Contents

National Risk Assessment: EXTREME

RISK ASSESSMENT FOR AUSTRALIA: **Blackbuck (*Antilope cervicapra*)**

Class – Mammalia**, Order –** Artiodactyla**, Family –** Bovidae**, Genus –** *Antilope.*

SPECIES:	Species description:
Antilope cervicapra (Linnaeus, 1758) **Synonyms:** *Capra cervicapra* (Linnaeus, 1758) *Antilope cervicapra centralis* (Zukowsky, 1928) *Antilope cervicapra rupicapra* (Muller, 1776) **Subspecies:** *Antilope cervicapra cervicapra* (Linnaeus 1758) *Antilope cervicapra rajputanae* (Zukowsky, 1927) **Common Names:** Indian Antelope Blackbuck	Blackbucks have a slender build and short tail with a body weight of between 19.5–56.7 kilograms for the males and between 19–33 kilograms for females. The shoulder height of the blackbuck is between 60 – 85 centimetres. The blackbuck is one of the few antelope species that exhibit pronounced sexual dimorphism. Males are easily distinguished by their large spiralling horns, which can reach 79 centimetres long. Females and juveniles are yellowish fawn on their back and head and are generally without horns. Both sexes have white underparts, including the insides of the legs and lower chest, as well as a white ring surrounding the eye and a white chin. The name 'blackbuck' is a reference to the dark colour of the males. Beginning at 2 years of age, males gradually darken with age, from tan to deep brown or black. **General information:** The blackbuck is native to parts of India, Pakistan and Nepal. Prior to the 19th century it was the most abundant ungulate in this region, with a population of around 4 million (Long, 2003). However, hunting and habitat loss has caused a substantial population decline (8,000 animals by 1964). The blackbuck is now listed as 'near threatened' on the IUCN Red List, with populations in Nepal and Pakistan regionally extinct. The blackbuck has been introduced into the United States of America, Argentina and Australia. It was first released in Texas in 1932, with repeated releases in subsequent years for hunting purposes. In 1988, the Texas Parks and Wildlife Department estimated the blackbuck population to be 21,232 (Willard, 1995). In Argentina, blackbucks where first introduced in 1906 (Long, 2003) and now have established populations. In Australia, blackbuck antelope were first introduced into Western Australia in the early 1900s (Allison, 1970). By 1929, wild populations near Perth were described as reaching "pest proportions" and were culled. The feral population in Western Australia is now considered no longer present. A small number of blackbucks were released (illegally) for hunting purposes on a Cape York (Queensland, Australia) grazing property in the late 1980s or early 1990s for sport. There were reliable reports of 4 to 5 animals surviving in the wild for a few years. Following trapping and

destruction efforts, these animals are believed to have died out. The species is a "declared pest" and is subject to restrictions in Queensland, Western Australia, New South Wales and Victoria.

The blackbuck can utilise a range of habitats including tropical and subtropical woodland, dry deciduous forest, open plains (grassland), riverbanks and semi-desert habitats. The blackbuck will also forage in crop land and pastureland (Long, 2003; Maldron, 2008). While generally sedentary, the blackbuck may move long distances in search of water and forage in the summer (Rahmani, 2001). In Texas (United States of America (USA)), naturalised populations inhabit rough, stony hills across the Edwards Plateau of southern central Texas, where elevation ranges from 400 to 1,000 metres. The climax vegetation in this region is described as "savannah and open grassland interspersed with dry scrub and woody plants such as mesquite" (Lever, 1985). More than 80% of blackbuck antelope in Texas inhabit the Edwards Plateau region, where the patchwork of open grassland and brush provides forage and cover. Their range is restricted to the north and west by cold winters, to the south by coyote predation and to the east by parasitism.

The blackbucks diet includes grass and cereal crops, leaves, forbs and browse (Long, 2003). The blackbuck is mainly diurnal, but sometimes nocturnal (Long, 2003). It lives either in groups (single or mixed sex, numbering anywhere from 15 to several thousand animals) or as single animals at densities of 0.5–3 per hectare (Long, 2003).

In its native range, mating can occur throughout the year but tends to be concentrated in two periods—March to May and August to October. During these times, males become territorial and maintain a territory of 1–100 hectares (Long, 2003). Females are sexually mature at approximately 15 months. Gestation is 5–6 months with females able to produce an average of 1.9 offspring per year (only a single offspring is born at a time, rarely two). The young can run soon after birth and are weaned at around 2 months.

Within India, the blackbuck damages several crops, particularly sorghum and millet (Jhala, 1993; Sekhar, 1998; Chauhan & Singh, 1990). It is reported to nibble on the young shoots of various cereal and pulse crops, but damage is not great (Chauhan & Singh, 1999). This study was unable to find published data on economic losses. Similarly, while the species is abundant in eastern Argentina and parts of Texas, impacts on crops and pasture are poorly documented. On some cattle grazing properties in eastern Argentina, blackbuck became so numerous that culling 'by the hundreds' was necessary (Barrett, 1968).

Longevity: Up to 18 years in the wild (Long, 2003). In captivity can live up to 23.9 years (Tacutu, 2018).

Conservation status:

	Once widespread across the entire subcontinent of India, its population has suffered a significant decline due to hunting and habitat modification. **IUCN –** Least Concern. Although range and numbers have declined during the last 100 years, blackbuck remain widespread and common in some areas, are increasing in many protected areas, and becoming a crop pest in other places. Habitat loss has reduced the overall range but is balanced, at least to some extent, by conversion of dense scrub and woodland to agriculture, creating more suitable, open habitats. Despite their adaptability, blackbucks are subject to increasing pressure from human population growth, increasing numbers of domestic livestock, and economic development. There are no quantified data on population trend, but even if the species is declining overall, there is no evidence to indicate a decline over 19 years (three generations) that is close to approaching the threshold for Vulnerable under criterion A. **CITES –** Appendix III
DATE OF ORIGINAL ASSESSMENT: 25/08/2009 **DATE OF CURRENT ASSESSMENT:** Nov 2020 (Jodi Buchecker) **EIC ENDORSEMENT:** 15/03/21 **Risk assessment model used for the assessment:** Bomford 2008, Mammals and Birds	**The risk assessment model:** Models for assessing the risk that exotic vertebrates could establish in Australia have been developed for mammals, birds (Bomford 2003, 2006, 2008), reptiles and amphibians (Bomford et al 2005, Bomford 2008). Developed by Dr Mary Bomford for the Bureau of Rural Sciences (BRS), the model uses criteria that have been demonstrated to have significant correlation between a risk factor and the establishment of populations of exotic species and the pest potential of those species that do establish. For example, a risk factor for establishment is similarity in climate (temperature and rainfall) within the species' distribution overseas and Australia. For pest potential, the species' overseas pest status is a risk factor. The model is published as 'Risk assessment models for the establishment of exotic vertebrates in Australia and New Zealand' (Bomford 2008) and is available online on the PestSmart website https://pestsmart.org.au/wp-content/uploads/sites/3/2020/06/Risk_Assess_Models_2008_FINAL.pdf **CLIMATE**: In 2021 a new version of the Climatch program used to assess similarity in climate was released by the Australian Bureau of Agricultural Resource Economics and Sciences (ABARES): CLIMATCH v2.0. The increase in resolution in this new version (from 50 km to 20 km) required recalibration of Climate Match Scores. See Table 1. Sixteen climate parameters (variables) of temperature and rainfall are used to estimate the extent of similarity between data from meteorological stations located within the species' world distribution and stations in Australia. Worldwide, data from approximately 19000 locations are available for analysis. The number of locations used in an analysis will vary according to the size of the species' distribution and the number of meteorological stations located within that distribution. To represent the climate match visually, the map of Australia is divided into 19236 grid squares, each measured in 0.2 degrees in both longitude and latitude. CLIMATCH v2.0 calculates a match for each Australian grid by comparing data from all meteorological stations within the species' distribution (excluding any populations in Australia) and allocating a score ranging from ten for the highest level match to zero for the poorest match. Levels of climate match are used in the risk assessment for questions B1 (scores are summed to give a cumulative score), C6, and C8. Climatch v2.0 can be accessed on the ABARES website, agriculture.gov.au/abares. The direct URL is https://climatch.cp1.agriculture.gov.au/.

Bird and Mammal Model:

FACTOR	SCORE	DETAIL
STAGE A: RISKS POSED BY CAPTIVE OR RELEASED ANIMALS		
A1. Risk to people from individual escapees (0–2) *Assess the risk that individuals of the species could harm people. (NB, this question only relates to aggressive behaviour shown by escaped or released individual animals. Question C11 addresses the risk of harm from aggressive behaviour if the species establishes a wild population).* *Aggressive behaviour, size, plus the possession of organs capable of inflicting harm, such as sharp teeth, claws, spines, a sharp bill, or toxin-delivering apparatus may enable individual animals to harm people. Any known history of the species attacking, injuring or killing people should also be taken into account. Assume the individual is not protecting nest or young.*	1	*Animal that is unlikely to make an unprovoked attack, but which can cause serious injury (requiring hospitalisation) or fatality if cornered or handled.* Blackbucks pose a low risk of harm to people. However, the males' large horns may have the ability to cause injury.
A2. Risk to public safety from individual captive animals (0–2) *Assess the risk that irresponsible use of products obtained from captive individuals of the species (such as toxins) pose a public safety risk (excluding the safety of anyone entering the animals' cage/enclosure or otherwise coming within reach of the captive animals)*	0	*Nil or low risk (highly unlikely or not possible).* Blackbucks pose no risk to public safety
STAGE A PUBLIC SAFETY RISK SCORE **SUM A1 - A2 (0-4)**	1	**Moderately dangerous**
STAGE B: PROBABILITY ESCAPED OR RELEASED INDIVIDUALS WILL ESTABLISH FREE-LIVING POPULATIONS		

Model 1: FOUR-FACTOR MODEL FOR BIRDS AND MAMMALS (BOMFORD 2008)

B1. Degree of climate match between species overseas range and Australia (1–6) *Map the selected mammal or bird species' overseas range, including its entire native and exotic (excluding Australia) ranges over the past 1000 years.* *Use CLIMATCH v2.0, CMS = sum of classes 6 – 10, see Table 1.*	3	*Moderate climate match to Australia* Value X = 3,910 Climate Match Score = 2 + 1 = 3 Due to the exact distribution of blackbucks within the USA and Argentina being unknown, and the Climate Match Score is at the top end of the '2' range with a score of 3,910 (680 – 4140), B1 score has been increased by 1 to not underestimate the species actual climate match to Australia.
B2. Exotic population established overseas (0–4) *An established exotic population means the introduced species must have bred outside of captivity and must currently maintain a viable free-living population where the animals are not being intentionally fed or sheltered, even though they may be living in a highly disturbed environment with access to non-natural food supplies or shelter.*	4	*Exotic population established on a larger island (> 50 000 km2) or anywhere on a continent (including elsewhere on the land mass where the natural distribution of the animal is, if this population is due to human introduction and is geographically separate from the natural range of the species).* Blackbuck have established feral populations in the USA and Argentina. Blackbucks require water daily, which restricts distribution to areas where surface water is available for the greater part of the year (Rahmani, 2001).
B3. Overseas range size score (0–2) < 1 = 0; 1– 70 = 1; >70 = 2 *Estimate the species overseas range size* including currently and the past 1000 years; natural and introduced range in millions of square kilometres*	1	*Overseas range size of less than 70 million square kilometres* (approximation)
B4. Taxonomic Class (0–1) Bird=0; mammal = 1	1	*Mammal*
B. ESTABLISHMENT RISK SCORE **SUM OF B1- B4 (1–13)**	9	**Serious establishment risk**
Model 2: Seven-Factor Model For Birds And Mammals (Bomford 2008)		
B5. Diet score (0–1) Specialist = 0; generalist = 1	1	*Generalist with a broad diet of many food types.* Blackbucks are generalist grazers (Novillo & Ojeda, 2008)

B6. Habitat score (0–1) *Undisturbed or disturbed habitat*	1	*Can survive and breed in human-disturbed habitats (including grazing and agricultural lands) without access to undisturbed (natural) habitats.*
B7. Migratory score (0–1) *Always migratory = 0; non-migratory = 1*	1	*Non-migratory or facultative migrant in its native range.*
B. ESTABLISHMENT RISK SCORE **SUM OF B1- B7 (1–16)**	12	**Serious establishment risk**

STAGE C: PROBABILITY AN ESTABLISHED SPECIES WILL BECOME A PEST		
C1. Taxonomic group (0–4)	4	*Mammal in one of the orders that have been demonstrated to have detrimental effects on prey abundance and/or habitat degradation (Artiodactyla) = 2.* *Mammal in one of the families that are particularly prone to cause agricultural damage (Bovidae) = 2.*
C2. Overseas range size including current and past 1000 years, natural and introduced range (0–2) *Estimate the species overseas range size (including current and past 1000 years, natural and introduced range) in millions of square kilometre*	0	*Overseas geographic range less than 10 million square kilometres.*
C3. Diet and feeding (0–3)	3	*Mammal that is a primarily a grazer or browser.*
C4. Competition with native fauna for tree hollows (0–2)	0	*Does not use tree hollows.*
C5. Overseas environmental pest status (0–3) *Has the species been reported to cause declines in abundance of any native species of plant or animal or cause degradation to any natural communities in any country or region of the world?*	1	*Minor environmental pest in any country or region* (Jhala, 1993; Chauhan & Singh, 1990)
C6. Climate match to areas with susceptible native species or communities (0–5)	5	*The species has more than 691 grid squares within the highest four climate match classes that overlap the distribution of any susceptible native species or ecological communities = 5*

Identify any native Australian animal or plant species or communities that could be susceptible to harm by the exotic species if it were to establish a wild population here.		Examples of susceptible native species or ecological communities include (DAWE Protected Matters Search Tool): Natural Grasslands of the Queensland Central Highlands and northern Fitzroy Basin – Endangered *Macrotis lagotis* (Greater Bilby) – Vulnerable
C7. Overseas primary production pest status (0–3) *Has the species been reported to damage crops or other primary production in any country or region of the world?*	2	*Moderate pest of primary production in any country or region.*
C8. Climate match to susceptible primary production (0–5) *Assess Potential Commodity Impact Scores for each primary production commodity listed in Table 9, based on species' attributes (diet, behaviour, ecology), excluding risk of spreading disease which is addressed in Question C9.* *0 = 0; 1-19 = 1; 20-49 = 2; 50-99 = 3; 100-149 = 4; ≥150 = 5*	3	Total Commodity Damage Score = 53 (see Table 2)
C9. Spread disease (1–2) *Assess the risk that the species could play a role in the spread of disease or parasites to other animals*	2	*All mammals (likely or unknown effect on native species and on livestock and other domestic animals).*
C10. Harm to property (0–3) *Assess the risk that the species could inflict damage on buildings, vehicles, fences, roads, equipment or ornamental gardens by chewing or burrowing or polluting with droppings or nesting material.*	1	*$1–$10 million (reasonable estimate)*
C11. Harm to people (0–5) *Assess the risk that, if a wild population established, the species could cause harm to or annoy people. Aggressive behaviour, plus the possession of organs capable of inflicting harm, such as sharp teeth, tusks, claws, spines, a sharp bill, horns, antlers or toxin delivering organs may enable animals*	2	*Injuries, harm or annoyance likely to be minor and few people exposed: low risk.* Blackbuck males can be territorial.

to harm people. Any known history of the species attacking, injuring or killing people should also be taken into account (see Stage A, Score A1).		
C. PEST RISK SCORE **SUM C 1 TO C 11 (1–37)**	23	**Extreme pest risk**
STAGE A. PUBLIC SAFETY RISK RANK – RISK TO PUBLIC SAFETY POSED BY CAPTIVE OR RELEASED INDIVIDUALS *0 = Not dangerous; 1 = Moderately dangerous; ≥ 2 = Highly dangerous*	1	Moderately dangerous
STAGE B. ESTABLISHMENT RISK RANK – RISK OF ESTABLISHING A WILD POPULATION MODEL 1: FOUR-FACTOR MODEL FOR BIRDS AND MAMMALS (BOMFORD 2008) *≤ 5 = low establishment risk; 6-8 = moderate establishment risk; 9-10 = serious establishment risk; ≥ 11-13 = extreme establishment risk*	9	Serious establishment risk
STAGE B. ESTABLISHMENT RISK RANK – RISK OF ESTABLISHING A WILD POPULATION MODEL 2: SEVEN-FACTOR MODEL FOR BIRDS AND MAMMALS (BOMFORD 2008) *≤ 6 = low establishment risk; 7-11 = moderate establishment risk; 12-13 = serious establishment risk; ≥14 = extreme establishment risk*	12	Serious establishment risk
STAGE C. PEST RISK RANK - RISK OF BECOMING A PEST FOLLOWING ESTABLISHMENT *< 9 = low pest risk; 9-14 = moderate pest risk; 15-19 = serious pest risk; > 19 = extreme pest risk*	23	Extreme pest risk

ENVIRONMENT AND INVASIVES COMMITTEE THREAT CATEGORY	**EXTREME**

World distribution map (IUCN Red List) and World distribution map indicating where meteorological data was sourced for the climate analysis (see B1):

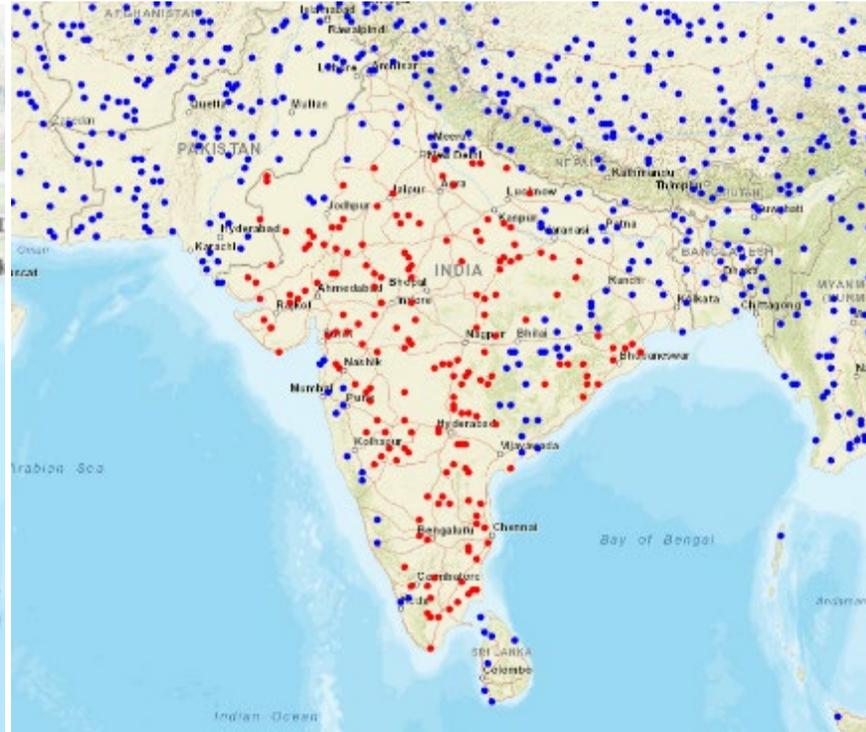*Figure 1- World Distribution Map - IUCN Red List*

Figure 2 - World Distribution Map - Climatch

Climate match between world distribution of species and Australia:
Areas of Australia where the climate appears suitable for *Antilope cervicapra*
CMS = 3910
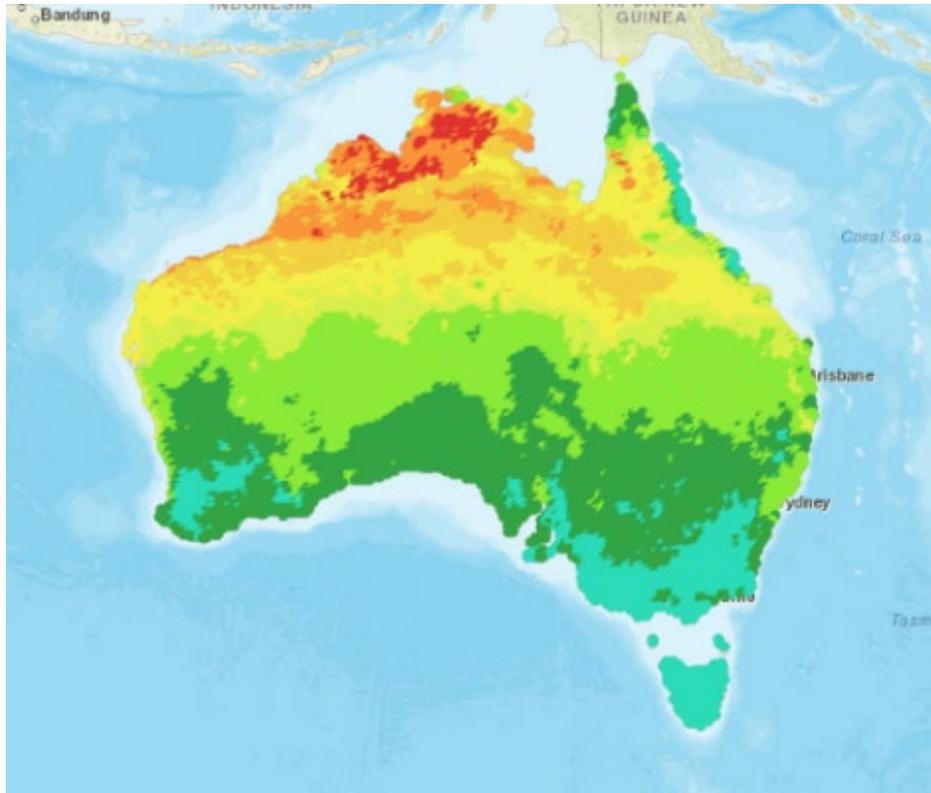
Score	Color	Count
0	●	2
1	●	1390
2	●	4359
3	●	4879
4	●	1785
5	●	2911
6	●	2514
7	●	1022
8	●	372
9	●	2
10	●	0

Species: Antilope cervicapra (Blackbuck)
Algorithm: Closest Standard Score
186 source features selected
19236 target features selected
Approximate selected area: 2,257,928 km²

Table 1: ABARES recalibration thresholds

Climate Match Score (CMS)	Current Bomford 2008 model classes (50 km)	Recalibrated classes to Climatch v2.0 (20 km)
1 (Very low)	< 100	< 691
2 (Low)	100-599	691-4137
3 (Moderate)	600-899	4138-6209
4 (High)	900-1699	6210-11735
5 (Very high)	1700-2699	11736-18642
6 (Extreme)	≥ 2700	≥ 18643

Table 2: Susceptible Australian Primary Production – Calculating Total Commodity Damage Score

The commodity value index scores in this table are derived from Australian Bureau of Statistics 2005 – 2006 data. The values will require updating if significant change has occurred in the value of the commodity (Bomford 2008).

Industry	Commodity Value Index 1 (CVI based on best available date)	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) consumption of stock fodder consumption of stock fodder only therefore commodity value adjusted down by 1/3	11			
Timber (includes native and plantation forests)	10			
Cereal grain (includes wheat, barley sorghum etc) no reports of damage to this commodity	8	2	3	48
Sheep (includes wool and sheep meat) consumption of stock fodder only therefore commodity value adjusted down by 1/3	5	1	0	5
Fruit (includes wine grapes)	4			
Vegetables	3			
Poultry and eggs	2			
Aquaculture(includes coastal mariculture)	2			
Oilseeds (includes canola, sunflower etc) no reports of damage to this commodity	1			
Grain legumes (includes soybeans) no reports of damage to this commodity	1			
Sugarcane	1			
Cotton	1			
Other crops and horticulture (includes nuts tobacco and flowers etc)	1			
Pigs	1			
Other livestock (includes goats, deer, camels, rabbits)	0.5			
Bees (included honey, beeswax and pollination)	0.5			
Total Commodity Damage Score (TCDS)				53

NB The Commodity Value Index scores in this table are derived from Australian Bureau of Statistics 2005–2006 data and will need to be updated if these values change significantly.

