9 – 10
Moderate	6 – 8
Low	≤ 5

SECTION 2: LIKELIHOOD OF ESTABLISHMENT FOR REPTILES AND AMPHIBIANS

The following instructions for using the Reptile and Amphibian Model to rank establishment risk for exotic reptiles are adapted from Bomford (2008 p.55-61). The Bomford model is based on an analysis of the historical outcome of biological introductions (Bomford 2008; Bomford *et al.* 2009). The model uses Kraus' database of reptiles and amphibians (Kraus 2009) to determine the proportion of introduction events worldwide that were successful for a given Family, Genus and Species. Three factors are used to estimate the likelihood of establishment in these models: the Family Random Effect Value; Prop.species Value; and S (Climate 6 value). The method for determining each of these parameters is discussed below.

B1. Family Random Effect Value

Family Random Effect values are provided in Table 3.2 of Bomford (2008). These values are only available for species that were introduced into Britain, California, and Florida and assessed by

Bomford (2008). If a Family Random Effect value is not available, the average value used in Bomford *et al.* (2009) of -0.61 is used. To determine the sensitivity of the assessment to this parameter the maximum value (1.69) and minimum (-1.3) can be used to determine whether it has a significant effect on the outcome of the risk assessment. Where there is uncertainty about this value a precautionary approach (that is, assuming a maximum value of the family random effect value) is recommended.

B2. Proportion of Introduction Events that Led to Species Establishment (Prop.species Value)

The Prop.species Value is the proportion of introduction events for a species that resulted in successful establishment. The database developed by Kraus (2009), which includes the outcome of more than 2000 introduction events, is used as the source of this data. Where there are fewer than three introduction events with known outcomes for a species, introduction events for all other species in that Genus with three or more introduction events are combined into a single success rate. This value is known as the Prop.genus Value. Likewise, where there are fewer than three introduction events for a Genus, a Prop.family Value is calculated using the same process at the Family level, and that value is used in the model.

B3. S(Climate 6 value)

Determine Value X for the species using Climatch (using the same process outlined above in Section 1 for mammals and birds).

The Climate 6 Score = Value X divided by 167 (the number of cells in Tasmania). The Bomford (2008) method then determines the S(Climate 6) value from the following equation:

S(Climate 6) = 4.25 x (Climate 6 Score) - 1.88

For example:

i. Value X = 25
ii. Climate 6 Score = 25/167 = 0.15
iii. 4.25 x 0.15 = 0.64
iv. 0.64 - 1.88 = -1.24
v. S(Climate 6) = **-1.24**

Establishment Risk Score

The Establishment Risk Score is then determined using the following equation:

Establishment Risk Score = 1/ (1 + exp * (0.80 – 2.90 (Prop.species) – S(Climate6) – Family Random Effect)).

Note: If Prop.genus or Prop.family is the only value available, it is used in place of Prop.species in the equation.

Establishment Risk Rank

The Establishment Risk Rank is then determined as follows:

Establishment Risk Rank	Establishment Risk Score
Extreme	≥ 0.86
High	0.40 – 0.85
Moderate	0.17 – 0.39
Low	≤ 0.16

C. CONSEQUENCE OF ESTABLISHMENT IN TASMANIA

Consequence of establishment

The third factor used to assess the level of threat a species represents is the potential consequence of an establishment in Tasmania. The method to quantitatively assess the potential consequences of mammals, birds, reptiles and amphibians is outlined in this section. Bomford (2008) recommends using a qualitative and quantitative approach for the assessment of reptiles and amphibians. The criteria to conduct a qualitative assessment of the consequences of establishment of reptiles and amphibians are outlined at the end of this section.

C1. Taxonomic group (0-4)

Bomford (2003) has determined several factors that can predict whether introduced species will become pests. This includes species that have detrimental environmental impact through effects on prey abundance and/or cause habitat degradation; species that are prone to causing agricultural damage; and species that can hybridise with native species. Animals noted for causing environmental impacts include the Carnivora (carnivores such as foxes, cats, dingos and ferrets), Artiodactyla (even-toed ungulates such as pigs, camels, deer, goats, and buffalo), Rodentia (rodents such as rats and mice), Lagomorpha (hares, rabbits and squirrels), Perissodactyla (odd-toed ungulates such as horses, zebras, donkeys and rhinoceroses) and Marsupialia (pouched mammals such as possums, kangaroos, wallabies and koalas).

Mammals and birds that belong to families that have been established in new areas and caused agricultural damage include Canidae (foxes and dogs), Mustelidae (stoats and ferrets), Cervidae (deer), Leporidae (rabbits and hares), Muridae (rodents), Bovidae (cattle, sheep and goats), Phascolarctidae (koalas), Psittaciformes (parrots), Fringillidae (old-world finches), Ploceidae (sparrows and weavers), Sturnidae (starlings and mynas), Anatidae (ducks, geese, and swans), and Corvidae (crows).