Assess Potential Commodity Impact Scores for each primary production commodity listed in Table 9, based on species' attributes (diet, behaviour, ecology), excluding risk of spreading disease which is addressed in Question C9, and pest status worldwide as:

0. *Nil (species does not have attributes to make it capable of damaging this commodity)*
1. *Low (species has attributes making it capable of damaging this or similar commodities and has had the opportunity but no reports or other evidence that it has caused damage in any country or region*
2. *Moderate–serious (reports of damage to this or similar commodities exist 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)*
3. *Extreme (damage occurs 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).*

Climate Match to Commodity Score (0–5)

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

Table 3: Assigning species to EIC Threat Categories (shaded cells relate to assignment of reptiles and amphibians to EIC Threat Categories based on an assessed establishment risk and an allocated pest risk of extreme) – adapted from Bomford 2008

Establishment Risk	Pest Risk	Public Safety Risk	EIC Threat Category	Implication for any proposed import into Australia	Implication for keeping and movement in Australia
Extreme	Extreme	Highly, Moderately or Not Dangerous	EXTREME	Prohibited, unless sufficient risk management measures exist to reduce the potential risks to an acceptable level	Limited to those collections approved for keeping particular EXTREME Threat species
Extreme	Serious	Highly, Moderately or Not Dangerous	EXTREME		
Extreme	Moderate	Highly, Moderately or Not Dangerous	EXTREME		
Extreme	Low	Highly, Moderately or Not Dangerous	EXTREME		
Serious	Extreme	Highly, Moderately or Not Dangerous	EXTREME		
Serious	Serious	Highly, Moderately or Not Dangerous	EXTREME		
Moderate	Extreme	Highly, Moderately or Not Dangerous	EXTREME		
Serious	Moderate	Highly, Moderately or Not Dangerous	SERIOUS	Import restricted to those collections approved for keeping SERIOUS Threat species	Limited to those collections approved for keeping particular SERIOUS Threat species
Serious	Low	Highly, Moderately or Not Dangerous	SERIOUS		
Moderate	Serious	Highly, Moderately or Not Dangerous	SERIOUS		
Moderate	Moderate	Highly Dangerous	SERIOUS		
Moderate	Low	Highly Dangerous	SERIOUS		
Low	Extreme	Highly, Moderately or Not Dangerous	SERIOUS		
Low	Serious	Highly, Moderately or Not Dangerous	SERIOUS		
Low	Moderate	Highly Dangerous	SERIOUS		
Low	Low	Highly Dangerous	SERIOUS		
Moderate	Moderate	Moderately or Not Dangerous	MODERATE	Import restricted to those collections approved for keeping MODERATE Threat species	Limited to those collections approved for keeping particular MODERATE Threat species
Moderate	Low	Moderately or Not Dangerous	MODERATE		
Low	Moderate	Moderately or Not Dangerous	MODERATE		
Low	Low	Moderately Dangerous	MODERATE		
Low	Low	Not Dangerous	LOW	Import permitted	May be limited to those collections approved for keeping particular LOW Threat species
Any Value	Any Value	Unknown	EXTREME until proven otherwise	Prohibited, unless sufficient risk management measures exist to reduce the potential risks to an acceptable level	Limited to those collections approved for keeping particular EXTREME Threat species
Unknown	Any Value	Any Value	EXTREME until proven otherwise		
Any Value	Unknown	Any Value	EXTREME until proven otherwise		
Unassessed	Unassessed	Unassessed	EXTREME until proven otherwise		

Adapted from:	Queensland Gov (Dept of Agriculture and Fisheries, Biosecurity Qld) Steve Csurhes and Paul Fisher 2010, updated 2016	By: Jodi Buchecker	Date: Nov 2020

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National Risk Assessment: SERIOUS

RISK ASSESSMENT FOR AUSTRALIA: **De Brazza's Monkey (*Cercopithecus neglectus)***

Class - Mammalia**, Order** - Primates**, Family** - Cercopithecidae**, Genus** - *Cercopithecus***.**

SPECIES:	Species description:
Cercopithecus neglectus (Schlegel, 1876)	De Brazza's monkeys are mostly covered with "grizzled" grey fur with black extremities and tail. They have a distinct white stripe across their thigh and rump, a white muzzle and long white beard. A conspicuous orange crown is displayed above the eyes. Markings on males are more prominent than those on females (Oregon Zoo, 2011). Body length of the De Brazza's monkey varies from 40 to 63.5 centimetres. De Brazza's monkeys have a round head, a non-prehensile tail and their feet are considered more robust than those of other Guenons (Oregon Zoo, 2011; Wolfheim, 1983).
Synonyms: No synonyms	Like other Guenons, De Brazza's monkey shows marked sexual dimorphism in a number of features (Leutenegger and Lubach, 1987). Males typically weigh around 7 kilograms, and are distinctly larger than females, who typically weigh 4 kilograms. Males also possess a blue scrotum.
Subspecies: Monotypic	
Common Names: De Brazza's Monkey De Brazza's Guenon Swamp Monkey (local)	**General information:** One of the most widespread of African forest monkeys, although never found at high densities, De Brazza's Monkey can be found from north-eastern Angola, through Cameroon, Equatorial Guinea and Gabon to Uganda, Kenya and south-western Ethiopia. The known range of the species continues to expand with the discovery of new populations in Kenya, Gabon and Congo (Maisles *et al.*, 2007; Mwenja, 2007). The current estimated range for the De Brazza's monkey is approximately 173,000 kilometres squared.
	De Brazza's monkeys generally inhabit tropical riverine forests, dense swamps, bamboo and dry mountain forests associated with streams, rivers and areas of flooded forest that are heavily utilised by the species (Wahome *et al.*, 1993; King, 2008). The De Brazza's monkey requires a habitat of dense vegetation and occurs from lowland areas to submontane forests at an elevation of up to 2,100m (Institute of Primate Research Kenya, 2008).
	De Brazza's Monkeys are occasionally found in dense vegetation away from water. However, groups found in such areas may have a water source within 1 day's travel (Decker, 1995). This suggests that they may be attracted to the dense vegetation that is often present near watercourses rather than the water itself.
	In Kenya, the De Brazza's Monkeys inhabit small, isolated and unprotected areas of forest and have a monthly home range between 0.20 to 0.85 hectares (Karere, 2000). However, if the area inhabited by the De Brazza's monkey has an extensive food and water source, the monkey's home range may vary from 4.1 to 6 hectares. Karere (2000) noted that the time spent at various heights within the canopy by the De Brazza's monkey was not influenced by the time of day. A group may

spend more than 50% of its time less than 5 metres above the forest floor and have a daily path length ranging from 330 to 1,001 meters (Wahome, 1993).

De Brazza's Monkeys are diurnal mammals that typically live in relatively small groups of about six individuals. They are sometimes observed in larger groups of 16-35 individuals, and solitary males are often sighted (King, 2008; Mugambi *et al*, 1997). Groups often comprise one resident male, at least three adult females and some juveniles (Muriuki, 1989). Females reach reproductive maturity at around four and half years, while males reach sexual maturity at around 7 years of age. Females give birth to only one offspring per year with a gestation period of 6 months. In areas with marked seasonal food availability, such as Gabon and some areas of Kenya, the breeding and birthing season is often fixed to coincide with maximum food levels.

De Brazza's Monkeys are mainly frugivorous; however a substantial proportion of their diet comes from leaves and invertebrates such as ants, termites and resting moths (Wahome *et al*., 1993). One study observed that the species spends about 47% of its time feeding on fruit and 32% feeding on leaves (Karere, 2000), however they are also known to eat mushrooms and lizards. The De Brazza's monkey may also raid agricultural sites of fruits and vegetables. Although De Brazza's Monkeys have not established feral populations outside their natural range, the species is noted as an agricultural pest. In Kenya, the De Brazza's monkey is known to raid crops of maize and potatoes (Mugambi *et al*., 1997). Raiding is particularly problematic in areas of high deforestation, where the monkey's natural food sources are depleted.

Wild populations of De Brazza's Monkey are vulnerable to a variety of diseases, including simian immunodeficiency viruses (SIVs), herpes B virus (*Herpesvirus simiae*), and multiple gastrointestinal parasites (Bibollet-Ruche *et al*., 2004; Thompson *et al*., 2000; Karere and Munene, 2002). Individuals may also be prone to ectoparasites such as ticks and mites. It is likely that some symptoms of pre-existing infectious diseases may only appear when the species is subject to stress in captivity or experimental manipulations.

De Brazza's Monkeys are not considered a direct threat to human safety and the species is not noted for attacking humans without provocation. Individuals have the potential to cause moderate physical injury by biting and scratching, which may require medical attention. The associated consequences from a bite or scratch may be serious and require hospitalisation. The Cercopithecus genus has been noted for its ability to harbour a wide variety of zoonoses. The diseases carried by this genus that pose a threat to human safety include herpes B, Marburg virus, yellow fever virus, monkeypox virus, leptospirosis, and tuberculosis (Pavlin et al., 2009). Humans can become infected with herpes B virus through bites, scratches, and contact with body fluid or tissue. Infection can be severe and result in ascending paralysis and has a high fatality rate, or neurological impairment (Williams and Barker, 2001). The prevalence of human infection with herpes B virus is low, as is secondary transmission of the virus.

	Longevity: In captivity the De Brazza's monkey can live up to 31 years of age (Weigl, 2005); however, longevity of the species in the wild is not documented. **Conservation status:** **IUCN:** Least Concern. The De Brazza's Monkey was assessed by the International Union for the Conservation of Nature (IUCN) in 2008 and is listed as 'Least Concern' (Struhsaker *et al.* 2008). Although one of the most widespread of African forest monkeys, the De Brazza's Monkey is not found in abundance throughout its range and limited information is available regarding the general population status of this species. This could be due to a lack of surveys undertaken (Decker, 1995) or difficulties associated with detecting the species (King, 2008). Particularly within Kenya, the species was considered to be threatened with extinction and subject to considerable pressure through deforestation, hunting for a food source and for crop protection. As a result of these pressures, the De Brazza's Monkey has been identified as facing reproductive isolation (Brennan, 1985). The Kenyan population remains threatened, despite a new population of approximately 300 individuals being discovered in 2007 (Mugambi *et al.,* 1997; Mwenja, 2007). **CITES**: Appendix II
DATE OF ORIGINAL ASSESSMENT: June 2011 **DATE OF CURRENT ASSESSMENT:** Oct 2020 (Jodi Buchecker) **EIC ENDORSEMENT:** 15/03/21 **Risk assessment model used for the assessment:** Bomford 2008, Mammals and Birds	**The risk assessment model:** Models for assessing the risk that exotic vertebrates could establish in Australia have been developed for mammals, birds (Bomford 2003, 2006, 2008), reptiles and amphibians (Bomford et al 2005, Bomford 2008). Developed by Dr Mary Bomford for the Bureau of Rural Sciences (BRS), the model uses criteria that have been demonstrated to have significant correlation between a risk factor and the establishment of populations of exotic species and the pest potential of those species that do establish. For example, a risk factor for establishment is similarity in climate (temperature and rainfall) within the species' distribution overseas and Australia. For pest potential, the species' overseas pest status is a risk factor. The model is published as 'Risk assessment models for the establishment of exotic vertebrates in Australia and New Zealand' (Bomford 2008) and is available online on the PestSmart website https://pestsmart.org.au/wp-content/uploads/sites/3/2020/06/Risk_Assess_Models_2008_FINAL.pdf **CLIMATE**: In 2021 a new version of the Climatch program used to assess similarity in climate was released by the Australian Bureau of Agricultural Resource Economics and Sciences (ABARES): CLIMATCH v2.0. The increase in resolution in this new version (from 50 km to 20 km) required recalibration of Climate Match Scores. See Table 1. Sixteen climate parameters (variables) of temperature and rainfall are used to estimate the extent of similarity between data from meteorological stations located within the species' world distribution and stations in Australia. Worldwide, data from approximately 19000 locations are available for analysis. The number of locations used in an analysis will vary according to the size of the species' distribution and the number of meteorological stations located within that distribution. To represent the climate match visually, the map of Australia is divided into 19236 grid squares, each measured in 0.2 degrees in both longitude and latitude. CLIMATCH v2.0 calculates a match for each Australian grid by comparing data from all meteorological stations within the species' distribution (excluding any populations in Australia) and allocating a score ranging from ten for the highest level match to zero for the poorest match. Levels of

	climate match are used in the risk assessment for questions B1 (scores are summed to give a cumulative score), C6, and C8. Climatch v2.0 can be accessed on the ABARES website, agriculture.gov.au/abares. The direct URL is https://climatch.cp1.agriculture.gov.au/.

Bird and Mammal Model:

FACTOR	SCORE	DETAIL
STAGE A: RISKS POSED BY CAPTIVE OR RELEASED ANIMALS		
A1. Risk to people from individual escapees (0–2) *Assess the risk that individuals of the species could harm people. (NB, this question only relates to aggressive behaviour shown by escaped or released individual animals. Question C11 addresses the risk of harm from aggressive behaviour if the species establishes a wild population).* *Aggressive behaviour, size, plus the possession of organs capable of inflicting harm, such as sharp teeth, claws, spines, a sharp bill, or toxin-delivering apparatus may enable individual animals to harm people. Any known history of the species attacking, injuring or killing people should also be taken into account. Assume the individual is not protecting nest or young.*	1	*Animal that is unlikely to make an unprovoked attack, but which can cause serious injury (requiring hospitalisation) or fatality if cornered or handled.* The De Brazza's monkey is not likely to attack humans and if they did, the injuries are not likely to be life threatening.
A2. Risk to public safety from individual captive animals (0–2) *Assess the risk that irresponsible use of products obtained from captive individuals of the species (such as toxins) pose a public safety risk (excluding the safety of anyone entering the animals' cage/enclosure or otherwise coming within reach of the captive animals)*	0	*Nil or low risk (highly unlikely or not possible).*
STAGE A PUBLIC SAFETY RISK SCORE **SUM A1 - A2 (0-4)**	1	**Moderately dangerous**
STAGE B: PROBABILITY ESCAPED OR RELEASED INDIVIDUALS WILL ESTABLISH FREE-LIVING POPULATIONS		

Model 1: FOUR-FACTOR MODEL FOR BIRDS AND MAMMALS (BOMFORD 2008)		
B1. Degree of climate match between species overseas range and Australia (1–6) *Map the selected mammal or bird species' overseas range, including its entire native and exotic (excluding Australia) ranges over the past 1000 years.* *Use CLIMATCH v2.0, CMS = sum of classes 6 – 10, see Table 1.*	1	*Very Low climate match score* Value X = 187 Climate Match Score = 1
B2. Exotic population established overseas (0–4) *An established exotic population means the introduced species must have bred outside of captivity and must currently maintain a viable free-living population where the animals are not being intentionally fed or sheltered, even though they may be living in a highly disturbed environment with access to non-natural food supplies or shelter.*	0	*No exotic populations ever established.*
B3. Overseas range size score (0–2) < 1 = 0; 1– 70 = 1; >70 = 2 *Estimate the species overseas range size* including currently and the past 1000 years; natural and introduced range in millions of square kilometres*	0	*Overseas size range <1 million km^2.* The geographic range is estimated at 173,000km^2.
B4. Taxonomic Class (0–1) Bird=0; mammal = 1	1	*Mammal*
B. ESTABLISHMENT RISK SCORE **SUM OF B1- B4 (1–13)**	2	**Low establishment risk**

Model 2: Seven-Factor Model For Birds And Mammals (Bomford 2008)		
B5. Diet score (0–1) Specialist = 0; generalist = 1	1	*Generalist with a broad diet of many food types.* Mainly frugivorous, however a substantial proportion of their diet comes from leaves and invertebrates such as ants, termites and resting moths. Also known to eat mushrooms and lizards.

B6. Habitat score (0–1) *Undisturbed or disturbed habitat*	1	*Can survive and breed in human-disturbed habitats (including grazing and agricultural lands, forests that are intensively managed or planted for timber harvesting and/or urban–suburban environments) without access to undisturbed (natural) habitats.* Can live in disturbed habitat as shown by their proclivity to raid crops in Kenya.
B7. Migratory score (0–1) *Always migratory = 0; non-migratory = 1*	1	*Non-migratory*
B. ESTABLISHMENT RISK SCORE **SUM OF B1- B7 (1–16)**	5	**Low establishment risk**
STAGE C: PROBABILITY AN ESTABLISHED SPECIES WILL BECOME A PEST		
C1. Taxonomic group (0–4)	0	*Not in one of the mammal orders that have been demonstrated to have detrimental effects on prey abundance and/or habitat degradation.* No taxonomic matches.
C2. Overseas range size including current and past 1000 years, natural and introduced range (0–2) *Estimate the species overseas range size (including current and past 1000 years, natural and introduced range) in millions of square kilometre*	0	*Overseas range size <10 million km^2.* The geographic range is estimated at 173,000 km^2. One of the most widespread of African forest monkeys, although never found at high densities, De Brazza's Monkey can be found from north-eastern Angola, through Cameroon, Equatorial Guinea and Gabon to Uganda, Kenya and south-western Ethiopia. The known range of the species continues to expand with the discovery of new populations in Kenya, Gabon and Congo (Maisles *et al.*, 2007; Mwenja, 2007).
C3. Diet and feeding (0–3)	3	*Mammal that is primarily a grazer or a browser.* Arboreal species that spends approximately 47.15% of its time feeding on fruits, and 32.2% feeding on leaves (Karere, 2000). They are also known to eat mushrooms, lizards and invertebrates such as ants, termites and moths.
C4. Competition with native fauna for tree hollows (0–2)	0	*Does not use tree hollows.*
C5. Overseas environmental pest status (0–3)	0	*Never reported as an environmental pest in any country or region.*

Has the species been reported to cause declines in abundance of any native species of plant or animal or cause degradation to any natural communities in any country or region of the world?		The species has not been reported to cause declines in abundance of any native species of plants or animal or caused degradation to any natural communities in any country of region.
C6. Climate match to areas with susceptible native species or communities (0–5) *Identify any native Australian animal or plant species or communities that could be susceptible to harm by the exotic species if it were to establish a wild population here.*	2	*The species has no grid squares within the highest two climate match classes (ie in classes 10 and 9) that overlap the distribution of any susceptible native species or ecological communities, and has 1-62 grid squares within the highest four climate match classes that overlap the distribution of any susceptible native species or ecological communities = 2*
C7. Overseas primary production pest status (0–3) *Has the species been reported to damage crops or other primary production in any country or region of the world?*	2	*Moderate pest of primary production in any country or region.* De Brazza's Monkeys are noted for crop raiding in Kenya.
C8. Climate match to susceptible primary production (0–5) *Assess Potential Commodity Impact Scores for each primary production commodity listed in Table 9, based on species' attributes (diet, behaviour, ecology), excluding risk of spreading disease which is addressed in Question C9.* *0 = 0; 1-19 = 1; 20-49 = 2; 50-99 = 3; 100-149 = 4; ≥150 = 5*	3	Total Commodity Damage Score = 69 (see Table 2) Potentially a problem to fruit and vegetable crops, their potential range covers significant fruit and crop areas.
C9. Spread disease (1–2) *Assess the risk that the species could play a role in the spread of disease or parasites to other animals*	2	*All mammals (likely or unknown effect on native species and on livestock and other domestic animals).* Wild populations of De Brazza's Monkey are vulnerable to a variety of diseases, including simian immunodeficiency viruses (SIVs), herpes B virus (*Herpesvirus simiae*), and multiple gastrointestinal parasites (Bibollet-Ruche *et al*., 2004; Thompson *et al*., 2000; Karere and Munene, 2002).
C10. Harm to property (0–3) *Assess the risk that the species could inflict damage on buildings, vehicles, fences, roads, equipment or ornamental gardens by*	1	*<$100,000 per year.*

chewing or burrowing or polluting with droppings or nesting material.		
C11. Harm to people (0–5) *Assess the risk that, if a wild population established, the species could cause harm to or annoy people. Aggressive behaviour, plus the possession of organs capable of inflicting harm, such as sharp teeth, tusks, claws, spines, a sharp bill, horns, antlers or toxin delivering organs may enable animals to harm people. Any known history of the species attacking, injuring or killing people should also be taken into account (see Stage A, Score A1).*	4	*Injuries or harm severe or fatal but few people at risk.* De Brazza's Monkeys may cause moderate injury by biting and scratching, and transmit diseases such as herpes B.
C. PEST RISK SCORE **SUM C 1 TO C 11 (1–37)**	17	**Serious pest risk**
STAGE A. PUBLIC SAFETY RISK RANK – RISK TO PUBLIC SAFETY POSED BY CAPTIVE OR RELEASED INDIVIDUALS *0 = Not dangerous; 1 = Moderately dangerous; ≥ 2 = Highly dangerous*	1	Moderately dangerous
STAGE B. ESTABLISHMENT RISK RANK – RISK OF ESTABLISHING A WILD POPULATION **MODEL 1: FOUR-FACTOR MODEL FOR BIRDS AND MAMMALS (BOMFORD 2008)** *≤ 5 = low establishment risk; 6-8 = moderate establishment risk; 9-10 = serious establishment risk; ≥ 11-13 = extreme establishment risk*	2	Low establishment risk
STAGE B. ESTABLISHMENT RISK RANK – RISK OF ESTABLISHING A WILD POPULATION **MODEL 2: SEVEN-FACTOR MODEL FOR BIRDS AND MAMMALS (BOMFORD 2008)** *≤ 6 = low establishment risk; 7-11 = moderate establishment risk; 12-13 = serious establishment risk; ≥14 = extreme establishment risk*	5	Low establishment risk
STAGE C. PEST RISK RANK - RISK OF BECOMING A PEST FOLLOWING ESTABLISHMENT	17	Serious pest risk

< 9 = low pest risk; 9-14 = moderate pest risk; 15-19 = serious pest risk; > 19 = extreme pest risk		

ENVIRONMENT AND INVASIVES COMMITTEE THREAT CATEGORY	**SERIOUS**

World distribution map (IUCN Red List) and World distribution map indicating where meteorological data was sourced for the climate analysis (see B1):
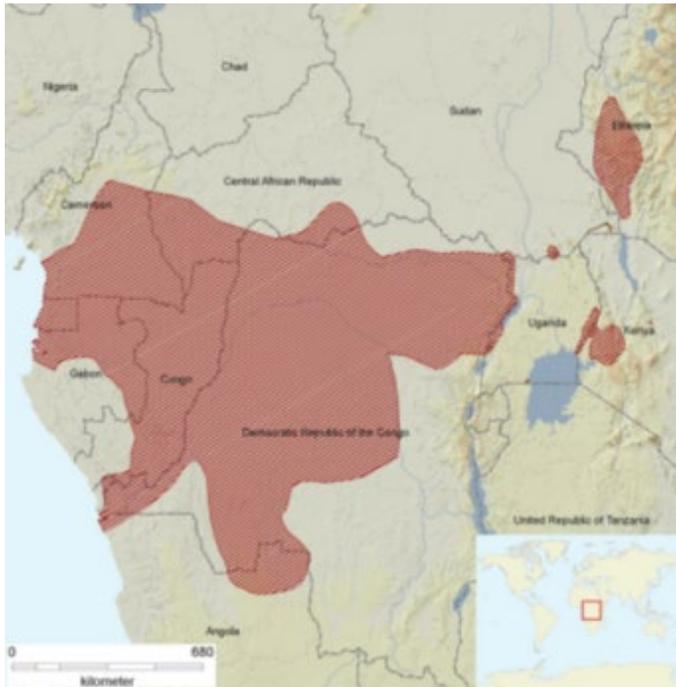

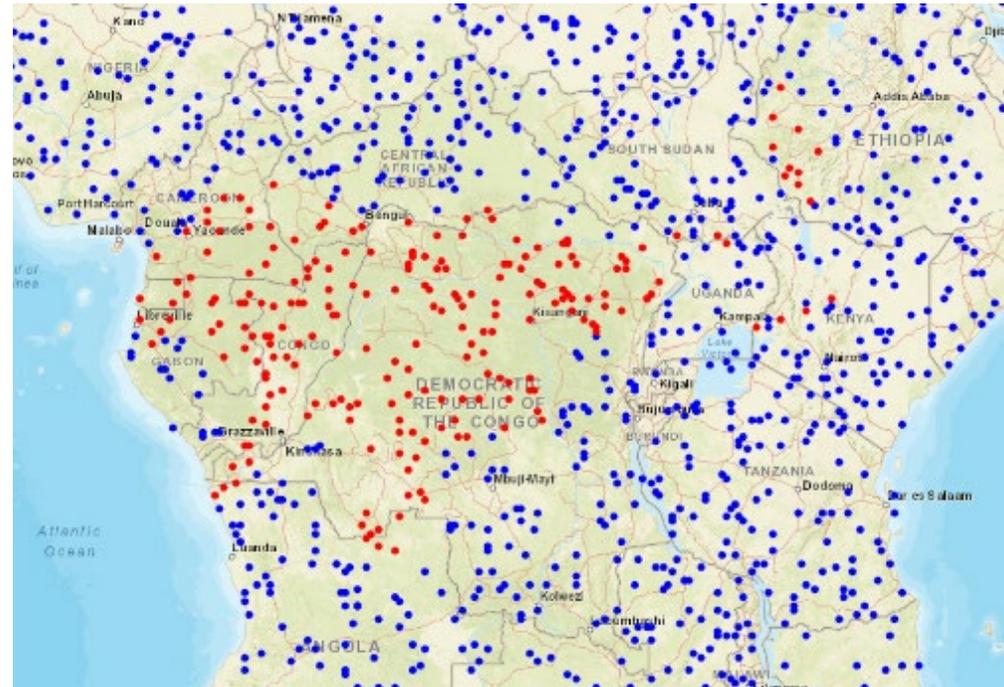*Figure 1- World Distribution Map - IUCN Red List*

Figure 2 - World Distribution Map - Climatch

Climate match between world distribution of species and Australia:
Areas of Australia where the climate appears suitable for *Cercopithecus neglectus*
CMS Score = 187
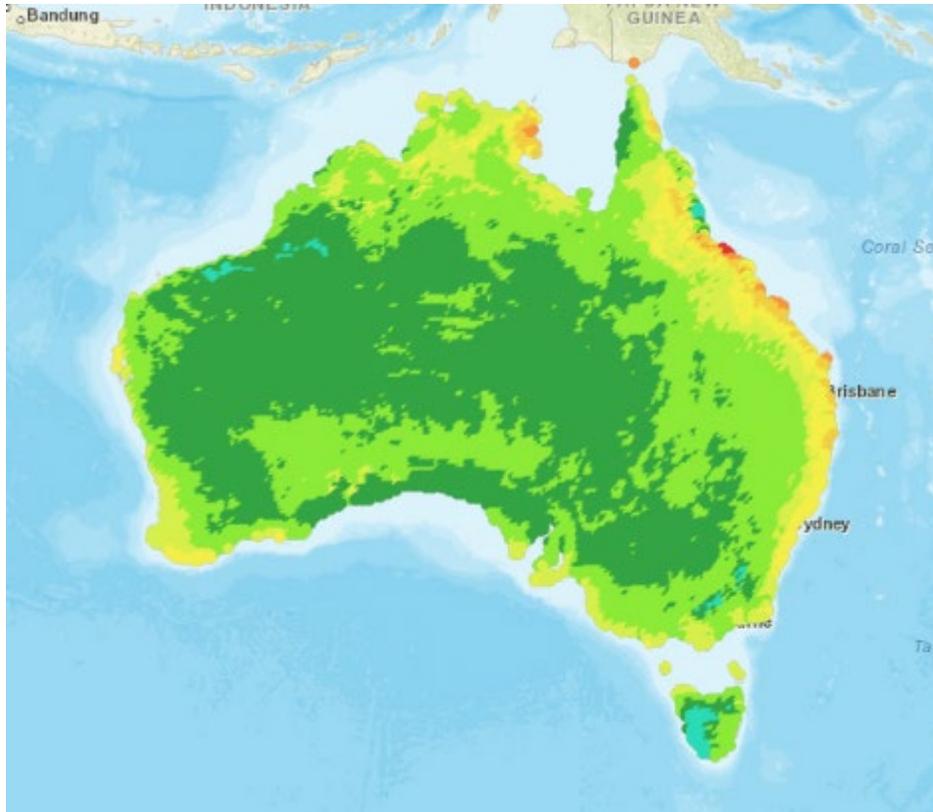
Score	Color	Count
0	●	0
1	●	130
2	●	9390
3	●	7150
4	●	1678
5	●	701
6	●	160
7	●	23
8	●	4
9	●	0
10	●	0

Species: Cercopithecus neglectus (De Brazza's Monkey)
Algorithm: Closest Standard Score
240 source features selected
19236 target features selected
Approximate selected area: 7,736,730 km²

Table 1: ABARES recalibration thresholds

Climate Match Score (CMS)	Current Bomford 2008 model classes (50 km)	Recalibrated classes to Climatch v2.0 (20 km)
1 (Very low)	< 100	< 691
2 (Low)	100-599	691-4137
3 (Moderate)	600-899	4138-6209
4 (High)	900-1699	6210-11735
5 (Very high)	1700-2699	11736-18642
6 (Extreme)	≥ 2700	≥ 18643

Table 2: Susceptible Australian Primary Production – Calculating Total Commodity Damage Score

The commodity value index scores in this table are derived from Australian Bureau of Statistics 2005 – 2006 data. The values will require updating if significant change has occurred in the value of the commodity (Bomford 2008).

Industry	Commodity Value Index 1 (CVI based on best available date)	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			
Cereal grain (includes wheat, barley sorghum etc)	8	3	1	24
Sheep (includes wool and sheep meat)	5			
Fruit (includes wine grapes)	4	3	2	24
Vegetables	3	3	2	18
Poultry and eggs	2			
Aquaculture(includes coastal mariculture)	6			
Oilseeds (includes canola, sunflower etc)	1	1	0	0
Grain legumes (includes soybeans)	1	1	0	0
Sugarcane	1			
Cotton	1			
Other crops and horticulture (includes nuts tobacco and flowers etc)	1	3	1	3
Pigs	1			
Other livestock (includes goats, deer, camels, rabbits)	0.3			
Bees (included honey, beeswax and pollination)	0.5			
Total Commodity Damage Score (TCDS)				69

NB The Commodity Value Index scores in this table are derived from Australian Bureau of Statistics 2005–2006 data and will need to be updated if these values change significantly.

Assess Potential Commodity Impact Scores for each primary production commodity listed in Table 9, based on species' attributes (diet, behaviour, ecology), excluding risk of spreading disease which is addressed in Question C9, and pest status worldwide as:

0. *Nil (species does not have attributes to make it capable of damaging this commodity)*
1. *Low (species has attributes making it capable of damaging this or similar commodities and has had the opportunity but no reports or other evidence that it has caused damage in any country or region*
2. *Moderate–serious (reports of damage to this or similar commodities exist 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)*
3. *Extreme (damage occurs 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).*

Climate Match to Commodity Score (0–5)

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

Table 3: Assigning species to EIC Threat Categories (shaded cells relate to assignment of reptiles and amphibians to EIC Threat Categories based on an assessed establishment risk and an allocated pest risk of extreme) – adapted from Bomford 2008

Establishment Risk	Pest Risk	Public Safety Risk	EIC Threat Category	Implication for any proposed import into Australia	Implication for keeping and movement in Australia
Extreme	Extreme	Highly, Moderately or Not Dangerous	EXTREME	Prohibited, unless sufficient risk management measures exist to reduce the potential risks to an acceptable level	Limited to those collections approved for keeping particular EXTREME Threat species
Extreme	Serious	Highly, Moderately or Not Dangerous	EXTREME		
Extreme	Moderate	Highly, Moderately or Not Dangerous	EXTREME		
Extreme	Low	Highly, Moderately or Not Dangerous	EXTREME		
Serious	Extreme	Highly, Moderately or Not Dangerous	EXTREME		
Serious	Serious	Highly, Moderately or Not Dangerous	EXTREME		
Moderate	Extreme	Highly, Moderately or Not Dangerous	EXTREME		
Serious	Moderate	Highly, Moderately or Not Dangerous	SERIOUS	Import restricted to those collections approved for keeping SERIOUS Threat species	Limited to those collections approved for keeping particular SERIOUS Threat species
Serious	Low	Highly, Moderately or Not Dangerous	SERIOUS		
Moderate	Serious	Highly, Moderately or Not Dangerous	SERIOUS		
Moderate	Moderate	Highly Dangerous	SERIOUS		
Moderate	Low	Highly Dangerous	SERIOUS		
Low	Extreme	Highly, Moderately or Not Dangerous	SERIOUS		
Low	Serious	Highly, Moderately or Not Dangerous	SERIOUS		
Low	Moderate	Highly Dangerous	SERIOUS		
Low	Low	Highly Dangerous	SERIOUS		
Moderate	Moderate	Moderately or Not Dangerous	MODERATE	Import restricted to those collections approved for keeping MODERATE Threat species	Limited to those collections approved for keeping particular MODERATE Threat species
Moderate	Low	Moderately or Not Dangerous	MODERATE		
Low	Moderate	Moderately or Not Dangerous	MODERATE		
Low	Low	Moderately Dangerous	MODERATE		
Low	Low	Not Dangerous	LOW	Import permitted	May be limited to those collections approved for keeping particular LOW Threat species
Any Value	Any Value	Unknown	EXTREME until proven otherwise	Prohibited, unless sufficient risk management measures exist to reduce the potential risks to an acceptable level	Limited to those collections approved for keeping particular EXTREME Threat species
Unknown	Any Value	Any Value	EXTREME until proven otherwise		
Any Value	Unknown	Any Value	EXTREME until proven otherwise		
Unassessed	Unassessed	Unassessed	EXTREME until proven otherwise		

Adapted from:	DPIPWE (2011) Pest Risk Assessment: De Brazza's Monkey (*Cercopithecus neglectus*). Department of Primary Industries, Parks, Water and Environment. Hobart, Tasmania.	By: Jodi Buchecker	Date: Oct 2020

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National Risk Assessment: MODERATE

RISK ASSESSMENT FOR AUSTRALIA: **Pygmy Hippopotamus _(Choeropsis liberiensis)_**

Class - Mammalia, **Order** - Artiodactyla, **Family** - Hippopotamidae, **Genus** - _Choeropsis_

SPECIES:	Species description:
Choeropsis liberiensis (Morton, 1849) **Synonyms:** _Hexaprotodon liberiensis_ (Morton, 1849) **Subspecies:** <u>Liberian Subspecies</u> _Hexaprotodon liberiensis liberiensis_ (Morton, 1849) _Choeropsis liberiensis liberiensis_ (Morton, 1849) <u>Nigerian Subspecies –</u> <u>Extinct</u> _Hexaprotodon liberiensis heslopi_ (Corbet, 1969) _Choeropsis liberiensis heslopi_ (Corbet, 1969) **Common Name:** Pygmy Hippopotamus Heslop's Pygmy Hippo)	The pygmy hippopotamus (pygmy hippo) is a small hippopotamid native to West Africa and is one of two species in the family Hippopotamidae. It is significantly smaller than the common hippopotamus (_Hippopotamus amphibious_), reaching weights of 180–270 kilograms and a height of 70-80 centimetres at the shoulder, and has comparatively longer limbs, neck and a smaller head. From observations in the field, it is thought that the pygmy hippo is less aquatic than the common hippopotamus and spends more time on land. Adaptations for this can be seen in the pygmy hippo having an anteriorly sloped body and more moderate webbing on toes. Pygmy hippos still show some aquatic adaptations such as strong muscular valves to the ears and nostrils as well as remaining largely dependent on water for thermoregulation (the species does not have any discernible sebaceous glands or sweat glands). Pygmy hippos must also keep their skin moist to prevent cracking from prolonged exposure to the sun. Their skin secretes a clear, oily substance which allows the animals to remain in either water or on land for extended periods. This substance may have antiseptic properties and protect the pygmy hippos from sun exposure (Mallon _et al._, 2011). **General information:** Two subspecies of pygmy hippo are recognised in literature: the Liberian Pygmy Hippo (_Choeropsis liberiensis liberiensis_) who is distributed sparsely through Ivory Coast, Guinea, Liberia and Sierra Leone. The closely related subspecies (_Choeropsis liberiensis heslopi_ or Heslop's Pygmy Hippo) is allegedly found in the Niger Delta in Nigeria. However reliable records of this subspecies have been difficult to obtain, and this species has not been positively identified in the wild since 1947 (Mallon _et al._, 2011). Heslop's Pygmy Hippo is currently classified as Extinct on the IUCN Red List. The historic distribution of the pygmy hippo has been determined to be far more extensive than the current distribution. In the present day, populations of this species have become fragmented and difficult to detect. Add to this a lack of surveys of many of these areas and the true distribution of pygmy hippos may be misrepresented by the data. However, in the absence of further surveys the best representation of this species' range can be seen in Figure 1 below (Mallon _et al._, 2011). Pygmy Hippos inhabit floodplains dominated by tall herbaceous vegetation and patches of riverine forest and _Raphia_ species (Calameae) palm dominated swampland. This species has a clear preference for small streams with complex

habitat structures such as fallen submerged trees, hollows formed by root systems of large trees, swampy areas and dense vegetation (Mallon *et al.*, 2011).

There is very little information available about pygmy hippo movement patterns, social structure or interactions in the wild due to a lack of field data. Based on the limited studies conducted, females of the species have overlapping home ranges of approximately 40-60 hectares, while males have a range of approximately 150 hectares. Movement within these ranges each day appears to be minimal with a maximum of 1.5 kilometres of movement per day. Home ranges seem to be positively associated with suitable habitat being available rather than other factors, however further study would be needed to identify other factors. During the rainy season of May–September within their native distribution, individuals of this species have been reported as dispersing over wide areas and this may be associated with breeding behaviour. Pygmy hippos are noted as being largely solitary outside of the breeding season with strong territorial behaviour (Ransom *et al.*, 2015).

Whilst this species is kept all over the world, in captivity pygmy hippos are not cold hardy and require a heated pool in their enclosure as well as heated containment areas when not on display. Limited ecological data makes this kind of information difficult to supply for pygmy hippos in the Wild. However, the mean temperature in the core of their home range in Liberia is approximately 27 degrees Centigrade with a range of approximately 23 to 31 degrees Centigrade (Robinson et al., 2017). It can therefore be inferred that if this species was to comfortably establish, it would require similar conditions to thrive.

The diet of Pygmy Hippos is mainly terrestrial and semi-aquatic plants surrounding whatever water source they are living in. This can include ferns, grasses, herbs, and the young roots, stems and leaves of young trees, vegetables and fallen fruits. Pygmy Hippos may also feed on crop plants such as sweet potatoes, okra, pepper and cassava however this species is not noted as a crop pest (Mallon *et al.,* 2011). Pygmy Hippos have been reported to feed for up to 6 hours per day, between mid-afternoon and midnight. However, camera trapping studies have shown they may feed throughout the night (Ransom et al, 2015). Physiologically, the Pygmy Hippo has four chambers in its stomach, and it appears that the microbial assisted digestion of food occurs in the front three stomach chambers. This arrangement is seen as an adaptation to a "low-quality" vegetable diet with a high fibre content and supports the observations of this species as a general browser and forager of vegetable matter (Ransom *et al.*, 2015).

Sexual maturity under captive conditions has been recorded between three and five years of age. Breeding occurs throughout the year with an interval between seven and nine months. The gestation period for pregnancies ranges between 188-210 days. Only one offspring is usually produced with the occurrence of twins being quite rare at a rate of approximately one occurrence in every 200 births.

Longevity:

	The longevity of this species in the wild is not well studied, however in captivity individuals have lived up to 56 years of age (Steck, 2012; Mallon *et al.,* 2011).
	Conservation status:
	IUCN: Endangered. The pygmy hippo is listed as Endangered on the IUCN Red List, under criterion C1, based on a population size of fewer than 2,500 mature individuals and a continuing decline estimated to reach 20% over the next 20 years (Mallon *et al.,* 2011). Although the current population of pygmy hippo is not accurately known it is thought to be in decline due to the continued destruction of habitat and the poaching of this species within its home range (Ransom *et al.,* 2015).
	CITES: Convention on International Trade in Endangered Species of Wild Fauna and Flora listing: Appendix II (CITES, 2018).
DATE OF ORIGINAL ASSESSMENT: 22/10/2018 **DATE OF CURRENT ASSESSMENT:** Oct 2020 (Jodi Buchecker) **EIC ENDORSEMENT:** 15/03/21	**The risk assessment model:** Models for assessing the risk that exotic vertebrates could establish in Australia have been developed for mammals, birds (Bomford 2003, 2006, 2008), reptiles and amphibians (Bomford et al 2005, Bomford 2008). Developed by Dr Mary Bomford for the Bureau of Rural Sciences (BRS), the model uses criteria that have been demonstrated to have significant correlation between a risk factor and the establishment of populations of exotic species and the pest potential of those species that do establish. For example, a risk factor for establishment is similarity in climate (temperature and rainfall) within the species' distribution overseas and Australia. For pest potential, the species' overseas pest status is a risk factor.
	The model is published as 'Risk assessment models for the establishment of exotic vertebrates in Australia and New Zealand' (Bomford 2008) and is available online on the PestSmart website https://pestsmart.org.au/wp-content/uploads/sites/3/2020/06/Risk_Assess_Models_2008_FINAL.pdf
Risk assessment model used for the assessment: Bomford 2008, Mammals and Birds	**CLIMATE**: In 2021 a new version of the Climatch program used to assess similarity in climate was released by the Australian Bureau of Agricultural Resource Economics and Sciences (ABARES): CLIMATCH v2.0. The increase in resolution in this new version (from 50 km to 20 km) required recalibration of Climate Match Scores. See Table 1. Sixteen climate parameters (variables) of temperature and rainfall are used to estimate the extent of similarity between data from meteorological stations located within the species' world distribution and stations in Australia. Worldwide, data from approximately 19000 locations are available for analysis. The number of locations used in an analysis will vary according to the size of the species' distribution and the number of meteorological stations located within that distribution. To represent the climate match visually, the map of Australia is divided into 19236 grid squares, each measured in 0.2 degrees in both longitude and latitude. CLIMATCH v2.0 calculates a match for each Australian grid by comparing data from all meteorological stations within the species' distribution (excluding any populations in Australia) and allocating a score ranging from ten for the highest level match to zero for the poorest match. Levels of climate match are used in the risk assessment for questions B1 (scores are summed to give a cumulative score), C6, and C8. Climatch v2.0 can be accessed on the ABARES website, agriculture.gov.au/abares. The direct URL is https://climatch.cp1.agriculture.gov.au/.

FACTOR	SCORE	DETAIL
Bird and Mammal Model:		
STAGE A: RISKS POSED BY CAPTIVE OR RELEASED ANIMALS		
A1. Risk to people from individual escapees (0–2) *Assess the risk that individuals of the species could harm people. (NB, this question only relates to aggressive behaviour shown by escaped or released individual animals. Question C11 addresses the risk of harm from aggressive behaviour if the species establishes a wild population).* *Aggressive behaviour, size, plus the possession of organs capable of inflicting harm, such as sharp teeth, claws, spines, a sharp bill, or toxin-delivering apparatus may enable individual animals to harm people. Any known history of the species attacking, injuring or killing people should also be taken into account. Assume the individual is not protecting nest or young.*	1	*Animal that 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.* Moderate risk to humans.
A2. Risk to public safety from individual captive animals (0–2) *Assess the risk that irresponsible use of products obtained from captive individuals of the species (such as toxins) pose a public safety risk (excluding the safety of anyone entering the animals' cage/enclosure or otherwise coming within reach of the captive animals)*	0	*Nil or low risk (highly unlikely or not possible).*
STAGE A PUBLIC SAFETY RISK SCORE **SUM A1 - A2 (0-4)**	1	**Moderately dangerous**
STAGE B: PROBABILITY ESCAPED OR RELEASED INDIVIDUALS WILL ESTABLISH FREE-LIVING POPULATIONS		

Model 1: Four-factor model for birds and mammals (Bomford **2008**)

B1. Degree of climate match between species overseas range and Australia (1–6) *Map the selected mammal or bird species' overseas range, including its entire native and exotic (excluding Australia) ranges over the past 1000 years.* *Use CLIMATCH v2.0, CMS = sum of classes 6 – 10, see Table 1.*	1	*Very low climate match* Value X = 3 Climate Match Score = 1 Confined to far northern Australia (primarily Cape York and northern Australia)
B2. Exotic population established overseas (0–4) *An established exotic population means the introduced species must have bred outside of captivity and must currently maintain a viable free-living population where the animals are not being intentionally fed or sheltered, even though they may be living in a highly disturbed environment with access to non-natural food supplies or shelter.*	0	*No exotic population ever established.*
B3. Overseas range size score (0–2) < 1 = 0; 1– 70 = 1; >70 = 2 *Estimate the species overseas range size* including currently and the past 1000 years; natural and introduced range in millions of square kilometres*	0	*Overseas range less than 1 million km^2.* The pygmy hippo is confined to coastal west Africa in isolated patches in Liberia, Ivory coast, Guinea and Sierra Leone.
B4. Taxonomic Class (0–1) *Bird = 0; mammal = 1*	1	*Mammal*
B. ESTABLISHMENT RISK SCORE **SUM OF B1- B4 (1–13)**	2	**Low establishment risk**

Model 2: Seven-Factor Model For Birds And Mammals (Bomford 2008)

B5. Diet score (0–1) *Specialist = 0; generalist = 1*	1	*Generalist with a broad diet of many food types.* Is a generalist browser/forager of aquatic and waterside vegetation.
B6. Habitat score (0–1) *Undisturbed or disturbed habitat*	0	*Requires access to undisturbed (natural) habitats to survive and breed.* Is only known to occur in relatively undisturbed habitat within its native range.

B7. Migratory score (0–1) *Always migratory = 0; non-migratory = 1*	1	*Non-migratory.* Not known to be migratory.
B. ESTABLISHMENT RISK SCORE **SUM OF B1- B7 (1–16)**	4	**Low establishment risk**
STAGE C: PROBABILITY AN ESTABLISHED SPECIES WILL BECOME A PEST		
C1. Taxonomic group (0–4)	0	*Other group.* Is not a member of any of the identified taxonomic groups.
C2. Overseas range size including current and past 1000 years, natural and introduced range (0–2) *Estimate the species overseas range size (including current and past 1000 years, natural and introduced range) in millions of square kilometre*	0	*Overseas geographic range less than 10 million square kilometres.* Overseas range confined to coastal west Africa in isolated patches in Liberia, Ivory coast, Guinea and Sierra Leone.
C3. Diet and feeding (0–3)	3	*Mammal that is a primarily a grazer or browser.* Is a generalist browser and forager of aquatic and waterside vegetation.
C4. Competition with native fauna for tree hollows (0–2)	0	*Does not occupy tree hollows.*
C5. Overseas environmental pest status (0–3) *Has the species been reported to cause declines in abundance of any native species of plant or animal or cause degradation to any natural communities in any country or region of the world?*	0	*Never reported as an environmental pest in any country or region.* Is not identified as an environmental pest in any of the literature.
C6. Climate match to areas with susceptible native species or communities (0–5)	2	*The species has no grid squares within the highest two climate match classes (ie in classes 10 and 9) that overlap the distribution of any susceptible native species or ecological communities, and has 1-62 grid squares within the highest four climate match classes that overlap the distribution of any susceptible native species or ecological communities = 2*

Identify any native Australian animal or plant species or communities that could be susceptible to harm by the exotic species if it were to establish a wild population here.		Is unlikely to have significant impact upon any threatened native species as its environmental niche does not significantly overlap that of any native species. In addition to this, the Climatch model generated using this species distribution indicates that there are a very small number of significant (above a Climatch of 5) matches for suitable climate within Australia. This would further limit the opportunities for this species to impact upon native fauna and flora.
C7. Overseas primary production pest status (0–3) *Has the species been reported to damage crops or other primary production in any country or region of the world?*	0	*No reports of damage to crops or other primary production in any country or region.* The pygmy hippo has not been identified in literature as a primary production pest.
C8. Climate match to susceptible primary production (0–5) *Assess Potential Commodity Impact Scores for each primary production commodity listed in Table 9, based on species' attributes (diet, behaviour, ecology), excluding risk of spreading disease which is addressed in Question C9.* *0 = 0; 1-19 = 1; 20-49 = 2; 50-99 = 3; 100-149 = 4; ≥150 = 5*	0	Total Commodity Damage Score = 0 (see Table 2)
C9. Spread disease (1–2) *Assess the risk that the species could play a role in the spread of disease or parasites to other animals*	2	*All mammals (likely or unknown effect on native species and on livestock and other domestic animals).*
C10. Harm to property (0–3) *Assess the risk that the species could inflict damage on buildings, vehicles, fences, roads, equipment or ornamental gardens by chewing or burrowing or polluting with droppings or nesting material.*	1	*$1 to $10 million dollars.* While the pygmy hippo is significantly smaller than common hippopotamus, this species is still large enough (180-270 kilograms in weight and up to 80 centimetres at the shoulder) to cause some damage to property or ecosystems. However, due to the limited potential range of this species within Australia according to Climatch modelling in this assessment, there would be limited interaction between this species and the environment or property. Hence the score of 1.