Introduced birds can also impact on native species through hybridisation. Birds in families that are likely to hybridise with native species include the Anatidae (ducks, geese and swans), Phasianidae (pheasants and partridges), Cacatuidae (cockatoos) and Psittacidae (parrots).

The Bomford model ranks the potential consequences according to the taxonomic group that the species belongs to as follows:

- Mammal in one of the orders that have been demonstrated to have detrimental effects on prey abundance and/or habitat degradation (Carnivora, Artiodactyla, Rodentia, Lagomorpha, Perissodactyla and Marsupialia) (**C1 = 2**).

AND/OR

- Mammal in one of the families that are particularly prone to causing agricultural damage (Canidae, Mustelidae, Cervidae, Leporidae, Muridae, Bovidae, Phascolarctidae) = (**C1 = 2**) (score 4 if the dot point above also applies).
- Birds in one of the orders or families that are particularly prone to causing agricultural damage (Psittaciformes, Fringillidae, Ploceidae, Sturnidae, Anatidae, and Corvidae) (**C1 = 2**).

AND/OR

- Bird in one of the families likely to hybridise with native species (including but not limited to Anatidae, Phasianidae, Cacatuidae and Psittacidae), and if there are relatives in the same genus among Tasmanian native birds (**C1 = 1**) (or **C1 = 3** if the dot point

above also applies).
Other group (**C1 = 0**).

C2. Overseas range size (0-2)

Estimate the species range (including current and past 1000 years, natural and introduced range).

- Less than 10 million square kilometres (**C2 = 0**).
- 10 – 30 million square kilometres (**C2 = 1**).
- Greater than 30 million square kilometres (**C2 = 2**).
- Unknown geographic range (**C2 = 2**).

C3. Diet and feeding (0-3)

Species are ranked on the following basis:

- Mammal that is a strict carnivore (eats only animal matter) and arboreal (climbs trees for anyreason) (**C3 = 3**).
- Mammal that is a strict carnivore and strictly ground living (**C3 = 2**).
- Mammal that is not a strict carnivore (mixed animal-plant matter in diet) (**C3 = 1**).
- Mammal that is primarily a grazer or browser (**C3 = 3**).
- Other herbivorous mammal or not a mammal (**C3 = 0**).
- Unknown diet (**C3 = 3**).

C4. Competition with native fauna for tree hollows (0-2)

- Can nest or shelter in tree hollows (**C4 = 2**).
- Does not use tree hollows (**C4 = 0**).
- Unknown (**C4 = 2**).

C5. Overseas environmental pest status (0-3)

The overseas environmental pest status is then determined based on whether the species has been reported to cause declines in abundance of any native species of plant or animal or caused degradation to any natural community in any country or region of the world.

- Major environmental pest in any country or region (**C5 = 3**).
- Moderate environmental pest in any country or region (**C5 = 2**).
- Minor environmental pest in any country or region (**C5 = 1**).
- Never reported as an environmental pest in any country or region (**C5 = 0**).
- Unknown overseas environmental pest status (**C5 = 3**).

C6. Climate match to areas with susceptible native species or communities (0-5)

The Tasmanian native species and communities that could be impacted if the species established in Tasmania is considered by comparing the distribution of susceptible species and communities with the climate match output. This includes criteria for evaluating impact on Tasmanian native species and native communities that are not listed as threatened under Tasmanian legislation as well as criteria for categorising potential impacts on Tasmanian threatened species. First any native species or communities that could be susceptible to harm by the exotic animal if it established in the State are identified. The literature in relation the impacts of the species, diet and habitat use should be used to identify any impacts that may occur.

Next the geographic distribution of the susceptible species or communities (both non-listed and listed threatened species) are compared with the climate match map that was generated in the Likelihood of Establishment assessment (see section B1). The potential impact of the species is determined by the number of grid squares within specified climate match classes that overlap with the distribution of any susceptible native species or ecological communities.

The potential impact of the species on susceptible native species or communities (non-listed and listed threatened species) is ranked as follows:

- The species has more than 10 grid squares within the highest two climate match classes, and/or has more than 20 grid squares within the highest four climate match classes, that overlap the distribution of any susceptible native species or ecological communities that are not listed as threatened;
  OR
  75% of the geographic range of one or more susceptible native species or ecological communities that are listed as threatened under Tasmanian legislation lies within the mapped area of the six climate match classes (10, 9, 8, 7, 6, and 5);
  OR
  The range of the species is unknown and the climate match to Tasmania is unknown (**C6 = 5**).

- The species has 6 to 10 grid squares within the highest two climate match classes, and/or has 11 to 20 grid squares within the highest four climate match classes that overlap the distribution of any susceptible native species or ecological communities that are not listed as threatened;
  OR
  50% of the geographic range of one or more susceptible native species or ecological communities that are listed as threatened under Tasmanian legislation lies within the mapped area of the six climate match classes (10, 9, 8, 7, 6, and 5) (**C6 = 4**);

- The species has 1 to 5 grid squares with the highest two climate match classes (i.e. classes

10 and 9) and/or has 6 to 10 grid squares within the highest four climate match classes that overlap the distribution of any susceptible native species or ecological community that are not listed as threatened;
OR
25% of the geographic range of one or more susceptible native species or ecological communities that are listed as threatened under Tasmanian legislation lies within the mapped area of the six climate match classes (10, 9, 8, 7, 6, and 5) (**C6 = 3**).