C11. Harm to people (0–5) *Assess the risk that, if a wild population established, the species could cause harm to or annoy people. Aggressive behaviour, plus the possession of organs capable of inflicting harm, such as sharp teeth, tusks, claws, spines, a sharp bill, horns, antlers or toxin delivering organs may enable animals to harm people. Any known history of the species attacking, injuring or killing people should also be taken into account (see Stage A, Score A1).*	2	*Injuries, harm or annoyance likely to be minor and few people exposed: Low risk.* As mentioned above, whilst not nearly as large or dangerous as the common hippopotamus, the pygmy hippo is still large enough to potentially cause injury to humans if it encounters them, within the limited range in Australia. Despite having sharp tusks in their mouths, the pygmy hippo is noted as being far less aggressive than the common hippopotamus and has never been implicated in any attacks on humans.
C. PEST RISK SCORE **SUM C 1 TO C 11 (1–37)**	10	**Moderate pest risk**
STAGE A. PUBLIC SAFETY RISK RANK – RISK TO PUBLIC SAFETY POSED BY CAPTIVE OR RELEASED INDIVIDUALS *0 = Not dangerous; 1 = Moderately dangerous; ≥ 2 = Highly dangerous*	1	Moderately dangerous
STAGE B. ESTABLISHMENT RISK RANK – RISK OF ESTABLISHING A WILD POPULATION **MODEL 1: FOUR-FACTOR MODEL FOR BIRDS AND MAMMALS (BOMFORD 2008)** *≤ 5 = low establishment risk; 6-8 = moderate establishment risk; 9-10 = serious establishment risk; ≥ 11-13 = extreme establishment risk*	2	Low establishment risk
STAGE B. ESTABLISHMENT RISK RANK – RISK OF ESTABLISHING A WILD POPULATION **MODEL 2: SEVEN-FACTOR MODEL FOR BIRDS AND MAMMALS (BOMFORD 2008)** *≤ 6 = low establishment risk; 7-11 = moderate establishment risk; 12-13 = serious establishment risk; ≥14 = extreme establishment risk*	4	Low establishment risk

STAGE C. PEST RISK RANK - RISK OF BECOMING A PEST FOLLOWING ESTABLISHMENT *< 9 = low pest risk; 9-14 = moderate pest risk; 15-19 = serious pest risk; > 19 = extreme pest risk*	10	Moderate pest risk

ENVIRONMENT AND INVASIVES COMMITTEE THREAT CATEGORY	**MODERATE**

World distribution map (IUCN Red List) and Climatch world distribution map indicating where meteorological data was sourced for the climate analysis (see B1):

Distribution map from **Ransom et al., 2015** with the yellow shaded areas representing the current distribution and the red shaded areas representing former distribution where the species is now thought to be extinct.

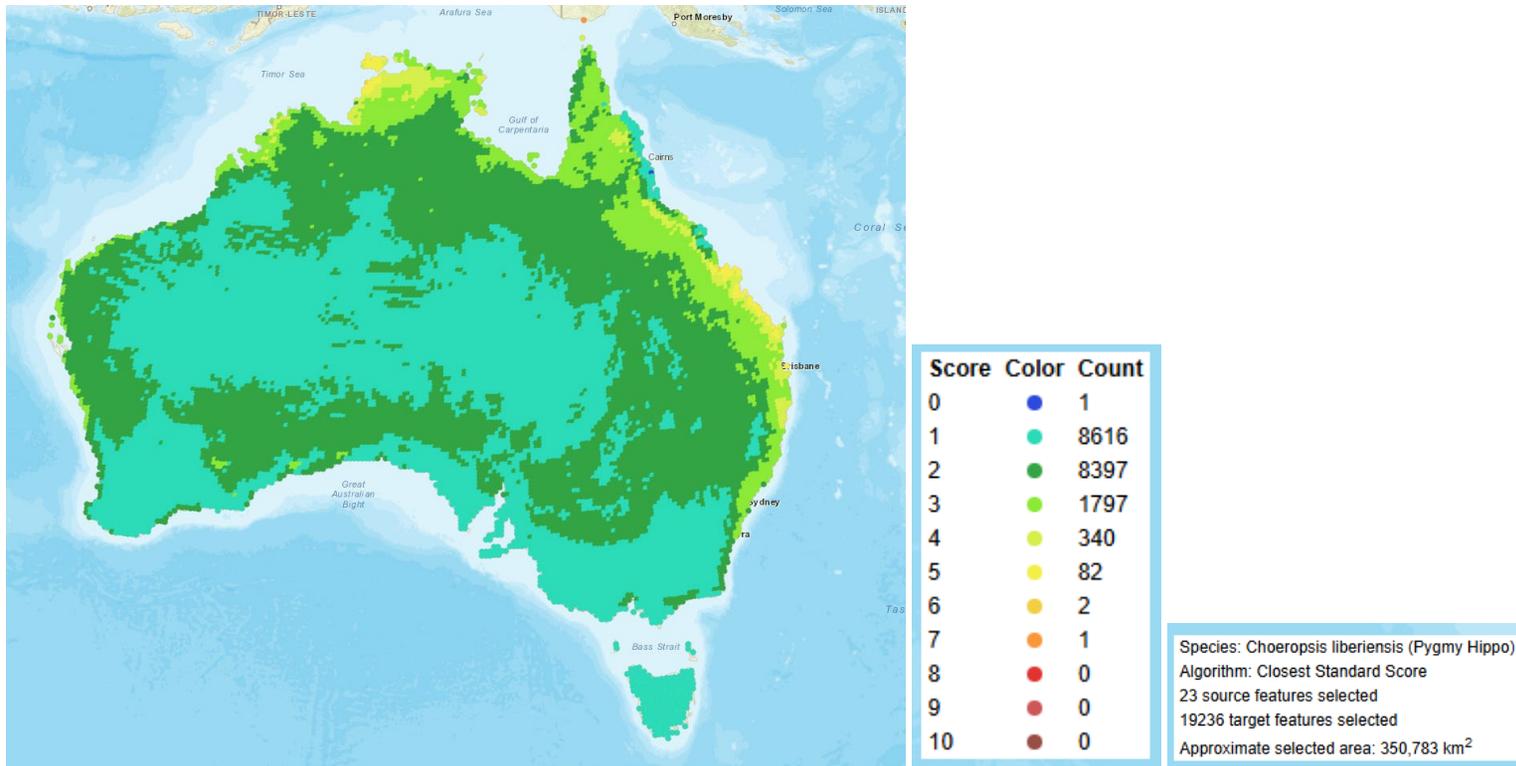*Figure 1- World Distribution Map - IUCN Red List*

Figure 2 - World Distribution Map - Climatch

Climate match between world distribution of species and Australia:

Areas of Australia where the climate appears suitable for *Choeropsis liberiensis*

CMS Score = 3

Score	Color	Count
0	•	1
1	•	8616
2	•	8397
3	•	1797
4	•	340
5	•	82
6	•	2
7	•	1
8	•	0
9	•	0
10	•	0

Species: Choeropsis liberiensis (Pygmy Hippo)
Algorithm: Closest Standard Score
23 source features selected
19236 target features selected
Approximate selected area: 350,783 km^2

Table 1: ABARES recalibration thresholds

Climate Match Score (CMS)	Current Bomford 2008 model classes (50 km)	Recalibrated classes to Climatch v2.0 (20 km)
1 (Very low)	< 100	< 691
2 (Low)	100-599	691-4137
3 (Moderate)	600-899	4138-6209
4 (High)	900-1699	6210-11735
5 (Very high)	1700-2699	11736-18642
6 (Extreme)	≥ 2700	≥ 18643

Table 2: Susceptible Australian Primary Production – Calculating Total Commodity Damage Score
The commodity value index scores in this table are derived from Australian Bureau of Statistics 2005 – 2006 data. The values will require updating if significant change has occurred in the value of the commodity (Bomford 2008).

Industry	Commodity Value Index 1 (CVI based on best available date)	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			
Cereal grain (includes wheat, barley sorghum etc)	8			
Sheep (includes wool and sheep meat)	5			
Fruit (includes wine grapes)	4			
Vegetables	3			
Poultry and eggs	2			
Aquaculture(includes coastal mariculture)	2			
Oilseeds (includes canola, sunflower etc)	1			
Grain legumes (includes soybeans)	1			
Sugarcane	1			
Cotton	1			
Other crops and horticulture (includes nuts tobacco and flowers etc)	1			
Pigs	1			
Other livestock (includes goats, deer, camels, rabbits)	0.5			
Bees (included honey, beeswax and pollination)	0.5			
Total Commodity Damage Score (TCDS)				0

NB The Commodity Value Index scores in this table are derived from Australian Bureau of Statistics 2005–2006 data and will need to be updated if these values change significantly.

Assess Potential Commodity Impact Scores for each primary production commodity listed in Table 9, based on species' attributes (diet, behaviour, ecology), excluding risk of spreading disease which is addressed in Question C9, and pest status worldwide as:

0. *Nil (species does not have attributes to make it capable of damaging this commodity)*
1. *Low (species has attributes making it capable of damaging this or similar commodities and has had the opportunity but no reports or other evidence that it has caused damage in any country or region*
2. *Moderate–serious (reports of damage to this or similar commodities exist 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)*
3. *Extreme (damage occurs 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).*

Climate Match to Commodity Score (0–5)

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

Table 3: Assigning species to EIC Threat Categories (shaded cells relate to assignment of reptiles and amphibians to EIC Threat Categories based on an assessed establishment risk and an allocated pest risk of extreme) – adapted from Bomford 2008

Establishment Risk	Pest Risk	Public Safety Risk	EIC Threat Category	Implication for any proposed import into Australia	Implication for keeping and movement in Australia
Extreme	Extreme	Highly, Moderately or Not Dangerous	EXTREME	Prohibited, unless sufficient risk management measures exist to reduce the potential risks to an acceptable level	Limited to those collections approved for keeping particular EXTREME Threat species
Extreme	Serious	Highly, Moderately or Not Dangerous	EXTREME		
Extreme	Moderate	Highly, Moderately or Not Dangerous	EXTREME		
Extreme	Low	Highly, Moderately or Not Dangerous	EXTREME		
Serious	Extreme	Highly, Moderately or Not Dangerous	EXTREME		
Serious	Serious	Highly, Moderately or Not Dangerous	EXTREME		
Moderate	Extreme	Highly, Moderately or Not Dangerous	EXTREME		
Serious	Moderate	Highly, Moderately or Not Dangerous	SERIOUS	Import restricted to those collections approved for keeping SERIOUS Threat species	Limited to those collections approved for keeping particular SERIOUS Threat species
Serious	Low	Highly, Moderately or Not Dangerous	SERIOUS		
Moderate	Serious	Highly, Moderately or Not Dangerous	SERIOUS		
Moderate	Moderate	Highly Dangerous	SERIOUS		
Moderate	Low	Highly Dangerous	SERIOUS		
Low	Extreme	Highly, Moderately or Not Dangerous	SERIOUS		
Low	Serious	Highly, Moderately or Not Dangerous	SERIOUS		
Low	Moderate	Highly Dangerous	SERIOUS		
Low	Low	Highly Dangerous	SERIOUS		
Moderate	Moderate	Moderately or Not Dangerous	MODERATE	Import restricted to those collections approved for keeping MODERATE Threat species	Limited to those collections approved for keeping particular MODERATE Threat species
Moderate	Low	Moderately or Not Dangerous	MODERATE		
Low	Moderate	Moderately or Not Dangerous	MODERATE		
Low	Low	Moderately Dangerous	MODERATE		
Low	Low	Not Dangerous	LOW	Import permitted	May be limited to those collections approved for keeping particular LOW Threat species
Any Value	Any Value	Unknown	EXTREME until proven otherwise	Prohibited, unless sufficient risk management measures exist to reduce the potential risks to an acceptable level	Limited to those collections approved for keeping particular EXTREME Threat species
Unknown	Any Value	Any Value	EXTREME until proven otherwise		
Any Value	Unknown	Any Value	EXTREME until proven otherwise		
Unassessed	Unassessed	Unassessed	EXTREME until proven otherwise		

Adapted from:	Department Risk Analysis, Application to add *Choeropsis liberiensis* (Pygmy Hippopotamus) to the Environment Protection and Biodiversity Conservation Act 1999 *List of Specimens taken to be Suitable for Live Import,* November 2018 Terms of Reference, Preparing a draft assessment report and application to amend the *List of Specimens taken to be Suitable for Live Import* (Live Import List)	By: Jodi Buchecker	Date: Oct 2020

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National Risk Assessment: MODERATE

RISK ASSESSMENT FOR AUSTRALIA: **Brazilian Agouti (*Dasyprocta leporina*)**

Class - Mammalia**, Order** - Rodentia**, Family** - Dasyproctidae**, Genus** - *Dasyprocta***.**

SPECIES:	Species description:
Dasyprocta leporina (Linnaeus, 1758)	Brazilian Agoutis are large-bodied diurnal rodents. They are very easily distinguished from all other agouti species by their distinctive colouration: dark brownish on the forebody becoming obviously orange or reddish on the rear part of the body (hence the alternative names of Orange-rumped Agouti, etc). All agouti species are similar in general appearance, being relatively large (about the size of a cat) but slender-bodied, with long thin legs, hooflike claws, coarse but glossy pelage, small ears, and almost no tail. Most agouti species are of a roughly similar size, with the Brazilian Agouti specifically having a body-length range of 45-69 centimetres and weight of 3-6 kilograms. Females average larger than males but the difference is not great.
Synonyms: *Mus leporinus* (Linnaeus, 1758) *Dasyprocta aguti* (Linnaeus, 1766) *Dasyprocta cayana* (Lacepede, 1802) *Dasyprocta cristata* (Geoffroy, 1803) *Dasyprocta rubrata* (Thomas, 1898)	
	General information: The Brazilian Agouti has a distribution covering a large part of north-eastern South America, including Venezuela, Guyana, Surinam, French Guiana, Brazil, and Trinidad and Tobago. Insular populations in the Lesser Antilles are largely derived from prehistoric introductions by man and have been isolated long enough to have evolved into distinct subspecies. Population figures are unknown, but the species is considered common and non-threatened throughout its range.
Subspecies: Monotypic	Their distribution is entirely tropical and while their primary habitat is rainforest, they also inhabit less vegetated areas including farmland, so long as there is some dense cover in the area. They live entirely terrestrially and are active by day, year-round (there is no hibernation period).
Common Names: Brazilian Agouti Golden-rumped Agouti Red-rumped Agouti Orange-rumped Agouti Golden Agouti	The primary diet of all agouti species is fallen fruit and seeds, collected opportunistically from the forest floor. Agoutis are known as "scatter-hoarders": they routinely cache food items (i.e. burying seeds and nuts) in separate locations when food is plentiful, which they return to when food becomes scarce. As they do not retrieve all cached items, the agouti's play a valuable role in their native habitat as seed dispersers for the forest trees. Brazilian Agoutis occupy home ranges of between 3 and 10 hectares. Population densities may be between 1 and 63 animals per square kilometre. Males are territorial towards other males. Sexual maturity is reached around 9 months, but this does appear to be affected by the presence or absence of males/adult females. Brazilian Agoutis form monogamous pairs which remain together long-term. There is no set season for breeding, however most births occur between November to April. Compared to most rodents, agoutis are

slow breeders and produce well-developed but few young. Litter sizes are between 1 to 3 young, born after a gestation of 104-120 days. Agoutis invest a lot of time in successfully raising their offspring with the young often remaining with the parents for extended periods, forming small family groups.

Longevity:
Like most large-bodied rodents, agoutis are quite long-lived animals. Little is known of the life spans of wild animals, but the oldest captive record for the Brazilian agouti is 17.8 years.

Conservation status:
IUCN: Least Concern
CITES: Not Listed

DATE OF ORIGINAL ASSESSMENT: 15/07/2013
DATE OF CURRENT ASSESSMENT: Oct 2020 (Jodi Buchecker)
EIC ENDORSEMENT: 15/03/21

Risk assessment model used for the assessment: Bomford 2008, Mammals and Birds

The risk assessment model: Models for assessing the risk that exotic vertebrates could establish in Australia have been developed for mammals, birds (Bomford 2003, 2006, 2008), reptiles and amphibians (Bomford et al 2005, Bomford 2008). Developed by Dr Mary Bomford for the Bureau of Rural Sciences (BRS), the model uses criteria that have been demonstrated to have significant correlation between a risk factor and the establishment of populations of exotic species and the pest potential of those species that do establish. For example, a risk factor for establishment is similarity in climate (temperature and rainfall) within the species' distribution overseas and Australia. For pest potential, the species' overseas pest status is a risk factor.
The model is published as 'Risk assessment models for the establishment of exotic vertebrates in Australia and New Zealand' (Bomford 2008) and is available online on the PestSmart website https://pestsmart.org.au/wp-content/uploads/sites/3/2020/06/Risk_Assess_Models_2008_FINAL.pdf

CLIMATE: In 2021 a new version of the Climatch program used to assess similarity in climate was released by the Australian Bureau of Agricultural Resource Economics and Sciences (ABARES): CLIMATCH v2.0. The increase in resolution in this new version (from 50 km to 20 km) required recalibration of Climate Match Scores. See Table 1. Sixteen climate parameters (variables) of temperature and rainfall are used to estimate the extent of similarity between data from meteorological stations located within the species' world distribution and stations in Australia. Worldwide, data from approximately 19000 locations are available for analysis. The number of locations used in an analysis will vary according to the size of the species' distribution and the number of meteorological stations located within that distribution. To represent the climate match visually, the map of Australia is divided into 19236 grid squares, each measured in 0.2 degrees in both longitude and latitude. CLIMATCH v2.0 calculates a match for each Australian grid by comparing data from all meteorological stations within the species' distribution (excluding any populations in Australia) and allocating a score ranging from ten for the highest level match to zero for the poorest match. Levels of climate match are used in the risk assessment for questions B1 (scores are summed to give a cumulative score), C6, and C8. Climatch v2.0 can be accessed on the ABARES website, agriculture.gov.au/abares. The direct URL is https://climatch.cp1.agriculture.gov.au/.

FACTOR	SCORE	DETAIL
Bird and Mammal Model:		
STAGE A: RISKS POSED BY CAPTIVE OR RELEASED ANIMALS		
A1. Risk to people from individual escapees (0–2) *Assess the risk that individuals of the species could harm people. (NB, this question only relates to aggressive behaviour shown by escaped or released individual animals. Question C11 addresses the risk of harm from aggressive behaviour if the species establishes a wild population).* *Aggressive behaviour, size, plus the possession of organs capable of inflicting harm, such as sharp teeth, claws, spines, a sharp bill, or toxin-delivering apparatus may enable individual animals to harm people. Any known history of the species attacking, injuring or killing people should also be taken into account. Assume the individual is not protecting nest or young.*	0	*All other animals posing a lower risk of harm to people (ie animals 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).* Agoutis are small, wary around people, and do not have toxins.
A2. Risk to public safety from individual captive animals (0–2) *Assess the risk that irresponsible use of products obtained from captive individuals of the species (such as toxins) pose a public safety risk (excluding the safety of anyone entering the animals' cage/enclosure or otherwise coming within reach of the captive animals)*	0	*Nil or low risk (highly unlikely or not possible).* The Brazilian agouti has been kept in captivity in zoos in Australia for decades with no known incidents.
STAGE A PUBLIC SAFETY RISK SCORE **SUM A1 - A2 (0-4)**	0	**Not dangerous**
STAGE B: PROBABILITY ESCAPED OR RELEASED INDIVIDUALS WILL ESTABLISH FREE-LIVING POPULATIONS		
Model 1: Four-factor model for birds and mammals (Bomford 2008)		
B1. Degree of climate match between species overseas range and Australia (1–6)	2	*Low climate match* Value X = 1,202

Map the selected mammal or bird species' overseas range, including its entire native and exotic (excluding Australia) ranges over the past 1000 years. Use CLIMATCH v2.0, CMS = sum of classes 6 – 10, see Table 1.		Climate Match Score = 2 Overseas native range: Venezuela, the Guianas, central Brazil, Trinidad and Tobago. Introduced range: Dominica, Grenada, USA Virgin Islands.
B2. Exotic population established overseas (0–4) An established exotic population means the introduced species must have bred outside of captivity and must currently maintain a viable free-living population where the animals are not being intentionally fed or sheltered, even though they may be living in a highly disturbed environment with access to non-natural food supplies or shelter.	2	*Exotic populations only established on small islands (< 50 000 km^2; Tasmania is 67 800 km^2).* The Brazilian agouti has been introduced to the Lesser Antilles; specifically, Dominica, Grenada, and USA Virgin Islands (Eisenberg and Redford, 1999) and Saint Lucia (Clarke, 2009).
B3. Overseas range size score (0–2) < 1 = 0; 1– 70 = 1; >70 = 2 Estimate the species overseas range size* including currently and the past 1000 years; natural and introduced range in millions of square kilometres	1	*Overseas range size between 1 to 70 million km^2.* Their range is approximately 3.3 million km^2.
B4. Taxonomic Class (0–1) Bird = 0; mammal = 1	1	*Mammal*
B. ESTABLISHMENT RISK SCORE **SUM OF B1- B4 (1–13)**	6	**Moderate establishment risk**

Model 2: Seven-Factor Model For Birds And Mammals (Bomford 2008)		
B5. Diet score (0–1) Specialist = 0; generalist = 1	1	*Generalist with a broad diet of many food types.* The Brazilian agouti is a generalist herbivore.
B6. Habitat score (0–1) Undisturbed or disturbed habitat	1	*Can survive and breed in human-disturbed habitats (including grazing and agricultural lands, forests that are intensively managed or planted for timber harvesting and/or urban–suburban environments) without access to undisturbed (natural) habitats.* The Brazilian agouti does live in human-modified habitats (particularly after destruction of natural habitat).

B7. Migratory score (0–1) *Always migratory = 0; non-migratory = 1*	1	*Non-migratory*
B. ESTABLISHMENT RISK SCORE **SUM OF B1- B7 (1–16)**	9	**Moderate establishment risk**

STAGE C: PROBABILITY AN ESTABLISHED SPECIES WILL BECOME A PEST		
C1. Taxonomic group (0–4)	2	*Mammal in one of the orders that have been demonstrated to have detrimental effects on prey abundance and/or habitat degradation (Rodentia).*
C2. Overseas range size including current and past 1000 years, natural and introduced range (0–2) *Estimate the species overseas range size (including current and past 1000 years, natural and introduced range) in millions of square kilometre*	0	*Overseas geographic range less than 10 million square kilometres.* Estimated overseas range size 3.3 million km^2.
C3. Diet and feeding (0–3)	0	*Other herbivorous mammal.* The Brazilian agouti is a herbivorous mammal.
C4. Competition with native fauna for tree hollows (0–2)	0	*Does not use tree hollows.* The Brazilian agouti does not have the ability to climb and therefore cannot use tree hollows.
C5. Overseas environmental pest status (0–3) *Has the species been reported to cause declines in abundance of any native species of plant or animal or cause degradation to any natural communities in any country or region of the world?*	0	*Never reported as an environmental pest in any country or region.* No record of it being a pest in any country overseas, including islands where it has been introduced.
C6. Climate match to areas with susceptible native species or communities (0–5)	4	*The species has 69-138 grid squares within the highest two climate match classes (ie in classes 10 and 9) that overlap the distribution of any susceptible native species or ecological communities, and/or has 208-691 grid squares within the highest four climate match classes that overlap the distribution of any susceptible native species or ecological communities = 4*

Identify any native Australian animal or plant species or communities that could be susceptible to harm by the exotic species if it were to establish a wild population here.		Susceptible native species (animal and plant) that could potentially be impacted are: *Casuarius casuarius* (Southern Cassowary) – Least Concern *Eclectus polychloros* (Papuan Eclectus parrot) – Least Concern *Bettongia tropica* (Northern Bettong) – Endangered *Macadamia jansenii* (Bulberin Nut Tree) – Endangered
C7. Overseas primary production pest status (0–3) *Has the species been reported to damage crops or other primary production in any country or region of the world?*	1	*Minor pest of primary production in any country or region.* Zoo information sheets indicate that agoutis are hunted because they damage crops, but no documentary evidence was found.
C8. Climate match to susceptible primary production (0–5) *Assess Potential Commodity Impact Scores for each primary production commodity listed in Table 9, based on species' attributes (diet, behaviour, ecology), excluding risk of spreading disease which is addressed in Question C9.* *0 = 0; 1-19 = 1; 20-49 = 2; 50-99 = 3; 100-149 = 4; ≥150 = 5*	2	Total Commodity Damage Score = 31 (see Table 2) Feeds on seeds, fruit and nuts. There are no records of Brazilian agouti's causing damage to crops but they have the capacity to do so.
C9. Spread disease (1–2) *Assess the risk that the species could play a role in the spread of disease or parasites to other animals*	2	*All mammals (likely or unknown effect on native species and on livestock and other domestic animals).*
C10. Harm to property (0–3) *Assess the risk that the species could inflict damage on buildings, vehicles, fences, roads, equipment or ornamental gardens by chewing or burrowing or polluting with droppings or nesting material.*	2	*$11 - $50 million.* No record of the Brazilian agouti causing damage to property in native or introduced ranges. However, the Brazilian agouti can chew and burrow, which could potentially cause a lot of damage. On Climatch the areas within the six highest climate match classes covers some parts of northern Australia, where infrastructure is not major. Precautionary rating of 2 is given here.
C11. Harm to people (0–5)	0	*Nil risk.*

Assess the risk that, if a wild population established, the species could cause harm to or annoy people. Aggressive behaviour, plus the possession of organs capable of inflicting harm, such as sharp teeth, tusks, claws, spines, a sharp bill, horns, antlers or toxin delivering organs may enable animals to harm people. Any known history of the species attacking, injuring or killing people should also be taken into account (see Stage A, Score A1).		The Brazilian agouti is a non-aggressive species and does not have any toxins.
C. PEST RISK SCORE **SUM C 1 TO C 11 (1–37)**	13	**Moderate pest risk**
STAGE A. PUBLIC SAFETY RISK RANK – RISK TO PUBLIC SAFETY POSED BY CAPTIVE OR RELEASED INDIVIDUALS *0 = Not dangerous; 1 = Moderately dangerous; ≥ 2 = Highly dangerous*	0	Not dangerous
STAGE B. ESTABLISHMENT RISK RANK – RISK OF ESTABLISHING A WILD POPULATION MODEL 1: FOUR-FACTOR MODEL FOR BIRDS AND MAMMALS (BOMFORD 2008) *≤ 5 = low establishment risk; 6-8 = moderate establishment risk; 9-10 = serious establishment risk; ≥ 11-13 = extreme establishment risk*	6	Moderate establishment risk
STAGE B. ESTABLISHMENT RISK RANK – RISK OF ESTABLISHING A WILD POPULATION MODEL 2: SEVEN-FACTOR MODEL FOR BIRDS AND MAMMALS (BOMFORD 2008) *≤ 6 = low establishment risk; 7-11 = moderate establishment risk; 12-13 = serious establishment risk; ≥14 = extreme establishment risk*	9	Moderate establishment risk
STAGE C. PEST RISK RANK - RISK OF BECOMING A PEST FOLLOWING ESTABLISHMENT	13	Moderate pest risk

< 9 = low pest risk; 9-14 = moderate pest risk; 15-19 = serious pest risk; > 19 = extreme pest risk		

ENVIRONMENT AND INVASIVES COMMITTEE THREAT CATEGORY	**MODERATE**

World distribution map (IUCN Red List) and World distribution map indicating where meteorological data was sourced for the climate analysis (see B1):

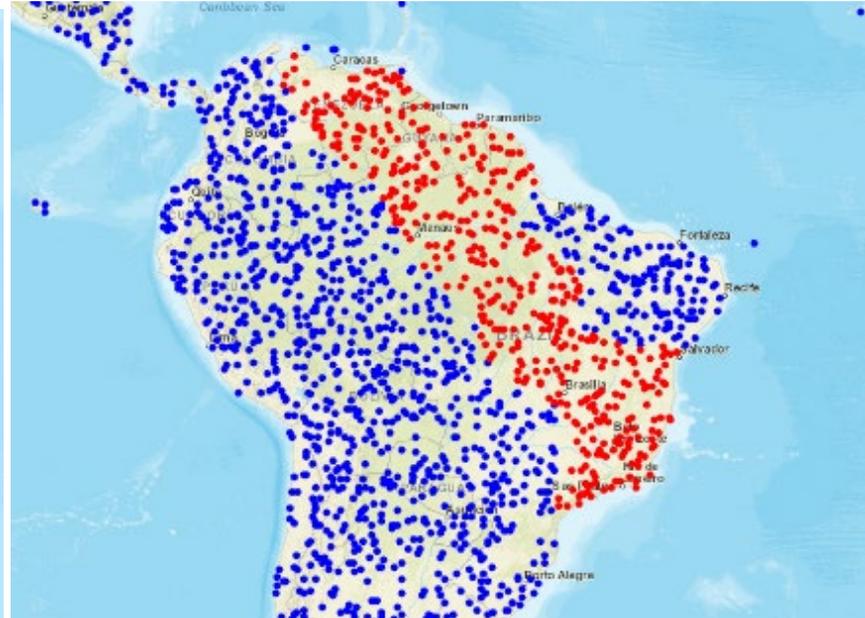*Figure 1 - World Distribution Map - IUCN Red List*

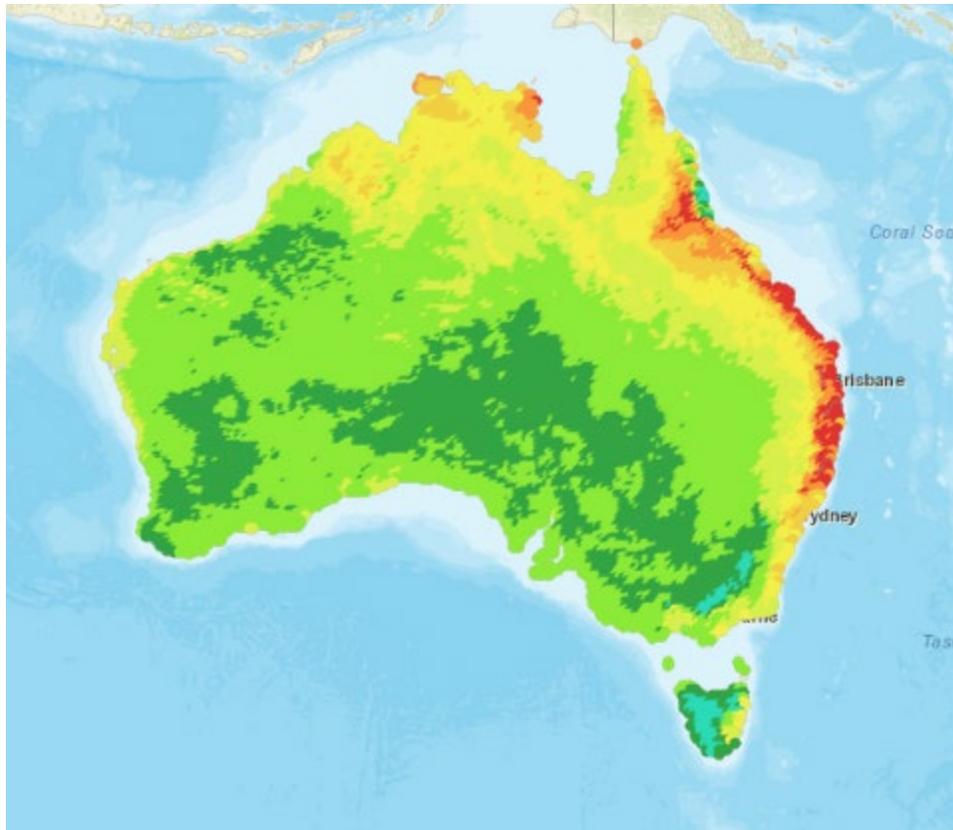*Figure 2 - World Distribution Map - Climatch*

Climate match between world distribution of species and Australia:
Areas of Australia where the climate appears suitable for *Dasyprocta leporina*
CMS = 1202

Score	Color	Count
0	●	0
1	●	126
2	●	4360
3	●	8369
4	●	2830
5	●	2349
6	●	647
7	●	355
8	●	187
9	●	13
10	●	0

Species: Dasyprocta leporina (Brazilian Agouti)
Algorithm: Closest Standard Score
452 source features selected
19236 target features selected
Approximate selected area: 5,154,414 km²

Table 1: ABARES recalibration thresholds

Climate Match Score (CMS)	Current Bomford 2008 model classes (50 km)	Recalibrated classes to Climatch v2.0 (20 km)
1 (Very low)	< 100	< 691
2 (Low)	100-599	691-4137
3 (Moderate)	600-899	4138-6209
4 (High)	900-1699	6210-11735
5 (Very high)	1700-2699	11736-18642
6 (Extreme)	≥ 2700	≥ 18643

Table 2: Susceptible Australian Primary Production – Calculating Total Commodity Damage Score
The commodity value index scores in this table are derived from Australian Bureau of Statistics 2005 – 2006 data. The values will require updating if significant change has occurred in the value of the commodity (Bomford 2008).

Industry	Commodity Value Index 1 (CVI based on best available date)	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)	10			
Timber (includes native and plantation forests)	10			
Cereal grain (includes wheat, barley sorghum etc)	10	1	2	20
Sheep (includes wool and sheep meat)	10			
Grapes	2			
Vegetables	2			
Poultry and eggs	2			
Aquaculture(includes coastal mariculture)	2			
Oilseeds (includes canola, sunflower etc)	2	1	2	4
Grain legumes (includes soybeans)	2	1	2	4
Sugarcane	2			
Cotton	2			
Other crops and horticulture (includes nuts tobacco and flowers etc)	1			
Pigs	1			
Other livestock (includes goats, deer, camels, rabbits)	1			
Bees (included honey, beeswax and pollination)	1			
Nuts	1	1	3	3
Total Commodity Damage Score (TCDS)				31

NB The Commodity Value Index scores in this table are derived from Australian Bureau of Statistics 2005–2006 data and will need to be updated if these values change significantly.

Assess Potential Commodity Impact Scores for each primary production commodity listed in Table 9, based on species' attributes (diet, behaviour, ecology), excluding risk of spreading disease which is addressed in Question C9, and pest status worldwide as:

0. *Nil (species does not have attributes to make it capable of damaging this commodity)*
1. *Low (species has attributes making it capable of damaging this or similar commodities and has had the opportunity but no reports or other evidence that it has caused damage in any country or region*
2. *Moderate–serious (reports of damage to this or similar commodities exist 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)*
3. *Extreme (damage occurs 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).*

Climate Match to Commodity Score (0–5)

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

Table 3: Assigning species to EIC Threat Categories (shaded cells relate to assignment of reptiles and amphibians to EIC Threat Categories based on an assessed establishment risk and an allocated pest risk of extreme) – adapted from Bomford 2008

Establishment Risk	Pest Risk	Public Safety Risk	EIC Threat Category	Implication for any proposed import into Australia	Implication for keeping and movement in Australia
Extreme	Extreme	Highly, Moderately or Not Dangerous	EXTREME	Prohibited, unless sufficient risk management measures exist to reduce the potential risks to an acceptable level	Limited to those collections approved for keeping particular EXTREME Threat species
Extreme	Serious	Highly, Moderately or Not Dangerous	EXTREME		
Extreme	Moderate	Highly, Moderately or Not Dangerous	EXTREME		
Extreme	Low	Highly, Moderately or Not Dangerous	EXTREME		
Serious	Extreme	Highly, Moderately or Not Dangerous	EXTREME		
Serious	Serious	Highly, Moderately or Not Dangerous	EXTREME		
Moderate	Extreme	Highly, Moderately or Not Dangerous	EXTREME		
Serious	Moderate	Highly, Moderately or Not Dangerous	SERIOUS	Import restricted to those collections approved for keeping SERIOUS Threat species	Limited to those collections approved for keeping particular SERIOUS Threat species
Serious	Low	Highly, Moderately or Not Dangerous	SERIOUS		
Moderate	Serious	Highly, Moderately or Not Dangerous	SERIOUS		
Moderate	Moderate	Highly Dangerous	SERIOUS		
Moderate	Low	Highly Dangerous	SERIOUS		
Low	Extreme	Highly, Moderately or Not Dangerous	SERIOUS		
Low	Serious	Highly, Moderately or Not Dangerous	SERIOUS		
Low	Moderate	Highly Dangerous	SERIOUS		
Low	Low	Highly Dangerous	SERIOUS		
Moderate	Moderate	Moderately or Not Dangerous	MODERATE	Import restricted to those collections approved for keeping MODERATE Threat species	Limited to those collections approved for keeping particular MODERATE Threat species
Moderate	Low	Moderately or Not Dangerous	MODERATE		
Low	Moderate	Moderately or Not Dangerous	MODERATE		
Low	Low	Moderately Dangerous	MODERATE		
Low	Low	Not Dangerous	LOW	Import permitted	May be limited to those collections approved for keeping particular LOW Threat species
Any Value	Any Value	Unknown	EXTREME until proven otherwise	Prohibited, unless sufficient risk management measures exist to reduce the potential risks to an acceptable level	Limited to those collections approved for keeping particular EXTREME Threat species
Unknown	Any Value	Any Value	EXTREME until proven otherwise		
Any Value	Unknown	Any Value	EXTREME until proven otherwise		
Unassessed	Unassessed	Unassessed	EXTREME until proven otherwise		

Adapted from:	DAWE Risk Assessment Report on Brazilian Agouti	**By:** Jodi Buchecker	**Date:** Oct 2020

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National Risk Assessment: EXTREME

RISK ASSESSMENT FOR AUSTRALIA: **Capybara (*Hydrochoerus hydrochaeris*)**

Class - Mammalia, **Order –** Rodentia, **Family** - Caviidae, **Subfamily –** Hydrochoerinae, **Genus –** *Hydrochoerus.*

SPECIES:	Species description:
Hydrochoerus hydrochaeris (Linnaeus, 1766)	Capybaras are the largest of rodents, weighing from 35 to 66 kilograms and standing up to0.6 meters at the shoulder, with a length of about 1.2 meters. Females of this species are slightly larger than males. The capybaras fur is coarse and thin, and is reddish brown over most of the body, turning yellowish brown on the belly and sometimes black on the face (Frankis et al., 2014). The body is barrel-shaped, sturdy, with a vestigial tail (Frankis et al., 2014).
Synonyms: *Sus hydrochaeris* (Linnaeus, 1766) *Hydrochaeris hydrochaeris* (Linnaeus, 1766)	The capybara is adapted to a semi-aquatic life. It can swim with only the nostrils, eyes and short, rounded ears protruding out of the water, as they are placed high on the head, and the body contains a large amount of fatty tissue, giving it a neutral buoyancy in water (Mones and Ojasti, 1986; Nowak, 1991). The feet are also partially webbed. Each of the forefeet has four toes, while the hind feet have only three, and each toe bears a strong, hoof-like claw (Nowak, 1991; Mones and Ojasti, 1986). The front legs are slightly shorter than the hind legs and the capybara often sits on its haunches like a dog. Unlike many other rodents, the capybara is unable to hold food in its forefeet (Nowak, 1991; MacDonald, 2006).
Subspecies: Monotypic	The male capybara can be distinguished from the female by the obvious, highly developed scent gland on top of the snout. This dark, naked, raised area secretes a copious white, sticky fluid, thought to be involved in signalling dominance status (MacDonald, 2006; Nowak, 1991).
Common Names: Capybara	**General information:** The capybara is a native resident to South America. The capybara can be found in Argentina, the Plurinational States of Bolivia, Brazil, Colombia, Ecuador, Guyana, Paraguay, Peru, Uruguay and the Bolivarian Republic of Venezuela (IUCN, 2020). The capybara is most numerous on the seasonally flooded grasslands of the Llanos in Venezuela and Colombia, and the Pantanal of Brazil (Mones and Ojasti, 1986). The capybara inhabits a variety of lowland habitats close to bodies of water (such as rivers and lakes) within rain forests, marshes, brackish wetlands, swamps, and seasonally flooded grassland and savanna (MacDonald, 2006; Nowak, 1991; Mones and Ojasti, 1986). Suitable capybara habitats need a mixture of water, dry ground and pasture (Mones and Ojasti, 1986), and habitat use may change seasonally to follow the availability of these resources (ARKive, 2014). The home range of the capybara averages 10 hectares (25 acres) in high-density populations (Mones and Ojasti, 1986).

Capybaras are herbivores, grazing mainly on grasses and aquatic plants, as well as other plants, grain, and sometimes bark and fruit (ARKive, 2014; Frankis et al, 2014). Capybaras are very selective feeders and will feed on the leaves of one species and disregard other species surrounding it. While they eat grass during the wet season, they will switch to more abundant reeds during the dry season (Barreto et al, 1998). Plants that capybaras eat during the summer lose their nutritional value in the winter and therefore are not consumed at that time (Barreto et al, 1998). The capybara is an efficient grazer, able to crop the short, dry grasses left at the end of the tropical dry season (MacDonald, 2006).

Capybaras are very gregarious. They are typically found in groups that average 10–20 individuals, comprising a dominant male, one or more females (which are often related), young of various ages, and one or more subordinate males (Alho and Rondon, 1987; Mones and Ojasti, 1986). Capybara groups can consist of as many as 50 or 100 individuals during the dry season, when the animals gather around available water sources (MacDonald, 2006).

The capybara reaches sexual maturity around 12 to 18 months (MacDonald, 2006; Nowak, 1991). Breeding peaks between April and May in Venezuela and between October and November in Mato Grosso, Brazil (Mones and Ojasti, 1986). Capybaras mate only in water, and if a female does not want to mate with a certain male, she will either submerge or leave the water (MacDonald, 2006). The female capybara usually gives birth to a single litter each year, at the end of the rainy season, after a gestation period of around 130-150 days (MacDonald, 2006; Mones and Ojasti, 1986). She will produce up to 8 young, although there are usually 4 in a litter. The infant capybaras are highly developed at birth. They will follow the female and even eat grass within the first week of life (MacDonald, 2006; Nowak, 1991; Mones and Ojasti, 1986). Weaning takes place at around 16 weeks (Nowak, 1991), although milk is a relatively minor part of the infant's diet compared to grass (Mones and Ojasti 1986). All young within the group tend to stay together in a crèche, and may suckle from any nursing female (MacDonald, 2006).

There is very little information on this species as an agricultural pest, although capybaras are sometimes killed by farmers as pests, either because they may attack cereal or fruit crops, or they are viewed as a competitor with domestic livestock (ARKive, 2014). Capybaras sometimes raid gardens or farms in search of food, such as melons, squashes, or grains. There are no known investigations into the Capybara's impact within the state of Florida. It has also been hypothesized that capybaras are carriers of certain livestock diseases (Frankis et al, 2014).

Longevity:
The capybara is relatively short-lived for its body size. One study in the wild reported a high juvenile mortality, particularly in the first year of life, resulting in a life expectancy of just over 1 year. The oldest females found in the same study were 6 years of age and the oldest males were 7 years of age. Other estimates and anecdotal reports suggest that the capybara may live up to 10 years in the wild. One captive specimen lived for 15.1 years (AnAge, 2011).

	Conservation status: **IUCN:** Least Concern. The capybara is not globally threatened and is listed as 'least concern' by the IUCN in view of its wide distribution, presumed large population, occurrence within several protected areas, and because it is unlikely to be declining at nearly the rate required to qualify for listing in a threatened category (Querolo, 2008). However, some local capybara populations have decreased or even disappeared where hunting pressure is intense, such as near human settlement and along rivers, which are the main travel routes of hunters (Lidicker, 1989). **CITES:** The capybara is not listed on the Appendices to the *Convention on International Trade in Endangered Species of Wild Flora and Fauna* (CITES, 2014). Therefore, international trade in specimens of capybara is not regulated under the convention and is not considered to be detrimental to the survival of the species in the wild. The capybara occurs in several protected areas throughout its range (Querolo, 2008), and efforts have been made to control hunting in many areas (ARKive, 2014). Despite this, the capybara is still often killed illegally, and capybara meat is commonly found in rural markets throughout Amazonia (Deschamps et al., 2007). The species is currently hunted commercially in licensed ranches in the Llanos of Venezuela, which has apparently resulted in stabilisation of the local capybara population (Deschamps et al, 2007).
DATE OF ORIGINAL ASSESSMENT: 12/03/15 **DATE OF CURRENT ASSESSMENT:** Oct 2020 (Jodi Buchecker) **EIC ENDORSEMENT:** 15/03/21 **Risk assessment model used for the assessment:** Bomford 2008, Mammals and Birds	**The risk assessment model:** Models for assessing the risk that exotic vertebrates could establish in Australia have been developed for mammals, birds (Bomford 2003, 2006, 2008), reptiles and amphibians (Bomford et al 2005, Bomford 2008). Developed by Dr Mary Bomford for the Bureau of Rural Sciences (BRS), the model uses criteria that have been demonstrated to have significant correlation between a risk factor and the establishment of populations of exotic species and the pest potential of those species that do establish. For example, a risk factor for establishment is similarity in climate (temperature and rainfall) within the species' distribution overseas and Australia. For pest potential, the species' overseas pest status is a risk factor. The model is published as 'Risk assessment models for the establishment of exotic vertebrates in Australia and New Zealand' (Bomford 2008) and is available online on the PestSmart website https://pestsmart.org.au/wp-content/uploads/sites/3/2020/06/Risk_Assess_Models_2008_FINAL.pdf **CLIMATE**: In 2021 a new version of the Climatch program used to assess similarity in climate was released by the Australian Bureau of Agricultural Resource Economics and Sciences (ABARES): CLIMATCH v2.0. The increase in resolution in this new version (from 50 km to 20 km) required recalibration of Climate Match Scores. See Table 1. Sixteen climate parameters (variables) of temperature and rainfall are used to estimate the extent of similarity between data from meteorological stations located within the species' world distribution and stations in Australia. Worldwide, data from approximately 19000 locations are available for analysis. The number of locations used in an analysis will vary according to the size of the species' distribution and the number of meteorological stations located within that distribution. To represent the climate match visually, the map of Australia is divided into 19236 grid squares, each measured in 0.2 degrees in both longitude and latitude. CLIMATCH v2.0 calculates a match for each Australian grid by comparing data from all meteorological stations within the species' distribution (excluding any populations in Australia) and allocating a score ranging from ten for the highest level match to zero for the poorest match. Levels of climate match are used in the risk assessment for questions B1 (scores are summed to give a cumulative score), C6, and C8. Climatch v2.0 can be accessed on the ABARES website, agriculture.gov.au/abares. The direct URL is https://climatch.cp1.agriculture.gov.au/.