- The species has no grid squares within the two highest climate match classes (i.e. classes 10 and 9) and has 1-5 grid squares within the highest four climate match classes (i.e. classes 10 to 7) that overlap the distribution of any susceptible native species or ecological communities including species listed as threatened (**C6 =2**).

- The species has no grid squares within the highest four climate match classes (i.e. classes 10 to 7) that overlap the distribution of any susceptible native species or communities that are not listed as threatened and has more than one grid square within the highest six climate match classes (i.e. classes 10 to 5) that overlap the distribution of any susceptible native species or ecological communities that are not listed as threatened (**C6 = 1**).

- The species has no grid squares within the highest six climate match classes (i.e. 10 to 5) that overlap the distribution of any susceptible native species or ecological communities (**C6 = 0**).

C7. Overseas primary production (0-3)

Reports of the species damaging crops or other primary production in any region in the world are then assessed and the species is categorised as follows:

- Major pest of primary production in any country or region (**C7 = 3**).
- Moderate pest of primary production in any country or region (**C7 = 2**).
- Minor pest of primary production in any country or region (**C7 = 1**).
- No reports of damage to crops or other primary production in any country or region (**C7 = 0**).
- Unknown primary production pest status (**C7 = 3**).

C8. Climate match to susceptible primary production (0-5)

Potential Commodity Impact Scores (PCIS) are determined for each primary industries commodity listed in Table 1. The potential impact for each primary industries sector is categorised as follows:

- Extreme (the species can cause damage at high levels to this or similar commodities and/or major control programs have been conducted against the species in any country or region and the listed commodity would be vulnerable to the type of harm this species can cause) (**PCIS = 3**).

- Moderate to serious (there are reports of damage to this or a similar commodity, but damage levels have never been high in any country or region and no major control programs against the species have ever been conducted OR the species has attributes making it capable of damaging this or similar commodities but has not had the opportunity) (**PCIS = 2**).
- Low (the species has attributes making it capable of damaging this or a similar commodity, and has had the opportunity, but there are no reports or other evidence that it has caused damage in any country or region) (**PCIS = 1**).
- Nil (the species does not have attributes to make it capable of damaging this commodity) (**PCIS = 0**).

The PCIS score is entered into column 3 of Table 1 over page.

Industry	Commodity Value Index (CVI)	Potential Commodity Impact Score (PCIS, 0-3)	Climate Match to Commodity Score (CMCS, 0-5)	Commodity Damage Score (CDS columns 2 x 3 x 4)
Cattle (includes dairy and beef)	11			
Timber (includes native and plantation forests)	10			
Aquaculture	6			
Sheep (includes wool and meat)	5			
Vegetables	5			
Fruit (includes wine grapes)	5			
Poultry (including eggs)	1.5			
Cereal grain (includes wheat, barley, sorghum etc)	1			
Other crops and horticulture (includes nuts and flowers)	1			
Pigs	1			
Bees (includes honey, beeswax, and pollination)	0.5			
Oilseeds (includes canola, sunflower etc)	0.5			
Grain legumes (includes soybeans)	0.3			
Other livestock (includes goats and deer)	0.3			
Total Commodity Damage Score (TCDS)	-	-	-	

Table 1. Calculating Total Commodity Damage Score. The Commodity Value Index (CVI) is an index of the value of the annual production of the commodity. Bomford (2008) recommends that adjustments to the CVI should be made when potential damage by the species is restricted to a component of the commodity being assessed. For example, some species may consume pasture and therefore cause an impact on livestock in pastures, but not impact on feedlots. The Commodity Value Index has been modified from Bomford (2008) to reflect the relative value of each primary industry sector in Tasmania.

A Climate Match to Commodity Score (CMCS) for the species in Tasmania is then calculated by comparing the geographic distribution of susceptible agricultural commodities in Tasmania with the climate match output developed in stage B (i.e. the potential distribution of the species in Tasmania). The CMCS is calculated as follows:

- More than 20% of the commodity is produced in areas where the species has a climate match within the highest three climate match classes (i.e. 10, 9 and 8) OR the overseas and Australian mainland range and climate match to Tasmania is unknown (**CMCS = 5**).
- More than 50% of the commodity is produced in areas where the species has a climate match within the highest six climate match classes BUT less than 20% of the commodity is produced in areas where the species has a climate match within the highest three climate match classes;
  OR
  Between 10% and 50% of the commodity is produced in areas where the species has a climate match within the highest six climate match classes AND more than 10% of the commodity is produced in areas where the species has a climate match within the highest three climate match classes (**CMCS = 4**).
- Between 10% and 50% of the commodity is produced in areas where the species has a climate match within the highest six climate match classes BUT less than 10% of the commodity is produced in areas where the species has a climate match within the highest three climate match classes (**CMCS = 3**).
- Between 1% and 10% of the commodity is produced in areas where the species has a climate match within the highest six climate match classes (**CMCS = 2**).
- Between 1% and 10% of the commodity is produced in areas where the species has a climate match within the highest eight climate match classes (**CMCS = 1**).
- None of the commodity is produced in areas where the species has a climate match within the highest eight climate match classes (i.e. classes 10, 9, 8, 7, 6, 5, 4 and 3) (**CMCS = 0**).