Bird and Mammal Model:

FACTOR	SCORE	DETAIL
STAGE A: RISKS POSED BY CAPTIVE OR RELEASED ANIMALS		
A1. Risk to people from individual escapees (0–2) *Assess the risk that individuals of the species could harm people. (NB, this question only relates to aggressive behaviour shown by escaped or released individual animals. Question C11 addresses the risk of harm from aggressive behaviour if the species establishes a wild population).* *Aggressive behaviour, size, plus the possession of organs capable of inflicting harm, such as sharp teeth, claws, spines, a sharp bill, or toxin-delivering apparatus may enable individual animals to harm people. Any known history of the species attacking, injuring or killing people should also be taken into account. Assume the individual is not protecting nest or young.*	1	*Animal that 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 animal that is unlikely to make an unprovoked attack, but which can cause serious injury (requiring hospitalisation) or fatality if cornered or handled.* Capybaras can be aggressive with sharp teeth capable of causing severe injuries and hospitalisation when cornered or handled (Capybara Madness, 2011; Rossetto et al., 2021).
A2. Risk to public safety from individual captive animals (0–2) *Assess the risk that irresponsible use of products obtained from captive individuals of the species (such as toxins) pose a public safety risk (excluding the safety of anyone entering the animals' cage/enclosure or otherwise coming within reach of the captive animals)*	0	*Nil or low risk (highly unlikely or not possible).*
STAGE A PUBLIC SAFETY RISK SCORE **SUM A1 - A2 (0-4)**	1	**Moderately dangerous**

STAGE B: PROBABILITY ESCAPED OR RELEASED INDIVIDUALS WILL ESTABLISH FREE-LIVING POPULATIONS

Model 1: FOUR-FACTOR MODEL FOR BIRDS AND MAMMALS (BOMFORD 2008)

B1. Degree of climate match between species overseas range and Australia (1–6) *Map the selected mammal or bird species' overseas range, including its entire native and exotic (excluding Australia) ranges over the past 1000 years.* *Use CLIMATCH v2.0, CMS = sum of classes 6 – 10, see Table 1.*	3	*Moderate climate match in Australia* Value X = 6,017 Climate Match Score = 3
B2. Exotic population established overseas (0–4) *An established exotic population means the introduced species must have bred outside of captivity and must currently maintain a viable free-living population where the animals are not being intentionally fed or sheltered, even though they may be living in a highly disturbed environment with access to non-natural food supplies or shelter.*	4	*Exotic population established on a larger island (> 50 000 km^2) or anywhere on a continent (including elsewhere on the land mass where the natural distribution of the animal is, if this population is due to human introduction and is geographically separate from the natural range of the species).* The capybara has established overseas populations in North America. Capybaras are known to be kept as pets in the United States of America. It is suspected that the feral population in Florida is the result of escapees from a private collection (Benson, 2020).
B3. Overseas range size score (0–2) < 1 = 0; 1– 70 = 1; >70 = 2 *Estimate the species overseas range size* including currently and the past 1000 years; natural and introduced range in millions of square kilometres*	1	*Overseas range between 1 to 70 km^2.* 13,512,612 km^2 plus Florida population
B4. Taxonomic Class (0–1) Bird=0; mammal = 1	1	*Mammal*
B. ESTABLISHMENT RISK SCORE **SUM OF B1- B4 (1–13)**	9	**Serious establishment risk**

Model 2: Seven-Factor Model For Birds And Mammals (Bomford 2008)

B5. Diet score (0–1) *Specialist = 0; generalist = 1*	1	*Generalist with a broad diet of many food types.*

		The capybara is a generalist herbivore that mainly grazes of grasses.
B6. Habitat score (0–1) *Undisturbed or disturbed habitat*	1	*Can survive and breed in human-disturbed habitats (including grazing and agricultural lands, forests that are intensively managed or planted for timber harvesting and/or urban–suburban environments) without access to undisturbed (natural) habitats.* The capybara can survive in modified habitats. Capybaras do very well on cattle ranches and may compete for forage with the cattle (Benson, 2020).
B7. Migratory score (0–1) *Always migratory = 0; non-migratory = 1*	1	*Non-migratory*
B. ESTABLISHMENT RISK SCORE **SUM OF B1- B7 (1–16)**	12	**Serious establishment risk**
STAGE C: PROBABILITY AN ESTABLISHED SPECIES WILL BECOME A PEST		
C1. Taxonomic group (0–4)	2	*Mammal in one of the orders that have been demonstrated to have detrimental effects on prey abundance and/or habitat degradation (Rodentia).* Rodents, including capybaras, are known to cause agricultural damage.
C2. Overseas range size including current and past 1000 years, natural and introduced range (0–2) *Estimate the species overseas range size (including current and past 1000 years, natural and introduced range) in millions of square kilometre*	1	*Overseas geographic range 10–30 million square kilometres.* 13,512,612 km^2 plus Florida population.
C3. Diet and feeding (0–3)	3	*Mammal that is a primarily a grazer or browser.*
C4. Competition with native fauna for tree hollows (0–2)	0	*Does not use tree hollows.*
C5. Overseas environmental pest status (0–3) *Has the species been reported to cause declines in abundance of any native species of plant or animal or*	3	*Unknown overseas environmental pest status.*

cause degradation to any natural communities in any country or region of the world?		The capybara has never reported as an environmental pest in its native range. However, it is unknown if environmental damage occurs in Florida, therefore the capybara has been given a precautionary score of 3.
C6. Climate match to areas with susceptible native species or communities (0–5) *Identify any native Australian animal or plant species or communities that could be susceptible to harm by the exotic species if it were to establish a wild population here.*	5	*The species has more than 138 grid squares within the highest two climate match classes, and/or has more than 691 grid squares within the four highest climate match classes, that overlap the distribution of any susceptible native species or communities = 5* Examples of susceptible native species or ecological communities (DAWE Protected Matters Search Tool) include: White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland – Critically Endangered *Neophema chrysogaster* (Orange-bellied Parrot) – Critically Endangered (potential for disturbance of migratory bird species during breeding)
C7. Overseas primary production pest status (0–3) *Has the species been reported to damage crops or other primary production in any country or region of the world?*	1	*Minor pest of primary production in any country or region.* Some capybaras have been culled in farmlands as they are considered a minor pest and blamed for crop damage.
C8. Climate match to susceptible primary production (0–5) *Assess Potential Commodity Impact Scores for each primary production commodity listed in Table 9, based on species' attributes (diet, behaviour, ecology), excluding risk of spreading disease which is addressed in Question C9.* *0 = 0; 1-19 = 1; 20-49 = 2; 50-99 = 3; 100-149 = 4; ≥150 = 5*	3	Total Commodity Damage Score = 88 (see Table 2) The capybara has the potential to impact fruit, sugar cane, and cattle production.
C9. Spread disease (1–2) *Assess the risk that the species could play a role in the spread of disease or parasites to other animals*	2	*All mammals (likely or unknown effect on native species and on livestock and other domestic animals).*

C10. Harm to property (0–3) *Assess the risk that the species could inflict damage on buildings, vehicles, fences, roads, equipment or ornamental gardens by chewing or burrowing or polluting with droppings or nesting material.*	1	*$1 to $10 million.* Damage to artificial wetlands, ponds and gardens.
C11. Harm to people (0–5) *Assess the risk that, if a wild population established, the species could cause harm to or annoy people. Aggressive behaviour, plus the possession of organs capable of inflicting harm, such as sharp teeth, tusks, claws, spines, a sharp bill, horns, antlers or toxin delivering organs may enable animals to harm people. Any known history of the species attacking, injuring or killing people should also be taken into account (see Stage A, Score A1).*	1	*Very low risk.* Populations of capybara have been considered a potential nuisance in east central Sao Paulo Brazil where they often live near humans. The capybara has been associated with the spread of Brazilian Spotted Fever to humans.
C. PEST RISK SCORE **SUM C 1 TO C 11 (1–37)**	22	**Extreme pest risk**
STAGE A. PUBLIC SAFETY RISK RANK – RISK TO PUBLIC SAFETY POSED BY CAPTIVE OR RELEASED INDIVIDUALS *0 = Not dangerous; 1 = Moderately dangerous; ≥ 2 = Highly dangerous*	1	Moderately dangerous
STAGE B. ESTABLISHMENT RISK RANK – RISK OF ESTABLISHING A WILD POPULATION **MODEL 1: FOUR-FACTOR MODEL FOR BIRDS AND MAMMALS (BOMFORD 2008)** *≤ 5 = low establishment risk; 6-8 = moderate establishment risk; 9-10 = serious establishment risk; ≥ 11-13 = extreme establishment risk*	9	Serious establishment risk

STAGE B. ESTABLISHMENT RISK RANK – RISK OF ESTABLISHING A WILD POPULATION **MODEL 2: SEVEN-FACTOR MODEL FOR BIRDS AND MAMMALS (BOMFORD 2008)** *≤ 6 = low establishment risk; 7-11 = moderate establishment risk; 12-13 = serious establishment risk; ≥14 = extreme establishment risk*	12	Serious establishment risk
STAGE C. PEST RISK RANK - RISK OF BECOMING A PEST FOLLOWING ESTABLISHMENT *< 9 = low pest risk; 9-14 = moderate pest risk; 15-19 = serious pest risk; > 19 = extreme pest risk*	22	Extreme pest risk

ENVIRONMENT AND INVASIVES COMMITTEE THREAT CATEGORY	**EXTREME**

World distribution map (IUCN Red List) and World distribution map indicating where meteorological data was sourced for the climate analysis (see B1):

Figure 1 - World Distribution Map - IUCN Red List
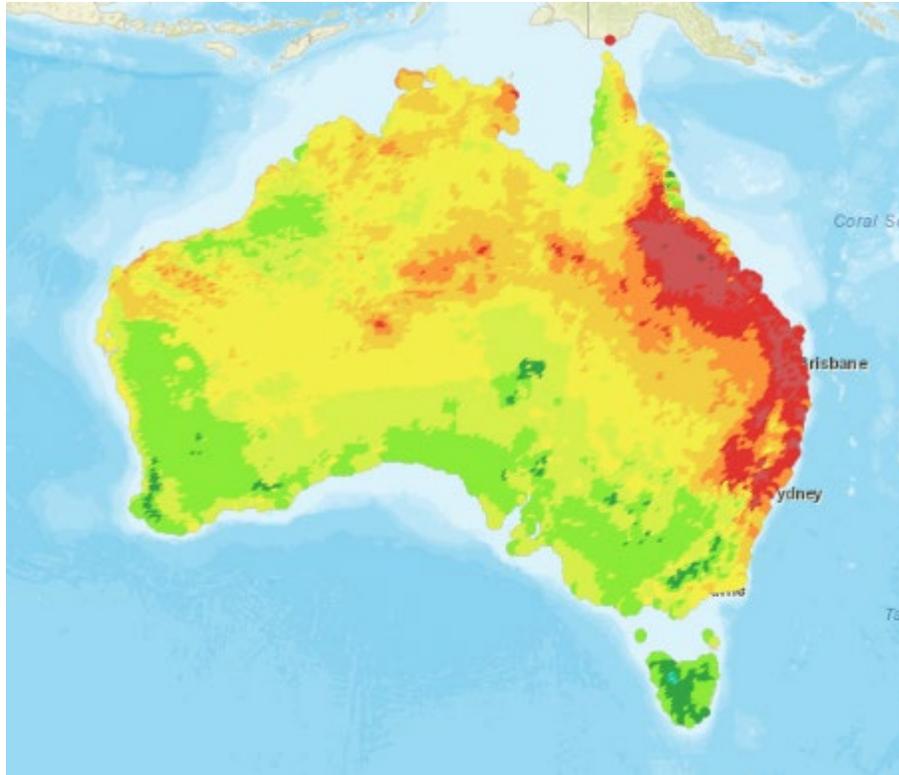

Figure 2 - World Distribution Map - Climatch

Climate match between world distribution of species and Australia:
Areas of Australia where the climate appears suitable for *Hydrochoerus hydrochaeris*
CMS = 6017

Score	Color	Count
0	●	0
1	●	5
2	●	218
3	●	2986
4	●	3916
5	●	6094
6	●	3202
7	●	1374
8	●	851
9	●	585
10	●	5

Species: Hydrochoerus hydrochaeris (Capybara)
Algorithm: Closest Standard Score
1310 source features selected
19236 target features selected
Approximate selected area: 13,512,612 km²

Table 1: ABARES recalibration thresholds

Climate Match Score (CMS)	Current Bomford 2008 model classes (50 km)	Recalibrated classes to Climatch v2.0 (20 km)
1 (Very low)	< 100	< 691
2 (Low)	100-599	691-4137
3 (Moderate)	600-899	4138-6209
4 (High)	900-1699	6210-11735
5 (Very high)	1700-2699	11736-18642
6 (Extreme)	≥ 2700	≥ 18643

Table 2: Susceptible Australian Primary Production – Calculating Total Commodity Damage Score

The commodity value index scores in this table are derived from Australian Bureau of Statistics 2005 – 2006 data. The values will require updating if significant change has occurred in the value of the commodity (Bomford 2008).

Industry	Commodity Value Index 1 (CVI based on best available date)	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	1	3	33
Timber (includes native and plantation forests)	10			
Cereal grain (includes wheat, barley sorghum etc)	8	1	2	16
Sheep (includes wool and sheep meat)	5	1	2	10
Fruit (includes wine grapes)	4	2	2	16
Vegetables	3	1	1	3
Poultry and eggs	2			
Aquaculture(includes coastal mariculture)	2			
Oilseeds (includes canola, sunflower etc)	1			
Grain legumes (includes soybeans)	1			
Sugarcane	1	2	5	10
Cotton	1			
Other crops and horticulture (includes nuts tobacco and flowers etc)	1			
Pigs	1			
Other livestock (includes goats, deer, camels, rabbits)	0.5			
Bees (included honey, beeswax and pollination)	0.5			
Total Commodity Damage Score (TCDS)				88

NB The Commodity Value Index scores in this table are derived from Australian Bureau of Statistics 2005–2006 data and will need to be updated if these values change significantly.

Assess Potential Commodity Impact Scores for each primary production commodity listed in Table 9, based on species' attributes (diet, behaviour, ecology), excluding risk of spreading disease which is addressed in Question C9, and pest status worldwide as:

0. *Nil (species does not have attributes to make it capable of damaging this commodity)*
1. *Low (species has attributes making it capable of damaging this or similar commodities and has had the opportunity but no reports or other evidence that it has caused damage in any country or region*
2. *Moderate–serious (reports of damage to this or similar commodities exist 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)*
3. *Extreme (damage occurs 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).*

Climate Match to Commodity Score (0–5)

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

Table 3: Assigning species to EIC Threat Categories (shaded cells relate to assignment of reptiles and amphibians to EIC Threat Categories based on an assessed establishment risk and an allocated pest risk of extreme) – adapted from Bomford 2008

Establishment Risk	Pest Risk	Public Safety Risk	EIC Threat Category	Implication for any proposed import into Australia	Implication for keeping and movement in Australia
Extreme	Extreme	Highly, Moderately or Not Dangerous	EXTREME	Prohibited, unless sufficient risk management measures exist to reduce the potential risks to an acceptable level	Limited to those collections approved for keeping particular EXTREME Threat species
Extreme	Serious	Highly, Moderately or Not Dangerous	EXTREME		
Extreme	Moderate	Highly, Moderately or Not Dangerous	EXTREME		
Extreme	Low	Highly, Moderately or Not Dangerous	EXTREME		
Serious	Extreme	Highly, Moderately or Not Dangerous	EXTREME		
Serious	Serious	Highly, Moderately or Not Dangerous	EXTREME		
Moderate	Extreme	Highly, Moderately or Not Dangerous	EXTREME		
Serious	Moderate	Highly, Moderately or Not Dangerous	SERIOUS	Import restricted to those collections approved for keeping SERIOUS Threat species	Limited to those collections approved for keeping particular SERIOUS Threat species
Serious	Low	Highly, Moderately or Not Dangerous	SERIOUS		
Moderate	Serious	Highly, Moderately or Not Dangerous	SERIOUS		
Moderate	Moderate	Highly Dangerous	SERIOUS		
Moderate	Low	Highly Dangerous	SERIOUS		
Low	Extreme	Highly, Moderately or Not Dangerous	SERIOUS		
Low	Serious	Highly, Moderately or Not Dangerous	SERIOUS		
Low	Moderate	Highly Dangerous	SERIOUS		
Low	Low	Highly Dangerous	SERIOUS		
Moderate	Moderate	Moderately or Not Dangerous	MODERATE	Import restricted to those collections approved for keeping MODERATE Threat species	Limited to those collections approved for keeping particular MODERATE Threat species
Moderate	Low	Moderately or Not Dangerous	MODERATE		
Low	Moderate	Moderately or Not Dangerous	MODERATE		
Low	Low	Moderately Dangerous	MODERATE		
Low	Low	Not Dangerous	LOW	Import permitted	May be limited to those collections approved for keeping particular LOW Threat species
Any Value	Any Value	Unknown	EXTREME until proven otherwise	Prohibited, unless sufficient risk management measures exist to reduce the potential risks to an acceptable level	Limited to those collections approved for keeping particular EXTREME Threat species
Unknown	Any Value	Any Value	EXTREME until proven otherwise		
Any Value	Unknown	Any Value	EXTREME until proven otherwise		
Unassessed	Unassessed	Unassessed	EXTREME until proven otherwise		

Adapted from:	Jensz, K. and Finley, L. (2014) Species profile for *Hydrochoerus hydrochaeris*. Latitude 42 Environmental Consultants Pty Ltd. Hobart, Tasmania. Tasmanian Government Capybara Risk Assessment 2015	By: Jodi Buchecker	Date: Oct 2020

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National Risk Assessment: EXTREME

RISK ASSESSMENT FOR AUSTRALIA: 'Savannah Cat' (Hybrid of *Leptailurus serval* (Serval) and *Felis catus* (domestic cat))

Class - Mammalia, **Order** - Carnivora, **Family** - Felidae, **Genus** – *Leptailurus / Felis cross*.

| SPECIES:
Leptailurus serval x *Felis catus*

Common Names:
Savannah cat
American savannah cat
Designer cat | **Species description:**
The Savannah cat is a cross between the domestic cat and wild serval that was developed in the late 20th Century. Morphologically, the F5 hybrid savannah cat has similar features to both the domestic cat and the wild serval, with the savannah cat often described as a smaller replica of the serval (TICA (Breed Standard), 2008). Compared with the domestic cat, the savannah cat has a long, lean neck, long, slender legs, with elongated toes and a somewhat more triangular face. The savannah cat's ears are exceptionally large and positioned high on the head and its back legs are slightly longer than the front. Fur colour is variable, with various combinations of black, brown spotted tabby, silver spotted tabby and black smoke. The coat pattern comprises large, dark spots and other bold markings, which closely resemble the wild serval.
There is significant genotype variation in savannah cats, with variation in size, even within a single litter. F1 males (first generation crosses between the wild serval and a domestic cat) can weigh from 8–11 kilograms, stand 40–45 centimetres tall at the shoulder, and have a body length (chest to rump) of 55–60 centimetres. F4 and F5 males can weigh from 6.3–8.2 kilograms, stand 32.5–38 centimetres tall, and be 40–45 centimetres long. There have been reports of male savannah cats weighing more than 18 kilograms (All About Spots, 2007). Females are slightly smaller compared to the males (Hummel, 2007).

General information:
Early generation savannah cats typically exhibit some degree of hybrid unviability. Male savannah cats often retain a larger size and are usually sterile until the F5 generation. In comparison, females are fertile from the F1 generation (All About Spots, 2007). Due to the difference in gestation periods between the domestic cat (63 days) and serval (73 days), early generation savannah cats are often born prematurely. F1 savannah cats will have 1 to 2 offspring (Sand Hollow Savannahs, 2008) whereas other generations will have on average, between 3–5 offspring (Krautheim, 2007).
Savannah cats are very active and can leap 2.5 metres high from a standing position. Wild-type behaviour can be observed in early generation or non- socialised savannah cats. For example, they may hiss and |

growl at strangers. The savannah cat will also make noises like a serval, such as chirping and loud hissing (Winchester, 2008).

In Africa, servals are a generalist predator feeding on lizards, snakes, frogs, small birds (quails, quelea, teal), insects, fish, ground squirrels, hyraxes, mole rats, domestic poultry, small antelopes, flamingos, vlei rats, hares and duiker (Cat Survival Trust, 2002; Sunquist et al, 2002). Servals achieve an extremely high rate of hunting success (49% of hunting attempts yield prey) (Geertsema, 1985), compared with lions (30%) and most other cat species (10%) (Cat Survival Trust, 2002). Feral cats in Australia also have a generalised diet that includes a variety of lizards, frogs, small birds, insects, fish, small mammals, domestic poultry and rabbits (Long, 2003).

Longevity
Longevity is not known but is thought to be comparable to domestic cats (c. 15 years) (Krautheim, 2007). Serval maximum longevity in captivity is 22.4 years however, it is estimated that servals live up to 23 years in the wild (HAGR Human Ageing Genomic Resources, 2006).

Conservation status:
CITES: The serval is a CITES Appendix II listed species, so for the purposes of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), the definition of animal hybrids used by the CITES Conference of the Parties resolution 10.17 is used (as revised at the fourteenth meeting of the Conference of the Parties, The Hague (Netherlands), 3–15 June 2007). By this definition, a hybrid animal that has in its previous four generations of lineage one or more specimens included in Appendix I or II of the Convention shall be subject to the provisions of the Convention just as if they were the full species. Under this interpretation, F1 to F4 hybrids of *Leptailurus serval* (serval) and *Felis catus* (domestic cat) are treated as *Leptailurus serval* (serval).

DATE OF ORIGINAL ASSESSMENT: 26/06/2008 **DATE OF CURRENT ASSESSMENT:** Oct 2020 (Jodi Buchecker) **EIC ENDORSEMENT:** 15/03/21	**The risk assessment model:** Models for assessing the risk that exotic vertebrates could establish in Australia have been developed for mammals, birds (Bomford 2003, 2006, 2008), reptiles and amphibians (Bomford et al 2005, Bomford 2008). Developed by Dr Mary Bomford for the Bureau of Rural Sciences (BRS), the model uses criteria that have been demonstrated to have significant correlation between a risk factor and the establishment of populations of exotic species and the pest potential of those species that do establish. For example, a risk factor for establishment is similarity in climate (temperature and rainfall) within the species' distribution overseas and Australia. For pest potential, the species' overseas pest status is a risk factor. The model is published as 'Risk assessment models for the establishment of exotic vertebrates in Australia and New Zealand' (Bomford 2008) and is available online on the PestSmart website https://pestsmart.org.au/wp-content/uploads/sites/3/2020/06/Risk_Assess_Models_2008_FINAL.pdf

Risk assessment model used for the assessment: Bomford 2008, Mammals and Birds	**CLIMATE**: In 2021 a new version of the Climatch program used to assess similarity in climate was released by the Australian Bureau of Agricultural Resource Economics and Sciences (ABARES): CLIMATCH v2.0. The increase in resolution in this new version (from 50 km to 20 km) required recalibration of Climate Match Scores. See Table 1. Sixteen climate parameters (variables) of temperature and rainfall are used to estimate the extent of similarity between data from meteorological stations located within the species' world distribution and stations in Australia. Worldwide, data from approximately 19000 locations are available for analysis. The number of locations used in an analysis will vary according to the size of the species' distribution and the number of meteorological stations located within that distribution. To represent the climate match visually, the map of Australia is divided into 19236 grid squares, each measured in 0.2 degrees in both longitude and latitude. CLIMATCH v2.0 calculates a match for each Australian grid by comparing data from all meteorological stations within the species' distribution (excluding any populations in Australia) and allocating a score ranging from ten for the highest level match to zero for the poorest match. Levels of climate match are used in the risk assessment for questions B1 (scores are summed to give a cumulative score), C6, and C8. Climatch v2.0 can be accessed on the ABARES website, agriculture.gov.au/abares. The direct URL is https://climatch.cp1.agriculture.gov.au/.

FACTOR	SCORE	DETAIL
STAGE A: RISKS POSED BY CAPTIVE OR RELEASED ANIMALS		
A1. Risk to people from individual escapees (0–2) *Assess the risk that individuals of the species could harm people. (NB, this question only relates to aggressive behaviour shown by escaped or released individual animals. Question C11 addresses the risk of harm from aggressive behaviour if the species establishes a wild population).* *Aggressive behaviour, size, plus the possession of organs capable of inflicting harm, such as sharp teeth, claws, spines, a sharp bill, or toxin-delivering apparatus may enable individual animals to harm people. Any known history of the species attacking, injuring or killing people should also be taken into account. Assume the individual is not protecting nest or young.*	1	*Animal that 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.* Servals that are kept as pets have attacked unprovoked, causing serious injuries that require hospitalisation. Feral domestic cats can attack causing injury if cornered and threatened.
A2. Risk to public safety from individual captive animals (0–2)	0	*Nil or low risk (highly unlikely or not possible).*

Assess the risk that irresponsible use of products obtained from captive individuals of the species (such as toxins) pose a public safety risk (excluding the safety of anyone entering the animals' cage/enclosure or otherwise coming within reach of the captive animals)		Apart from someone entering an enclosure or otherwise being in reach of a captive animal, there is nil or low physical risk to public safety. Low risk.
STAGE A PUBLIC SAFETY RISK SCORE **SUM A1 - A2 (0-4)**	1	**Moderately dangerous**

STAGE B: PROBABILITY ESCAPED OR RELEASED INDIVIDUALS WILL ESTABLISH FREE-LIVING POPULATIONS		

Model 1: FOUR-FACTOR MODEL FOR BIRDS AND MAMMALS (BOMFORD 2008)		
B1. Degree of climate match between species overseas range and Australia (1–6) Map the selected mammal or bird species' overseas range, including its entire native and exotic (excluding Australia) ranges over the past 1000 years. Use CLIMATCH v2.0, CMS = sum of classes 6 – 10, see Table 1.	6	*Extreme climate match to Australia* Serval Value X = 7,370 Domestic cat Value X = 18,999 Combined Climate Match Score = 6
B2. Exotic population established overseas (0–4) An established exotic population means the introduced species must have bred outside of captivity and must currently maintain a viable free-living population where the animals are not being intentionally fed or sheltered, even though they may be living in a highly disturbed environment with access to non-natural food supplies or shelter.	4	*Exotic population established on a larger island (> 50 000 km2) or anywhere on a continent (including elsewhere on the land mass where the natural distribution of the animal is, if this population is due to human introduction and is geographically separate from the natural range of the species).* Servals only exist in wild populations in Africa and are kept as pets in the United States of America and Europe. There is no record of servals establishing outside of Africa. Feral populations of domestic cats are common throughout the world.
B3. Overseas range size score (0–2) < 1 = 0; 1– 70 = 1; >70 = 2 Estimate the species overseas range size* including currently and the past 1000 years; natural and introduced range in millions of square kilometres	1	*Overseas range between 1 to 70 million km^2.* Serval: 12.5 million km^2 (based on distribution in Nowell and Jackson, 1996). Servals are now restricted to sub-Saharan north, central and southern Africa.

		Domestic cat: >30 million km^2 Introduced range of domestic cats is large, covering several continents.
B4. Taxonomic Class (0–1) *Bird=0; mammal = 1*	1	*Mammal*
B. ESTABLISHMENT RISK SCORE **SUM OF B1- B4 (1–13)**	12	**Extreme establishment risk**
Model 2: Seven-Factor Model For Birds And Mammals (Bomford 2008)		
B5. Diet score (0–1) *Specialist = 0; generalist = 1*	1	*Generalist with a broad diet of many food types.* The serval has a generalist diet that includes a variety of prey species: lizards, snakes, frogs, small birds (quails, quelea, teal), insects, fish, ground squirrels, hyraxes, mole rats, domestic poultry, small antelopes, flamingos, vlei rats, hares and duiker. The feral domestic cat in Australia has a generalised diet that includes a variety of lizards, frogs, small birds, insects, fish, small mammals, domestic poultry and rabbits. The hybrid would be expected to utilise at least the same range of prey.
B6. Habitat score (0–1) *Undisturbed or disturbed habitat*	1	*Can survive and breed in human-disturbed habitats (including grazing and agricultural lands, forests that are intensively managed or planted for timber harvesting and/or urban–suburban environments) without access to undisturbed (natural) habitats.* Servals and domestic cats adapt very well to human agricultural environments. Domestic cats live in a wide range of disturbed habitats including urban settings.
B7. Migratory score (0–1) *Always migratory = 0; non-migratory = 1*	1	*Non-migratory.* The serval is non-migratory in its native range. The feral domestic cat is also non-migratory.
B. ESTABLISHMENT RISK SCORE **SUM OF B1- B7 (1–16)**	15	**Extreme establishment risk**
STAGE C: PROBABILITY AN ESTABLISHED SPECIES WILL BECOME A PEST		

C1. Taxonomic group (0–4)	2	*Mammal in one of the orders that have been demonstrated to have detrimental effects on prey abundance and/or habitat degradation (Carnivora).*
C2. Overseas range size including current and past 1000 years, natural and introduced range (0–2) *Estimate the species overseas range size (including current and past 1000 years, natural and introduced range) in millions of square kilometre*	2	*Overseas geographic range greater than 30 million square kilometres.* Serval: 12.5 million km^2 (based on distribution in Nowell and Jackson, 1996). Servals are now restricted to sub-Saharan north, central and southern Africa. Domestic cat: >30 million km^2 Introduced range of domestic cats is large, covering several continents.
C3. Diet and feeding (0–3)	3	*Mammal that is a strict carnivore (eats only animal matter) and arboreal (climbs trees for any reason).* The serval, domestic cat and hybrid are all strict carnivores and arboreal.
C4. Competition with native fauna for tree hollows (0–2)	2	*Can nest or shelter in tree hollows.* Use tree hollows to shelter young.
C5. Overseas environmental pest status (0–3) *Has the species been reported to cause declines in abundance of any native species of plant or animal or cause degradation to any natural communities in any country or region of the world?*	3	*Major environmental pest in any country or region.* The serval is not an environmental pest in any country or region. The feral domestic cat is a severe environmental pest in many countries, especially on islands.
C6. Climate match to areas with susceptible native species or communities (0–5) *Identify any native Australian animal or plant species or communities that could be susceptible to harm by the exotic species if it were to establish a wild population here.*	5	*The species has more than 138 grid squares within the highest two climate match classes, and/or has more than 691 grid squares within the four highest climate match classes, that overlap the distribution of any susceptible native species or communities = 5* Examples of susceptible native species or ecological communities, from the DCCEEW Protected Matters Search Tool, include: Orange Bellied parrot (*Neophema chrysogaster*) – Critically Endangered Gilbert's Potoroo *(Potorous gilbertii)* – Critically Endangered

C7. Overseas primary production pest status (0–3) *Has the species been reported to damage crops or other primary production in any country or region of the world?*	1	*Minor pest of primary production in any country or region.* Both the serval and domestic cat will take domestic poultry.
C8. Climate match to susceptible primary production (0–5) *Assess Potential Commodity Impact Scores for each primary production commodity listed in Table 9, based on species' attributes (diet, behaviour, ecology), excluding risk of spreading disease which is addressed in Question C9.* *0 = 0; 1-19 = 1; 20-49 = 2; 50-99 = 3; 100-149 = 4; ≥150 = 5*	3	Total Commodity Damage Score = 57.5 (see Table 2)
C9. Spread disease (1–2) *Assess the risk that the species could play a role in the spread of disease or parasites to other animals*	2	*All mammals (likely or unknown effect on native species and on livestock and other domestic animals).*
C10. Harm to property (0–3) *Assess the risk that the species could inflict damage on buildings, vehicles, fences, roads, equipment or ornamental gardens by chewing or burrowing or polluting with droppings or nesting material.*	0	*$0*
C11. Harm to people (0–5) *Assess the risk that, if a wild population established, the species could cause harm to or annoy people. Aggressive behaviour, plus the possession of organs capable of inflicting harm, such as sharp teeth, tusks, claws, spines, a sharp bill, horns, antlers or toxin delivering organs may enable animals to harm people. Any known history of the species attacking, injuring or killing people should also be taken into account (see Stage A, Score A1).*	3	*Injuries or risk of harm moderate but unlikely to be fatal and few people at risk (see A1).* Human exposure to zoonotic disease not likely to be greater than that posed by the domestic cat.

C. PEST RISK SCORE **SUM C 1 TO C 11 (1–37)**	26	**Extreme pest risk**
STAGE A. PUBLIC SAFETY RISK RANK – RISK TO PUBLIC SAFETY POSED BY CAPTIVE OR RELEASED INDIVIDUALS *0 = Not dangerous; 1 = Moderately dangerous; ≥ 2 = Highly dangerous*	1	Moderately dangerous
STAGE B. ESTABLISHMENT RISK RANK – RISK OF ESTABLISHING A WILD POPULATION Model 1: Four-factor model for birds and mammals (Bomford 2008) *≤ 5 = low establishment risk; 6-8 = moderate establishment risk; 9-10 = serious establishment risk; ≥ 11-13 = extreme establishment risk*	12	Extreme establishment risk
STAGE B. ESTABLISHMENT RISK RANK – RISK OF ESTABLISHING A WILD POPULATION Model 2: Seven-factor model for birds and mammals (Bomford 2008) *≤ 6 = low establishment risk; 7-11 = moderate establishment risk; 12-13 = serious establishment risk; ≥14 = extreme establishment risk*	15	Extreme establishment risk
STAGE C. PEST RISK RANK - RISK OF BECOMING A PEST FOLLOWING ESTABLISHMENT *< 9 = low pest risk; 9-14 = moderate pest risk; 15-19 = serious pest risk; > 19 = extreme pest risk*	26	Extreme pest risk

ENVIRONMENT AND INVASIVES COMMITTEE THREAT CATEGORY	**EXTREME**

Climate match between world distribution of species and Australia

It is difficult to accurately predict the potential geographic distribution of the Savannah Cat in Australia, simply because it is an artificial hybrid that does not occur in the wild. However, it is reasonable to predict that its potential range is likely to be comparable to that of its progenitor species; the serval and the domestic cat.

Climate-based predictions have been generated for the wild serval and the domestic (feral) cat, using CLIMATCH 2020, a climate modelling computer program. Based purely on an assessment of climatic parameters, large areas of Australia appear suitable for both species, and hence their hybrids. However, it is important to note that other habitat requirements, such as the availability of food, will influence range and abundance within this broad climatic envelope.

Climate match between world distribution of species (IUCN Red List) and Australia:
Areas of Australia where the climate appears suitable for *Leptailurus serval*
CMS = 7,370

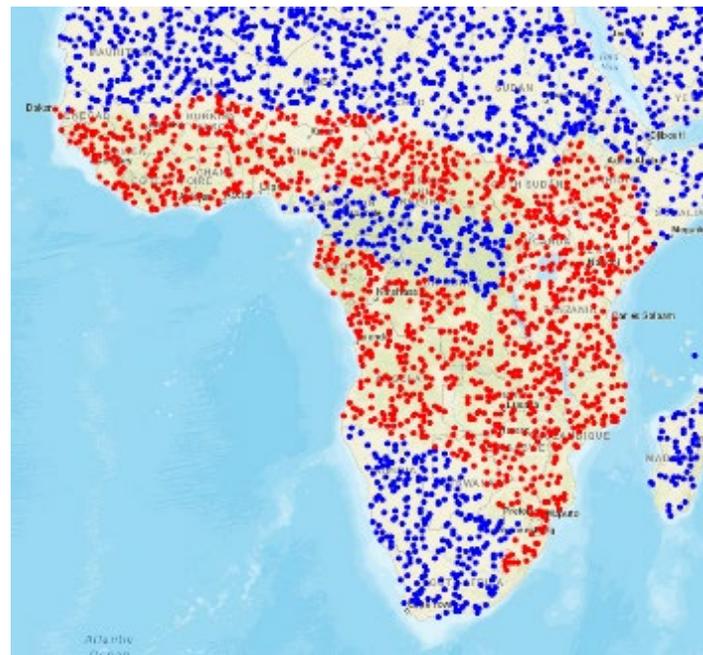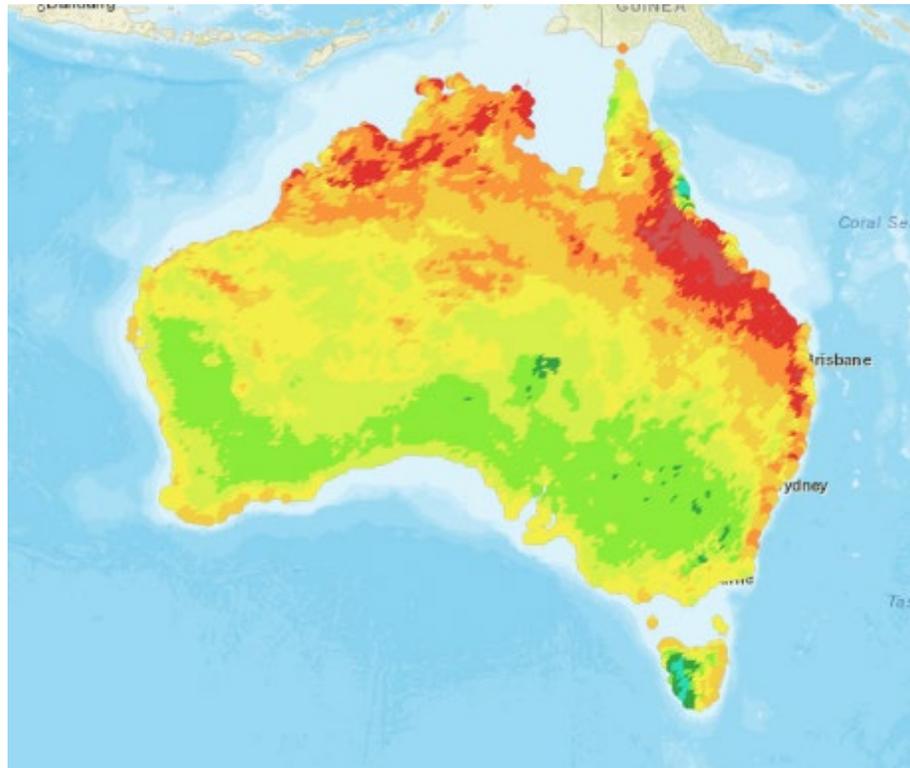*Figure 1- World Distribution Map - IUCN Red List*

Figure 2 - World Distribution Map - Climatch

Score	Color	Count
0	🔵	0
1	🟢	30
2	🟢	100
3	🟢	3561
4	🟢	4036
5	🟡	4139
6	🟠	3518
7	🟠	2523
8	🔴	1054
9	🔴	275
10	🔴	0

Species: Serval
Algorithm: Closest Standard Score
1300 source features selected
19236 target features selected
Approximate selected area: 14,049,908 km²

Climate match between world distribution of species (Invasive Species Compendium) and Australia:
Areas of Australia where the climate appears suitable for *Felis catus*
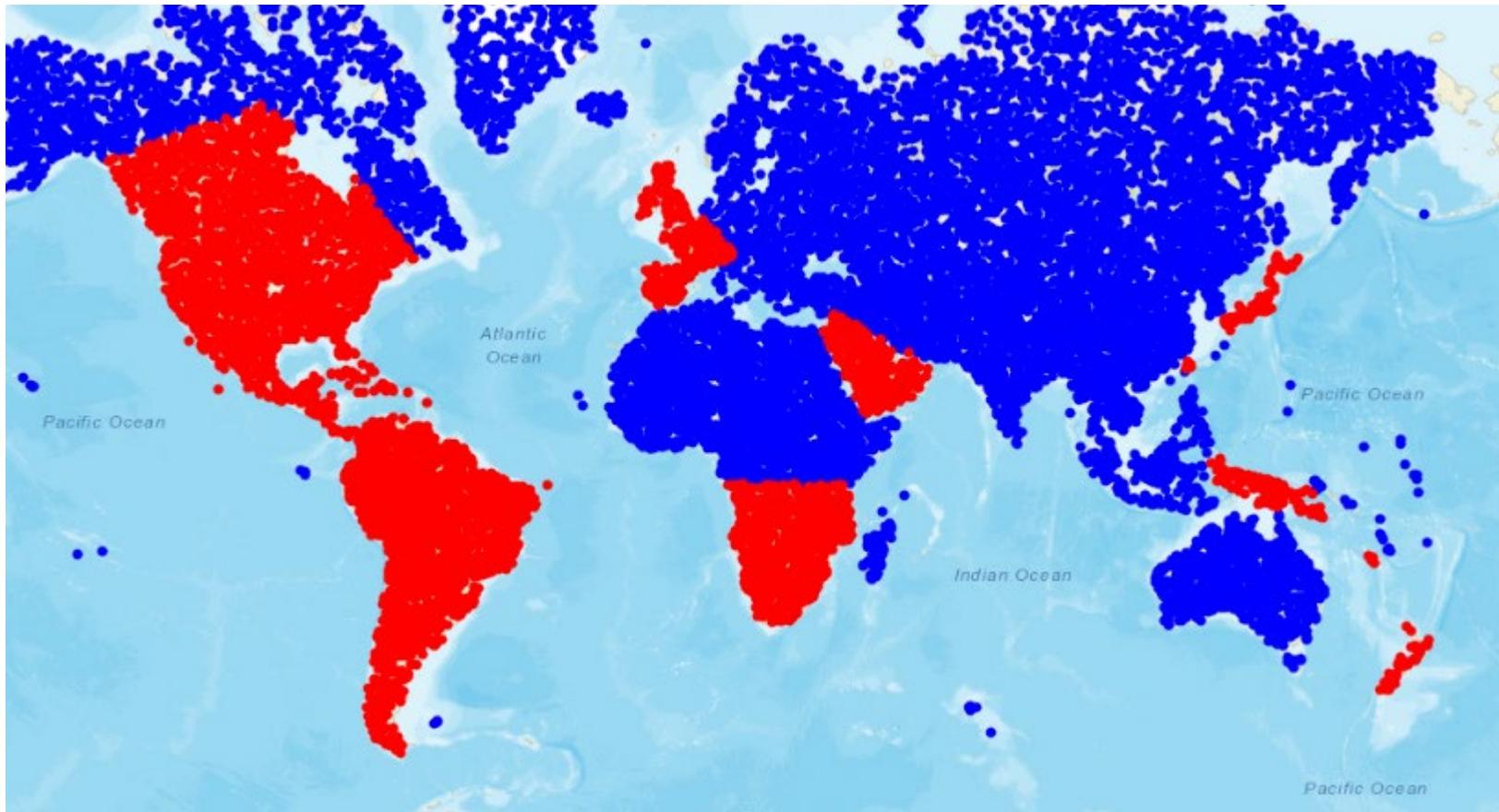CMS = 18,999
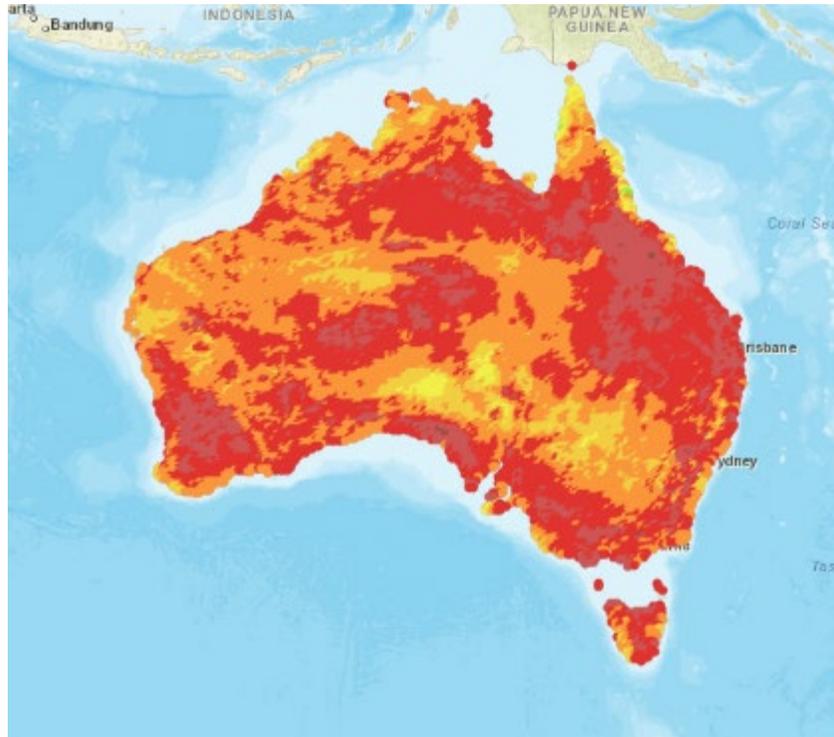
No IUCN map is available for Felis catus.

Figure 1 - World Distribution Map - Climatch

Score	Color	Count
0		0
1		0
2		0
3		4
4		14
5		219
6		1556
7		7029
8		7726
9		2665
10		23

Species: Feral cat

Algorithm: Closest Standard Score

5703 source features selected

19236 target features selected

Approximate selected area: 47,884,416 km^2

After reviewing the biological and ecological attributes of the serval and the feral domestic cat, this study suggests that the savannah cat is well suited to a broad range of habitat types, comparable to feral domestic cats. While it is difficult to predict exactly which habitats are most suitable, this study speculates that tropical savannahs are most suitable, followed by open grasslands in semi-arid areas and perhaps riparian habitats within the arid zone. The wild serval is known to have a broad habitat range, across tropical savannahs and extending to high altitude and adjacent arid zones in Africa. It is also commensal, occupying the margins of towns and settlements. Even though the savannah cat is not a pure serval, this taxon still exhibits many of the serval's wild traits, such as size, agility and behaviour.

While 90% of the wild serval's diet comprises prey items less than 200 grams, it is known to take medium-sized mammals, birds and reptiles. Hence, it is reasonable to predict that the hybrid savannah cat would prey upon Australia's small and medium-sized vertebrate fauna.

Perhaps of most concern is genetic adaptations from the savannah cat hybrid (particularly, genetics from the wild serval) entering the existing feral cat population in Australia. Given the size and agility of the wild serval and the savannah cat, it seems reasonable to expect that crossbreeding with feral domestic cats could result in considerably larger feral cats. Also, considering the high kill-rate of the wild serval (50%), in comparison to feral cats (10%), any crossbreeding could result in increased hunting efficiency within the feral cat population.

Table 1: ABARES recalibration thresholds

Climate Match Score (CMS)	Current Bomford 2008 model classes (50 km)	Recalibrated classes to Climatch v2.0 (20 km)
1 (Very low)	< 100	< 691
2 (Low)	100-599	691-4137
3 (Moderate)	600-899	4138-6209
4 (High)	900-1699	6210-11735
5 (Very high)	1700-2699	11736-18642
6 (Extreme)	≥ 2700	≥ 18643

Table 2: Susceptible Australian Primary Production – Calculating Total Commodity Damage Score
The commodity value index scores in this table are derived from Australian Bureau of Statistics 2005 – 2006 data. The values will require updating if significant change has occurred in the value of the commodity (Bomford 2008).

Industry	Commodity Value Index 1 (CVI based on best available date)	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			
Cereal grain (includes wheat, barley sorghum etc)	8			
Sheep (includes wool and sheep meat)	5	1	5	25
Fruit (includes wine grapes)	4			
Vegetables	3			
Poultry and eggs	2	2	5	20
Aquaculture(includes coastal mariculture)	2	1	5	10
Oilseeds (includes canola, sunflower etc)	1			
Grain legumes (includes soybeans)	1			
Sugarcane	1			
Cotton	1			
Other crops and horticulture (includes nuts tobacco and flowers etc)	1			
Pigs	1			
Other livestock (includes goats, deer, camels, rabbits)	0.5	1	5	2.5
Bees (included honey, beeswax and pollination)	0.5			
Total Commodity Damage Score (TCDS)				57.5

NB The Commodity Value Index scores in this table are derived from Australian Bureau of Statistics 2005–2006 data and will need to be updated if these values change significantly.

Assess Potential Commodity Impact Scores for each primary production commodity listed in Table 9, based on species' attributes (diet, behaviour, ecology), excluding risk of spreading disease which is addressed in Question C9, and pest status worldwide as:

0. *Nil (species does not have attributes to make it capable of damaging this commodity)*
1. *Low (species has attributes making it capable of damaging this or similar commodities and has had the opportunity but no reports or other evidence that it has caused damage in any country or region*
2. *Moderate–serious (reports of damage to this or similar commodities exist 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)*
3. *Extreme (damage occurs 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).*

Climate Match to Commodity Score (0–5)

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

Table 3: Assigning species to EIC Threat Categories (shaded cells relate to assignment of reptiles and amphibians to EIC Threat Categories based on an assessed establishment risk and an allocated pest risk of extreme) – adapted from Bomford 2008

Establishment Risk	Pest Risk	Public Safety Risk	EIC Threat Category	Implication for any proposed import into Australia	Implication for keeping and movement in Australia
Extreme	Extreme	Highly, Moderately or Not Dangerous	EXTREME	Prohibited, unless sufficient risk management measures exist to reduce the potential risks to an acceptable level	Limited to those collections approved for keeping particular EXTREME Threat species
Extreme	Serious	Highly, Moderately or Not Dangerous	EXTREME		
Extreme	Moderate	Highly, Moderately or Not Dangerous	EXTREME		
Extreme	Low	Highly, Moderately or Not Dangerous	EXTREME		
Serious	Extreme	Highly, Moderately or Not Dangerous	EXTREME		
Serious	Serious	Highly, Moderately or Not Dangerous	EXTREME		
Moderate	Extreme	Highly, Moderately or Not Dangerous	EXTREME		
Serious	Moderate	Highly, Moderately or Not Dangerous	SERIOUS	Import restricted to those collections approved for keeping SERIOUS Threat species	Limited to those collections approved for keeping particular SERIOUS Threat species
Serious	Low	Highly, Moderately or Not Dangerous	SERIOUS		
Moderate	Serious	Highly, Moderately or Not Dangerous	SERIOUS		
Moderate	Moderate	Highly Dangerous	SERIOUS		
Moderate	Low	Highly Dangerous	SERIOUS		
Low	Extreme	Highly, Moderately or Not Dangerous	SERIOUS		
Low	Serious	Highly, Moderately or Not Dangerous	SERIOUS		
Low	Moderate	Highly Dangerous	SERIOUS		
Low	Low	Highly Dangerous	SERIOUS		
Moderate	Moderate	Moderately or Not Dangerous	MODERATE	Import restricted to those collections approved for keeping MODERATE Threat species	Limited to those collections approved for keeping particular MODERATE Threat species
Moderate	Low	Moderately or Not Dangerous	MODERATE		
Low	Moderate	Moderately or Not Dangerous	MODERATE		
Low	Low	Moderately Dangerous	MODERATE		
Low	Low	Not Dangerous	LOW	Import permitted	May be limited to those collections approved for keeping particular LOW Threat species
Any Value	Any Value	Unknown	EXTREME until proven otherwise	Prohibited, unless sufficient risk management measures exist to reduce the potential risks to an acceptable level	Limited to those collections approved for keeping particular EXTREME Threat species
Unknown	Any Value	Any Value	EXTREME until proven otherwise		
Any Value	Unknown	Any Value	EXTREME until proven otherwise		
Unassessed	Unassessed	Unassessed	EXTREME until proven otherwise		

Adapted from:	Anna Markula, Martin Hannan-Jones and Steve Csurhes (First published 2009, Updated 2016) 'Risk assessment for Hybrids of *Leptailurus serval* (serval) and *Felis catus* (domestic cat), including the 'savannah cat'.	By: Jodi Buchecker	Date: Oct 2020

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National Risk Assessment: EXTREME

RISK ASSESSMENT FOR AUSTRALIA: **Brown-nosed Coati (*Nasua nasua*)**

Class - Mammalia**, Order** - Carnivora**, Family –** Procyonidae**, Genus** - *Nasua***.**

SPECIES: *Nasua nasua* (Linnaeus, 1766) **Synonyms:** *Viverra nasua* (Linnaeus, 1766) *Nasua fusca* (Desmarest, 1820) *Nasua nasua mephisto* (Thomas, 1927) *Nasua nasua mexianae* (Vieira, 1945) *Nasua nasua molaris* (Merriam, 1902) *Nasua nasua soederstroemmi* (Lönnberg, 1921) **Subspecies:** *Nasua nasua aricana* (Vieira, 1945) *Nasua nasua boliviensis* (Cabrera, 1956) *Nasua nasua candace* (Thomas, 1912) *Nasua nasua cinerascens* (Lönnberg, 1921) *Nasua nasua dorsalis* (Gray, 1866) *Nasua nasua manium* (Thomas, 1912)	**Species description:** Head and body length of the brown-nosed coati is between 410-670 millimetres with a tail length between 320-690 millimetres. The tapered tail is banded and is usually longer than the head and body. The coati stands at a shoulder height of 305 millimetres, and weighs between 3.5-6.0 kilograms (Nowak, 1999) with males typically larger than females. The general colour of the coati is a reddish brown to black on the dorsal, or upper surface, and yellowish to dark brown on the ventral, or lower surface. The muzzle, chin and throat are whitish, the feet are blackish, and there are black, and grey markings present on the face. The muzzle is also long and pointed. The coati's forelegs are short whereas its hind legs are longer (Nowak, 1999). **General information:** Natural distribution of the coati includes Argentina, Bolivia, Brazil, Colombia, Guyana, Peru, Venezuela, Paraguay, Surinam, Uruguay (Wilson and Reeder, 1993). In Argentina, the range is restricted to the eastern portions of the provinces of Salta and Jujuy, northeastern Santa Fe, eastern portions of Chaco and Formosa, and throughout Misiones and Corrientes (Gompper and Decker, 1998). Wild populations of coati have established on Mas a Tierra Island (renamed Robinson Crusoe Island in 1966 (Kislakci, 2009)), an island that is 47.1 kilometres squared in size and is located in the Juan Fernandez archipelago off the coast of Chile. The coati was introduced from the mainland of South America (Venezuela or Ecuador) after Robinson Crusoe Island was declared a national park in 1935. In 1976, the size of the coati population on Robinson Crusoe Island estimated to be between 2,500 and 5,000, and in the absence of controlling agents devastated the island's vegetation and avifauna (Lever, 1985; Long, 2003). The coati was also introduced to Juan Fernandez Island off the coast of Chile to control rats and have since become established on the island (Long, 2003). The species occupies forested habitats including deciduous and evergreen forests, gallery and cloud forests, Chaco and savannah (Beisiegel, 2001). In Venezuela, the coati is common in secondary forest and along forest edges (Gompper and Decker, 1998). Although primarily terrestrial the species can easily climb small trees and vines but has difficulty climbing smooth trunked large trees. The coati is primarily diurnal and is also a strong swimmer (Gompper and Decker, 1998).