The CMCS score is entered into column 4 of Table 1.

The potential Commodity Damage Scores (CDS) are then determined by multiplying the Commodity Value Indices (CVI) in Column 2, with the Potential Commodity Impact Scores (PCIS) in Column 3 and the Climate Match to Commodity Score (CMCS) in Column 4. The product of the three scores in then entered into column 5 of Table 1. A Total Commodity Damage Score (TCDS) is then determined as the sum of column 5.

The total score for C8 (climate match to susceptible primary production) is then determined based on the following criteria:

Total Commodity Damage Score (TCDS)	Climate match to susceptible primary production (C8)
≥ 150	5
100 – 149	4
50 – 99	3
20 – 49	2
1 – 19	1
0	0

C9. Spread of disease (1-2)

The risk that the species could spread diseases or parasites in Tasmania is then assessed. The increased level of risk is only assessed for those diseases and parasites already in Tasmania. The risk that individual animals of the species could carry exotic diseases or parasites in with them when they are imported into Tasmania is subject to a separate assessment and management conducted under the *Animal Health Act 1995*. The risk that the species could spread disease or parasites within Tasmania is categorised as follows:

- All birds and mammals (likely or unknown effect on native species and on livestock and other domestic animals) (**C9 = 2**).
- All amphibians and reptiles (likely or unknown effect on native species, generally unlikely to affect livestock and other domestic animals) (**C9 = 1**).

C10. Harm to property (0-3)

The potential for the species to inflict damage on property (including buildings, vehicles, fences, roads, equipment or ornamental gardens), or to require the building of additional infrastructure (such as fences) is then assessed. The property damage is estimated assuming that the species established throughout the area of Tasmania where there was a climate match score of 5 or higher based on the analysis in stage B, Score B1.

The property damage risk score is calculated on the basis of the total annual dollar value of damage that may occur as follows:

Estimated annual value of damage	Property damage risk score (C10)
> $5 million / year	3
$1.1 – $5 million / year	2
$100,000 - $1 million / year	1
< $100,000	0

C11. Harm to people (0-5)

It is then assessed whether the species could cause harm to or annoy people. The species is categorised based on the following:

- Injuries or harm moderate, severe, or fatal and many people at risk (**C11 = 5**).
- Injuries or harm severe or fatal but few people at risk (**C11 = 4**).
- Injuries or harm moderate but unlikely to be fatal and few people at risk;

OR

Annoyance moderate or severe but few people exposed;

OR

Injuries, harm, or annoyance minor but many people at risk (**C11 = 3**).

- Injuries or harm or annoyance likely to be minor and few people exposed (**C11 = 2**).
- Low risk of harm to people (**C11 = 1**).
- Negligible risk (**C11 = 0**).

Pest Risk Score

The Pest Risk Score (C) is the sum of risk scores under section C1 to C11.

Pest Risk Rank

The consequence of establishment is then determined using the following thresholds:

Consequence of Establishment	Pest Risk Score (Sum C1 to C11)
Extreme	> 19
Serious	15 – 19
Moderate	9 – 14
Low	≤ 8

Qualitative assessment of the consequence of establishment: reptiles and amphibians

The method outlined above quantitatively assesses the potential consequences of the establishment of mammals, birds, reptiles and amphibians. However, Bomford (2008) recommends using a combination of qualitative and quantitative approaches for the assessment of reptiles and amphibians because of the great level of uncertainty surrounding the impact of those species. The following checklist can be used as part of the qualitative assessment. Does the species:

- have adverse impacts elsewhere;
- have close relatives with similar behavioural and ecological strategies that have had adverse impacts elsewhere;

- have a generalist diet;
- stir up sediments to increase turbidity in aquatic habitats;
- occur in high densities in their native or introduced range;
- have the potential to cause poisoning and/or physical injury;
- harbour or transmit diseases or parasites that are present in Tasmania;
- have close relatives among Tasmania's endemic reptiles and amphibians; and
- have a record of spreading rapidly following their release into new environments?

Risk assessments are conducted quantitatively initially for reptiles and amphibians, and then the outcome of this assessment is validated using the checklist provided above. If the qualitative assessment suggests that the potential for additional consequences of an introduction is higher than the quantitative estimate, then the qualitative assessment of the consequence of establishment will be used.

4. ASSIGNMENT TO THREAT CATEGORIES

The three scores from sections A, B and C are then used to assign the exotic species to one of four threat categories (extreme, serious, moderate or low) using the rules for combining scores specified in Table 2.

Table 2: Assigning species to threat categories (overpage):

A: Danger posed by individual animals (risk a captive or escaped individual would harm people)	**B: Likelihood of establishment** (risk that a particular species will establish a wild population in Tasmania)	**C: Consequence of establishment** (risk that an established population would cause harm)	**Threat category**
Highly, Moderately or Not Dangerous	Extreme	Extreme	Extreme
Highly, Moderately or Not Dangerous	Extreme	High	
Highly, Moderately or Not Dangerous	Extreme	Moderate	
Highly, Moderately or Not Dangerous	Extreme	Low	
Highly, Moderately or Not Dangerous	High	Extreme	
Highly, Moderately or Not Dangerous	High	High	
Highly, Moderately or Not Dangerous	Moderate	Extreme	
Highly, Moderately or Not Dangerous	High	Moderate	Serious
Highly, Moderately or Not Dangerous	High	Low	
Highly, Moderately or Not Dangerous	Moderate	High	
Highly Dangerous	Moderate	Moderate	
Highly Dangerous	Moderate	Low	
Highly, Moderately or Not Dangerous	Low	Extreme	
Highly, Moderately or Not Dangerous	Low	High	
Highly Dangerous	Low	Moderate	
Highly Dangerous	Low	Low	
Moderately or Not Dangerous	Moderate	Moderate	Moderate
Moderately or Not Dangerous	Moderate	Low	
Moderately or Not Dangerous	Low	Moderate	
Moderately Dangerous	Low	Low	
Not Dangerous	Low	Low	Low
Unknown	Any value	Any value	Extreme until proven otherwise
Any Value	Unknown	Any value	
Any Value	Any value	Unknown	
Unassessed	Unassessed	Unassessed	

5. ASSUMPTIONS AND LIMITATIONS

The assumptions and limitations of the risk assessment model are discussed in detail in Dr Mary Bomford's publications (Bomford 2003; Bomford 2008). Significantly it is noted that the model for mammals and birds is different to the approach for reptiles and amphibians (Bomford 2003; Bomford 2008). There are also several additional assumptions and limitations that are specific to applying the Bomford model when assessing the level of threat of introduced mammals, birds, reptiles and amphibians to Tasmania.

Applying the Australian model to Tasmania

The way in which the model for the introduction of vertebrate wildlife into Australia is applied to Tasmania assumes that the likelihood of establishment of introduced species in Tasmania is the same as that which has been observed in Australia as a whole. This is because the Bomford model was calibrated based on the history of introduction events in Australia.

It is also assumed that the updated climate modelling software developed by DAWE (Climatch V2) is reliable in Tasmania. This is most likely to pose an issue in areas such as the south west wilderness area, which have fewer meteorological stations than the more populated areas of Tasmania. Likewise, the climate modelling software is also reliant on the input of meteorological data in areas overseas and interstate where the species being assessed is present. If a species' distribution covers areas with few meteorological stations, then the risk assessment may underestimate the level of risk. In this situation a precautionary approach is recommended as discussed in the method above.

Future development

Future development of this model for the Tasmanian context could include testing the model against introduction events that have been successful and unsuccessful in the State to determine whether the model predictions are reliable. However, the small sample size of Tasmanian introductions is unlikely to provide statistically robust results. It is likely that this will remain an area of significant uncertainty because there are many factors that affect the likelihood of introduction of a species and the potential consequences (for discussion see Bomford 2008).

Conclusions

As with any model, there are a number of assumptions and limitations associated with applying the Bomford model to assess the risk of introductions into Tasmania. It is therefore critical that, in addition to applying the model rigorously for each assessment, the results are qualitatively assessed to determine whether there are any factors that suggest that the risk assessment results are not reliable. If there is significant uncertainty surrounding an assessment a precautionary approach should be adopted, suitable to the situation.

Management options that are recommended in response to the outcome of pest risk assessments should take into account the uncertainty surrounding assessments.

It is considered that the advantages of the approach outweigh the limitations of the model. The model is internationally recognised as world's best practice (Simons & De Poorter 2009). It has been applied routinely in a number of situations within Australia both nationally and by the Western
Australian and Queensland Governments. Finally, the approach uses accessible climate matching software (Climatch V2) to assess the likelihood of establishment that is both easy to use and publicly available, and therefore can be used by stakeholders wishing to have a species assessed for possible inclusion on the list of wildlife suitable for import.

6. CONTACT

For further information about this risk assessment methodology, or any supporting documents, contact Wildlife Management of NRE Tasmania.

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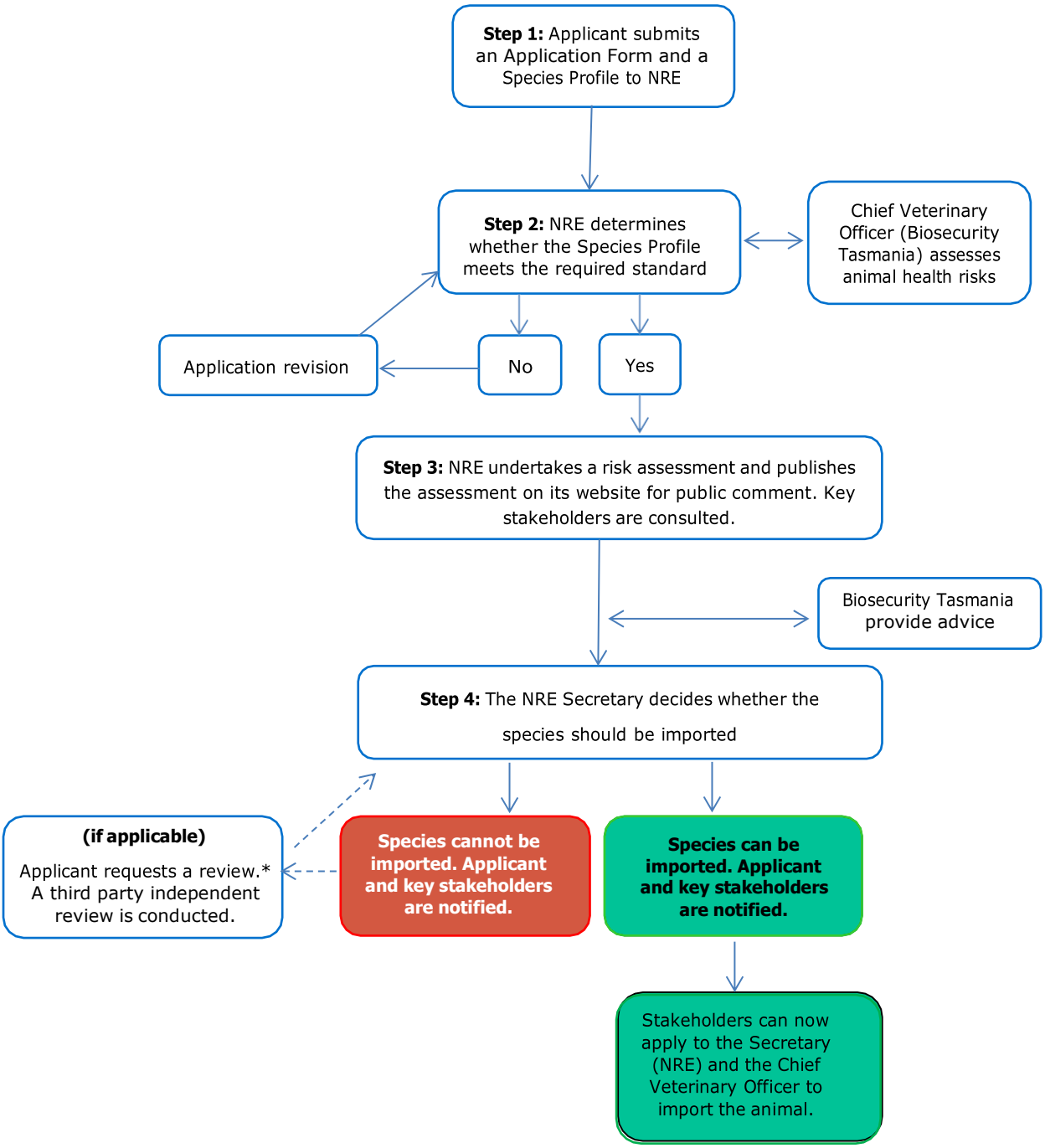
APPENDIX 1: PROCESS FOR APPLICATIONS, ASSESSMENTS AND DECISIONS

The flow chart below shows the process for applying to import a species and associated decision making. The assessment is conducted by the Natural Values, Science & Services Branch and Biosecurity Tasmania (BT) Divisions within NRE. The process supports public consultation and allows for decisions to be reviewed by an independent third party.



** Note the Secretary may decide that an independent review is not appropriate. Rights of review under the* Judicial Review Act 2002 *and review mechanisms for administrative matters provided by the Ombudsman Tasmania are also available.*

APPENDIX 2: TEMPLATE RISK ASSESSMENT FOR BIRDS AND MAMMALS

Species:		
Date of Assessment:		
Literature search type and date:		
Factor	**Score**	
A1. Risk posed from individual escapees (0-2)		
A2. Risk to public safety from individual captive animals (0-2)		
Stage A. Risk posed by individual animals (risk that a captive or escape animal would harm people)	**Public Safety Risk Score** = A1 + A2 =	**Public Safety Risk Ranking** A ≥ 2, Highly Dangerous A = 1, Moderately Dangerous A = 0, Not Dangerous =
B1. Climate match score (1-6)		
B2. Exotic population established overseas score(0-4)		
B3. Overseas range size score (0-2)		
B4. Taxonomic class score (0-1)		
Stage B. Likelihood of establishment (risk that a particular species will establish a wild population in Tasmania)	**Establishment Risk Score** = B1 + B2 + B3 + B4 =	**Establishment Risk Ranking** B = 11-13, ExtremeB = 9-10, High B = 6-8, Moderate B ≤ 5, Low =
C1. Taxonomic group (0-4)		
C2. Overseas range size (0-2)		
C3. Diet and feeding (0-3)		
C4. Competition for native fauna for tree hollows(0-2)		
C5. Overseas environmental pest status (0-3)		
C6. Climate match to areas with susceptible native species or communities (0-5)		
C7. Overseas primary production (0-3)		
C8. Climate match to susceptible primary production (0-5)		
C9. Spread disease (1-2)		
C10. Harm to property (0-3)		
C11. Harm to people (0-5)		

Stage C. Consequence of Establishment (risk that an established population would cause harm)	Consequence Risk Score = sum of C1 to C11 =	Consequence Risk Ranking C > 19, Extreme C = 15-19, High C = 9-14, Moderate C < 9, Low =
ASSIGNED THREAT CATEGORY:	**EXTREME** **SERIOUS** **MODERATE** **LOW** **EXTREME UNTIL PROVEN OTHERWISE**	
PROPOSED IMPORT CLASSIFICATION:	**PROHIBITED** **IMPORT RESTRICTED TO THOSE LICENCE HOLDERS APPROVED FOR KEEPING SERIOUSTHREAT SPECIES** **IMPORT RESTRICTED TO THOSE LICENCE HOLDERS APPROVED FOR KEEPING MODERATETHREAT SPECIES** **IMPORT PERMITTED**	

Calculating Total Commodity Damage Score

Industry	Commodity Value Index (CVI)	Potential Commodity Impact Score (PCIS, 0-3)	Climate Match to Commodity Score (CMCS, 0-5)	Commodity Damage Score (CDS columns 2 x 3 x 4)
Cattle (includes dairy and beef)	11			
Timber (includes native and plantation forests)	10			
Aquaculture	6			
Sheep (includes wool and meat)	5			
Vegetables	5			
Fruit (includes wine grapes)	5			
Poultry (including eggs)	1.5			
Cereal grain (includes wheat, barley, sorghum etc)	1			
Other crops and horticulture(includes nuts and flowers)	1			
Pigs	1			
Bees (includes honey, beeswax, andpollination)	0.5			
Oilseeds (includes canola, sunfloweretc)	0.5			
Grain legumes (includes soybeans)	0.3			
Other livestock (includes goats anddeer)	0.3			
Total Commodity Damage Score (TCDS)				

A: Danger posed by individual animals (risk a captive or escaped individual would harm people)	**B: Likelihood of establishment** (risk that a particular species will establish a wild population in Tasmania)	**C: Consequence of establishment** (risk that an established population would cause harm)	**Threat category**
Highly, Moderately or Not Dangerous	Extreme	Extreme	Extreme
Highly, Moderately or Not Dangerous	Extreme	High	
Highly, Moderately or Not Dangerous	Extreme	Moderate	
Highly, Moderately or Not Dangerous	Extreme	Low	
Highly, Moderately or Not Dangerous	High	Extreme	
Highly, Moderately or Not Dangerous	High	High	
Highly, Moderately or Not Dangerous	Moderate	Extreme	
Highly, Moderately or Not Dangerous	High	Moderate	Serious
Highly, Moderately or Not Dangerous	High	Low	
Highly, Moderately or Not Dangerous	Moderate	High	
Highly Dangerous	Moderate	Moderate	
Highly Dangerous	Moderate	Low	
Highly, Moderately or Not Dangerous	Low	Extreme	
Highly, Moderately or Not Dangerous	Low	High	
Highly Dangerous	Low	Moderate	
Highly Dangerous	Low	Low	
Moderately or Not Dangerous	Moderate	Moderate	Moderate
Moderately or Not Dangerous	Moderate	Low	
Moderately or Not Dangerous	Low	Moderate	
Moderately Dangerous	Low	Low	
Not Dangerous	Low	Low	Low
Unknown	Any value	Any value	Extreme until proven otherwise
Any Value	Unknown	Any value	
Any Value	Any value	Unknown	
Unassessed	Unassessed	Unassessed	

APPENDIX 3: TEMPLATE RISK ASSESSMENT FOR REPTILES AND AMPHIBIANS

Species:	**Common name *(Genus species)***	
Date of Assessment:		
Literature search type and date:		
Factor	**Score**	
A1. Risk posed from individual escapees (0-2)		
A2. Risk to public safety from individual captive animals (0-2)		
Stage A. Risk posed by individual animals (risk that a captive or escape animal would harm people)	**Public Safety Risk Score** = A1 + A2 =	**Public Safety Risk Ranking** A ≥ 2, Highly Dangerous A = 1, Moderately Dangerous A = 0, Not Dangerous =
B1. Family random effect value		
B2. Proportion of introduction events that ledto species establishment (Prop.species value)		
B3. S(Climate 6 value)		
Stage B. Likelihood of establishment (risk that a particular species will establish a wild population in Tasmania)	**Establishment Risk Score** = 1/ (1 + exp(0.80 – 2.90 (Prop. species) – S(Climate6) – Family Random Effect)) =1/(1+EXP(0.8-2.9*(Prop. species)-S(Climate6)-(Family Random Effect))) =	**Establishment Risk Ranking** B = ≥0.86, ExtremeB = 0.40-0.85, High B = 0.17-0.39, Moderate B = ≤ 0.16, Low =
C1. Taxonomic group (0-4)		
C2. Overseas range size (0-2)		
C3. Diet and feeding (0-3)		
C4. Competition for native fauna for tree hollows (0-2)		
C5. Overseas environmental pest status (0-3)		
C6. Climate match to areas with susceptible native species or communities (0-5)		
C7. Overseas primary production (0-3)		
C8. Climate match to susceptible primary production (0-5)		
C9. Spread disease (1-2)		
C10. Harm to property (0-3)		

C11. Harm to people (0-5)		
Stage C. Quantitative Consequence Assessment	**Consequence Risk Score** = sum of C1 to C11 =	**Consequence Risk Ranking** C > 19, Extreme C = 15-19, High C = 9-14, Moderate C < 9, Low =
Adverse impacts		
Close relatives with similar behavioural and ecological strategies that have had adverse impacts elsewhere		
Dietary generalists		
Stir up sediments to increase turbidity in aquatic habitats		
Occur in high densities in their native or introduced range		
Have the potential to cause poisoning and/or physical injury		
Harbour or transmit diseases or parasites thatare present in Australia		
Have close relatives among Australia's endemic reptiles and amphibians		
Are known to have spread rapidly following their release into new environments		
Stage C. Qualitative Consequence Assessment		
Stage C. Consequence of Establishment (risk that an established population would cause harm)	Quantitative Consequence:Qualitative Consequence: **Highest Consequence Assessment:**	
ASSIGNED THREAT CATEGORY:	**(delete those which don't apply)** **EXTREME** **SERIOUS** **MODERATE** **LOW** **EXTREME UNTIL PROVEN OTHERWISE**	
PROPOSED IMPORT CLASSIFICATION:	**(delete those which don't apply)** **PROHIBITED** **IMPORT RESTRICTED TO THOSE LICENSE HOLDERS APPROVED FOR KEEPING SERIOUS THREAT SPECIES** **IMPORT RESTRICTED TO THOSE LICENSE HOLDERSAPPROVED FOR KEEPING MODERATE THREAT SPECIES** **IMPORT PERMITTED**	

Calculating Total Commodity Damage Score

Industry	Commodity Value Index (CVI)	Potential Commodity Impact Score (PCIS, 0-3)	Climate Match to Commodity Score (CMCS, 0-5)	Commodity Damage Score (CDS columns 2 x 3 x 4)
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Aquaculture	6			
Sheep (includes wool and meat)	5			
Vegetables	5			
Fruit (includes wine grapes)	5			
Poultry (including eggs)	1.5			
Cereal grain (includes wheat, barley, sorghum etc)	1			
Other crops and horticulture (includes nuts and flowers)	1			
Pigs	1			
Bees (includes honey, beeswax, and pollination)	0.5			
Oilseeds (includes canola, sunflower etc)	0.5			
Grain legumes (includes soybeans)	0.3			
Other livestock (includes goats and deer)	0.3			
Total Commodity Damage Score (TCDS)				

A: Danger posed by individual animals (risk a captive or escaped individual would harm people)	**B: Likelihood of establishment** (risk that a particular species will establish a wild population in Tasmania)	**C: Consequence of establishment** (risk that an established population would cause harm)	**Threat category**
Highly, Moderately or Not Dangerous	Extreme	Extreme	Extreme
Highly, Moderately or Not Dangerous	Extreme	High	
Highly, Moderately or Not Dangerous	Extreme	Moderate	
Highly, Moderately or Not Dangerous	Extreme	Low	
Highly, Moderately or Not Dangerous	High	Extreme	
Highly, Moderately or Not Dangerous	High	High	
Highly, Moderately or Not Dangerous	Moderate	Extreme	
Highly, Moderately or Not Dangerous	High	Moderate	Serious
Highly, Moderately or Not Dangerous	High	Low	
Highly, Moderately or Not Dangerous	Moderate	High	
Highly Dangerous	Moderate	Moderate	
Highly Dangerous	Moderate	Low	
Highly, Moderately or Not Dangerous	Low	Extreme	
Highly, Moderately or Not Dangerous	Low	High	
Highly Dangerous	Low	Moderate	
Highly Dangerous	Low	Low	
Moderately or Not Dangerous	Moderate	Moderate	Moderate
Moderately or Not Dangerous	Moderate	Low	
Moderately or Not Dangerous	Low	Moderate	
Moderately Dangerous	Low	Low	
Not Dangerous	Low	Low	Low
Unknown	Any value	Any value	Extreme until proven otherwise
Any Value	Unknown	Any value	
Any Value	Any value	Unknown	
Unassessed	Unassessed	Unassessed	

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