Nasua nasua montana (Tschundi, 1844) *Nasua nasua nasua* (Linnaeus, 1766) *Nasua nasua quichua* (Thomas, 1901) *Nasua nasua solitaria* (Schinz, 1823*)* *Nasua nasua spadicea* (Olfers, 1818) *Nasua nasua vittata* (Tschudi, 1844) **Common Names:** Brown-nosed Coati South American Coati Ring-tailed Coati	The coati is considered insectivorous-frugivorous. Its diet consists mainly of invertebrates and fruits (such as *Ficus* and *Copernicia* palms), and to a lesser degree vertebrates and carrion (Alves-Costa *et al.,* 2004; Hirsch, 2009)*.* Items found in the stomach contents of coatis included beetles, scorpions, spiders, centipedes, fruits of *Guazuma ulmifolia*, reptiles, rodents, fish, snakes and crabs. Eggs of the Paraguayan caiman (*Caiman yacare*) are heavily predated on by the coati (Gompper and Decker, 1998). Coati social groups are loosely organised bands of 4-20 individuals made up of all females and males up to 2 years old. Males more than 2 years old are usually solitary, except during the breeding season when 1 male is accepted into a band of females. The male is subordinate to the females during breeding (Nowak, 1999). The brown-nosed coati differs from its relative the white-nosed coati (*Nasua narica*) primarily by having grey or brown pelage on the muzzle, and hairs on nape of neck in reversed anterior position (Gompper and Decker, 1998). **Longevity:** A wild born brown-nosed coat was around 23 years old when it died in captivity (HAGR Human Ageing Genomic Resources, 2006). Average lifespan of pet coatis is around 15 years (Central Pets, 2009). **Conservation status:** **IUCN:** This species is listed as Least Concern. The species is widespread and apparently common in an area of relatively intact habitat. Population density varies greatly from region to region and there are no major threats (although the species is probably declining due to hunting and habitat loss). **CITES:** Protected under CITES Appendix III as *N. n. solitaria* in Uruguay. The species occurs in numerous protected areas.
DATE OF ORIGINAL ASSESSMENT: 6/02/2009 **DATE OF CURRENT ASSESSMENT:** Oct 2020 (Jodi Buchecker) **EIC ENDORSEMENT:** 15/03/21 **Risk assessment model used for the assessment:**	**The risk assessment model:** Models for assessing the risk that exotic vertebrates could establish in Australia have been developed for mammals, birds (Bomford 2003, 2006, 2008), reptiles and amphibians (Bomford et al 2005, Bomford 2008). Developed by Dr Mary Bomford for the Bureau of Rural Sciences (BRS), the model uses criteria that have been demonstrated to have significant correlation between a risk factor and the establishment of populations of exotic species and the pest potential of those species that do establish. For example, a risk factor for establishment is similarity in climate (temperature and rainfall) within the species' distribution overseas and Australia. For pest potential, the species' overseas pest status is a risk factor. The model is published as 'Risk assessment models for the establishment of exotic vertebrates in Australia and New Zealand' (Bomford 2008) and is available online on the PestSmart website https://pestsmart.org.au/wp-content/uploads/sites/3/2020/06/Risk_Assess_Models_2008_FINAL.pdf

Bomford 2008, Mammals and Birds	**CLIMATE**: In 2021 a new version of the Climatch program used to assess similarity in climate was released by the Australian Bureau of Agricultural Resource Economics and Sciences (ABARES): CLIMATCH v2.0. The increase in resolution in this new version (from 50 km to 20 km) required recalibration of Climate Match Scores. See Table 1. Sixteen climate parameters (variables) of temperature and rainfall are used to estimate the extent of similarity between data from meteorological stations located within the species' world distribution and stations in Australia. Worldwide, data from approximately 19000 locations are available for analysis. The number of locations used in an analysis will vary according to the size of the species' distribution and the number of meteorological stations located within that distribution. To represent the climate match visually, the map of Australia is divided into 19236 grid squares, each measured in 0.2 degrees in both longitude and latitude. CLIMATCH v2.0 calculates a match for each Australian grid by comparing data from all meteorological stations within the species' distribution (excluding any populations in Australia) and allocating a score ranging from ten for the highest level match to zero for the poorest match. Levels of climate match are used in the risk assessment for questions B1 (scores are summed to give a cumulative score), C6, and C8. Climatch v2.0 can be accessed on the ABARES website, agriculture.gov.au/abares. The direct URL is https://climatch.cp1.agriculture.gov.au/.

Bird and Mammal Model:		
FACTOR	**SCORE**	**DETAIL**
STAGE A: RISKS POSED BY CAPTIVE OR RELEASED ANIMALS		
A1. Risk to people from individual escapees (0–2) *Assess the risk that individuals of the species could harm people. (NB, this question only relates to aggressive behaviour shown by escaped or released individual animals. Question C11 addresses the risk of harm from aggressive behaviour if the species establishes a wild population).* *Aggressive behaviour, size, plus the possession of organs capable of inflicting harm, such as sharp teeth, claws, spines, a sharp bill, or toxin-delivering apparatus may enable individual animals to harm people. Any known history of the species attacking, injuring or killing people should also be taken into account. Assume the individual is not protecting nest or young.*	1	*Animal that is unlikely to make unprovoked attacks but which can cause serious injury (requiring hospitalisation) or fatality if cornered or handled.* Coatis can be tamed and make interesting and inquisitive pets. However, pet coatis can be unpredictable and develop behavioural problems such as biting people and other pets (Central Pets, 2009; CLAWS, 2009). Captive coatis may become unpredictably aggressive if they are bored, kept in inappropriate enclosures, or do not receive enough social interaction. They are not recommended as pets, as they can be unpredictable, capable of inflicting injury with their sharp claws and teeth, and may carry zoonotic diseases including rabies (CLAWS, 2009; Grant, 2009). The coati has large sharp canine teeth that are used in defence when hunted by dogs. Serious wounds can be inflicted on dogs by the coati (Nowak, 1999). Large signs in the Iguazu National Park, Argentina, advise people to be aware that coatis bite, and to hide food in their presence (Willsfca, 2008).

A2. Risk to public safety from individual captive animals (0–2) *Assess the risk that irresponsible use of products obtained from captive individuals of the species (such as toxins) pose a public safety risk (excluding the safety of anyone entering the animals' cage/enclosure or otherwise coming within reach of the captive animals)*	0	*Nil or low risk (highly unlikely or not possible).*
STAGE A PUBLIC SAFETY RISK SCORE **SUM A1 - A2 (0-4)**	1	**Moderately dangerous**

STAGE B: PROBABILITY ESCAPED OR RELEASED INDIVIDUALS WILL ESTABLISH FREE-LIVING POPULATIONS		

Model 1: FOUR-FACTOR MODEL FOR BIRDS AND MAMMALS (BOMFORD 2008)		
B1. Degree of climate match between species overseas range and Australia (1–6) *Map the selected mammal or bird species' overseas range, including its entire native and exotic (excluding Australia) ranges over the past 1000 years.* *Use CLIMATCH v2.0, CMS = sum of classes 6 – 10, see Table 1.*	3	*Moderate climate match to Australia* Value X = 5,122 Climate Match Score = 3
B2. Exotic population established overseas (0–4) *An established exotic population means the introduced species must have bred outside of captivity and must currently maintain a viable free-living population where the animals are not being intentionally fed or sheltered, even though they may be living in a highly disturbed environment with access to non-natural food supplies or shelter.*	2	*Exotic population only established on small islands less than 50 000 km^2.* Wild populations of coati have established on Mas a Tierra Island (renamed Robinson Crusoe Island in 1966 (Kislakci, 2009)), an island that is 47.1 kilometres squared in size and is located in the Juan Fernandez archipelago off the coast of Chile. The coati was introduced from the mainland of South America (Venezuela or Ecuador) after Robinson Crusoe Island was declared a national park in 1935. In 1976, the size of the coati population on Robinson Crusoe Island was estimated to be between 2,500 and 5,000, and in the absence of controlling agents devastated the island's vegetation and avifauna (Lever, 1985; Long, 2003).

		The coati was also introduced to Juan Fernandez Island off the coast of Chile to control rats and have since become established on the island (Long, 2003).
B3. Overseas range size score (0–2) < 1 = 0; 1– 70 = 1; >70 = 2 *Estimate the species overseas range size* including currently and the past 1000 years; natural and introduced range in millions of square kilometres*	1	*Overseas range between 1 to 70 million km².* The overseas range of the coati is estimated at 7.74 million km². This has been calculated using the CLIMATCH analysis tool (ABARES, 2020) and includes current and past 1,000 years of natural and introduced ranges. Natural distribution of the coati includes Argentina, Bolivia, Brazil, Colombia, Guyana, Peru, Venezuela, Paraguay, Surinam, Uruguay (Wilson and Reeder, 1993). In Argentina, the range is restricted to the eastern portions of the provinces of Salta and Jujuy, northeastern Santa Fe, eastern portions of Chaco and Formosa, and throughout Misiones and Corrientes (Gompper and Decker, 1998). Introduced populations of the coati occur on offshore islands (Long, 2003), see reference in B2.
B4. Taxonomic Class (0–1) *Bird=0; mammal = 1*	1	*Mammal*
B. ESTABLISHMENT RISK SCORE **SUM OF B1- B4 (1–13)**	**7**	**Moderate establishment risk**
Model 2: Seven-Factor Model For Birds And Mammals (Bomford 2008)		
B5. Diet score (0–1) *Specialist = 0; generalist = 1*	1	*Generalist with a broad diet of many food types.* The coati is considered insectivorous-frugivorous. Its diet consists mainly of invertebrates and fruits (such as *Ficus* and *Copernicia* palms), and to a lesser degree vertebrates and carrion (Alves-Costa *et al.,* 2004; Hirsch, 2009). Items found in the stomach contents of coatis included beetles, scorpions, spiders, centipedes, fruits of *Guazuma ulmifolia*, reptiles, rodents, fish, snakes and crabs. Eggs of the Paraguayan caiman (*Caiman yacare*) are heavily predated on by the coati (Gompper and Decker, 1998). The coati is also important for seed dispersal and may provide a key role in maintaining seed dispersal services in their ecosystem (Alves-Costa and Eterovick, 2007). Bromeliad plants are an important food resource due to the various fauna contained in the water held within the plant's leaves (Beisiegel, 2001).

B6. Habitat score (0–1) *Undisturbed or disturbed habitat*	1	*Can survive and breed in human-disturbed habitats (including grazing and agricultural lands, forests that are intensively managed or planted for timber harvesting and/or urban–suburban environments) without access to undisturbed (natural) habitats.* Coatis thrive in disturbed habitat fragments (Alves-Costa *et al.,* 2004). In the Iguazu National Park, Argentina, some areas that are human-disturbed, such as grassed areas for tourists and park employees, are used by coatis as walkways as they travel to reach fruiting trees in secondary growth forest (Hirsch, 2009). In Venezuela, the coati is common in secondary forest and along forest edges. Researchers have suggested that low-level habitat modification (including deforestation and road building) may only have a slight negative and perhaps a positive effect on the species. However, intensive deforestation, dam building and hunting has a negative effect on populations (Gompper and Decker, 1998).
B7. Migratory score (0–1) *Always migratory = 0; non-migratory = 1*	1	*Non-migratory.* Coatis have a daily movement between 1,500-2,000 metres in search of food. Home ranges of 4 solitary males in Arizona were estimated between 70-270 hectares each. Frequent long-distance movement by coatis outside of Mangabeiras Park, Brazil, was recorded during the dry season (Alves-Costa *et al.,* 2004).
B. ESTABLISHMENT RISK SCORE **SUM OF B1- B7 (1–16)**	**10**	**Moderate establishment risk**
STAGE C: PROBABILITY AN ESTABLISHED SPECIES WILL BECOME A PEST		
C1. Taxonomic group (0–4)	2	*Mammal in one of the orders that have been demonstrated to have detrimental effects on prey abundance and/or habitat degradation (Carnivora).*
C2. Overseas range size including current and past 1000 years, natural and introduced range (0–2) *Estimate the species overseas range size (including current and past 1000 years, natural and introduced range) in millions of square kilometre*	0	*Overseas range less than 10 million km^2.* Estimated at 7.74 million km^2

C3. Diet and feeding (0–3)	1	*Mammal that is non-strict carnivore (mixed animal-plant matter in diet).* The species has an omnivorous diet (Hirsch, 2009).
C4. Competition with native fauna for tree hollows (0–2)	2	*Can nest or shelter in tree hollows.* The coati is diurnal and in forest areas spends the night in trees (Wilson and Ruff, 1999). The coati nests at night in caves and tree hollows (Honduras This Week online, 2003). It is therefore likely that coatis would use tree hollows of some size.
C5. Overseas environmental pest status (0–3) *Has the species been reported to cause declines in abundance of any native species of plant or animal or cause degradation to any natural communities in any country or region of the world?*	2	*Moderate environmental pest in any country or region* Coatis are opportunistic feeders with birds included in the list of vertebrates eaten. The coati would depredate on the hummingbird eggs and nestlings, or an adult found brooding or perching at night (Colwell, 1989). The coati has been reported to have had a negative effect on the avifauna of Robinson Crusoe Island. In the Juan Fernandez Archipelago, introduced coatis have been implicated in the decline of the Juan Fernandez Firecrown (*Sephanoides fernandensis*), an endemic hummingbird which nests in exposed sites (Jaksic, 1998). Historical records show that Juan Fernandez Firecrown survived early introductions of rats, cats, dogs, goats, feral livestock, and habitat destruction however, with the introduction of the coati and European rabbit (*Oryctolagus cuniculus),* the hummingbird began to decline dramatically and became extinct on two islands; it is now restricted to Robinson Crusoe Island. First identified in 1989 (Colwell, 1989), the Juan Fernandez Firecrown is now listed as critically endangered, with the introduced coati listed among the major threats (IUCN, 2009). In the Juan Fernández Archipelago, the coati is also held responsible for the decline of other native endemic birds including the Juan Fernández petrel (*Pterodroma externa*), Cook's petrel (*Pterodroma cooki*), Kermadec petrel (*Pterodroma neglecta*), pink-footed shearwater (*Puffinus creatopus*, now recognised as *Ardenna creatopus*), and flesh-footed shearwater (*Puffinus carneipes*, now recognised as *Ardenna carneipes*) (Araya and Bernal, 1995) cited in: (AGUSTÍN IRIARTE *et al.,* 2005).

		Digging by introduced coatis may have contributed to the deterioration of the native flora on the island (Sanders *et al.,* 1982) cited in (Gompper and Decker, 1998).
C6. Climate match to areas with susceptible native species or communities (0–5) *Identify any native Australian animal or plant species or communities that could be susceptible to harm by the exotic species if it were to establish a wild population here.*	5	*The species has more than 138 grid squares within the highest two climate match classes, and/or has more than 691 grid squares within the four highest climate match classes, that overlap the distribution of any susceptible native species or communities = 5* *One or more susceptible native species or ecological communities that are listed as vulnerable or endangered under the Australian Government* Environment Protection and Biodiversity Conservation Act 1999 *has a restricted geographical range that lies with the mapped are of the highest six climate match classes for the exotic species being assessed.* Reference for all vulnerable or endangered species and communities (status noted in bold) (Dept of the Environment Water Heritage and the Arts, 2007; Dept of the Environment Water Heritage and the Arts, 2008). Susceptible Australian native species or natural communities that could be threatened include: **Mammals:** **Endangered** - Northern Hopping-mouse (*Notomys aquilo*) (Strahan, 1995). **Birds:** **Critically Endangered** - Buff-breasted Button-quail (*Turnix olivii*) (Barrett *et al.,* 2003; Christidis and Boles, 2008). **Reptiles:** **Endangered** – Nangur Spiny Skink (*Nangura spinosa*), Yellow-snouted Gecko (*Lucasium occultum*), (Cogger 2000). **Communities:** No listed vulnerable or endangered communities likely to be at risk.
C7. Overseas primary production pest status (0–3) *Has the species been reported to damage crops or other primary production in any country or region of the world?*	1	*Minor pest of primary production in any country or region.* Research conducted by Pérez and Pacheco (2006) in Bolivia included the coati in a list of mammals that were considered harmful to crops. Subsistence crops that were affected include yucca (*Manihot esculenta*), walusa (*Colocasia esculenta, Xanthosoma* species), racacha (*Arracacia xanthorriza*), corn (*Zea mays*) and peanut (*Arachis hypogea*).

		(The list of mammals that affected these subsistence crops are as follows: collared peccary *(Pecari tajacu)*, brown agouti (*Dasyprocta variegata*), paca (*Cuniculus paca*), pacarana *(Dinomys branickii),* brown capuchin monkey *(Cebus apella),* coati*,* and several small rodents) (Pérez and Pacheco, 2006).
C8. Climate match to susceptible primary production (0–5) *Assess Potential Commodity Impact Scores for each primary production commodity listed in Table 9, based on species' attributes (diet, behaviour, ecology), excluding risk of spreading disease which is addressed in Question C9.* *0 = 0; 1-19 = 1; 20-49 = 2; 50-99 = 3; 100-149 = 4; ≥150 = 5*	3	Total Commodity Damage Score = 60 See Table 2 – species has attributes making it capable of damaging fruit, vegetables, aquaculture (Larcombe *et al.,* 2006) and poultry commodities.
C9. Spread disease (1–2) *Assess the risk that the species could play a role in the spread of disease or parasites to other animals*	2	*All mammals (likely or unknown effect on native species and on livestock and other domestic animals).*
C10. Harm to property (0–3) *Assess the risk that the species could inflict damage on buildings, vehicles, fences, roads, equipment or ornamental gardens by chewing or burrowing or polluting with droppings or nesting material.*	1	*$1-10 million* Damage to property by coatis is possible. During a study of Coati living in an Atlantic Forest area in Brazil, coatis frequently plucked off electric tape used on the sensors of camera traps (Alves-Costa et al., 2004).
C11. Harm to people (0–5) *Assess the risk that, if a wild population established, the species could cause harm to or annoy people. Aggressive behaviour, plus the possession of organs capable of inflicting harm, such as sharp teeth, tusks, claws, spines, a sharp bill, horns, antlers or toxin delivering organs may enable animals to harm people. Any known history of the species attacking, injuring or killing people should also be taken into account (see Stage A, Score A1).*	1	*Very low risk* No reports of attacks to people by wild coatis found for this assessment however, the species has sharp teeth capable of inflicting serious bites on people. A sign in Iguazu National Park, Argentina advises people to be aware that coatis bite, so hide food in their presence (Willsfca, 2008). Presumably this is a warning about coatis living in the wild and a warning to tourist about the danger of feeding the wildlife. Coatis can be unpredictable, capable of inflicting injury, and may carry zoonotic diseases including rabies (Grant, 2009).

		As an example of their strength, a coati cornered by a dog can inflict serious wounds with its large, sharp canine teeth (Nowak, 1999). Apart from the generic statements above and the warning sign image, no reference to attacks on people by wild brown-nosed coatis were found. Several studies conducted on coatis in the wild (Beisiegel, 2001; Hirsch, 2009) mentioned that when the presence of humans was noticed by the coatis, they immediately left the area, either escaping via the ground or the trees. The risk of a wild population of coatis attacking humans would likely be low.
C. PEST RISK SCORE **SUM C 1 TO C 11 (1–37)**	**20**	**Extreme pest risk**
STAGE A. PUBLIC SAFETY RISK RANK – RISK TO PUBLIC SAFETY POSED BY CAPTIVE OR RELEASED INDIVIDUALS *0 = Not dangerous; 1 = Moderately dangerous; ≥ 2 = Highly dangerous*	1	Moderately dangerous
STAGE B. ESTABLISHMENT RISK RANK – RISK OF ESTABLISHING A WILD POPULATION MODEL 1: FOUR-FACTOR MODEL FOR BIRDS AND MAMMALS (BOMFORD **2008**) *≤ 5 = low establishment risk; 6-8 = moderate establishment risk; 9-10 = serious establishment risk; ≥ 11-13 = extreme establishment risk*	7	Moderate establishment risk
STAGE B. ESTABLISHMENT RISK RANK – RISK OF ESTABLISHING A WILD POPULATION MODEL 2: SEVEN-FACTOR MODEL FOR BIRDS AND MAMMALS (BOMFORD **2008**) *≤ 6 = low establishment risk; 7-11 = moderate establishment risk; 12-13 = serious establishment risk; ≥14 = extreme establishment risk*	10	Moderate establishment risk
STAGE C. PEST RISK RANK - RISK OF BECOMING A PEST FOLLOWING ESTABLISHMENT	20	Extreme pest risk

< 9 = low pest risk; 9-14 = moderate pest risk; 15-19 = serious pest risk; > 19 = extreme pest risk		

ENVIRONMENT AND INVASIVES COMMITTEE THREAT CATEGORY	**EXTREME**

World distribution map (IUCN Red List) and World distribution map indicating where meteorological data was sourced for the climate analysis (see B1):

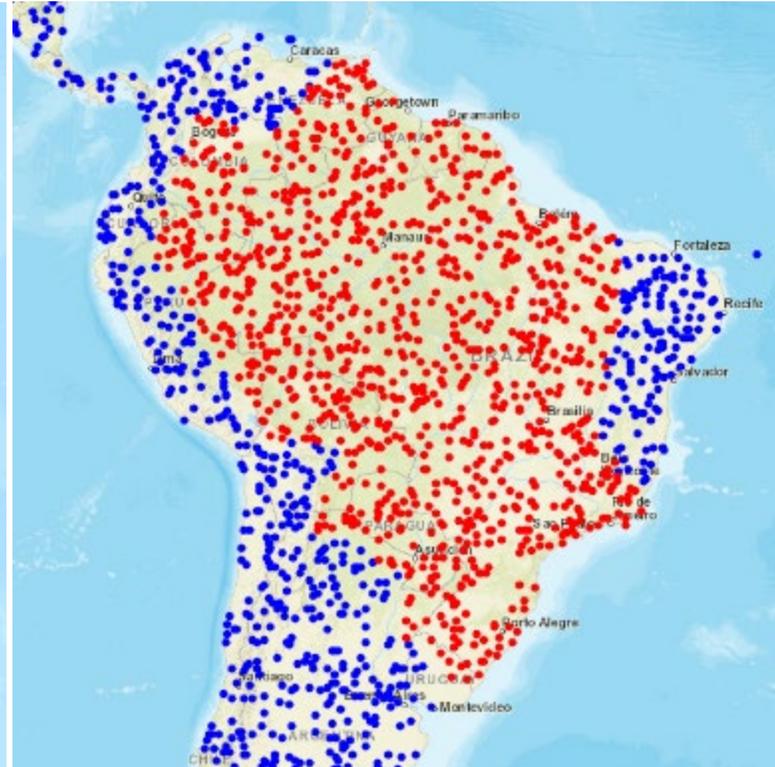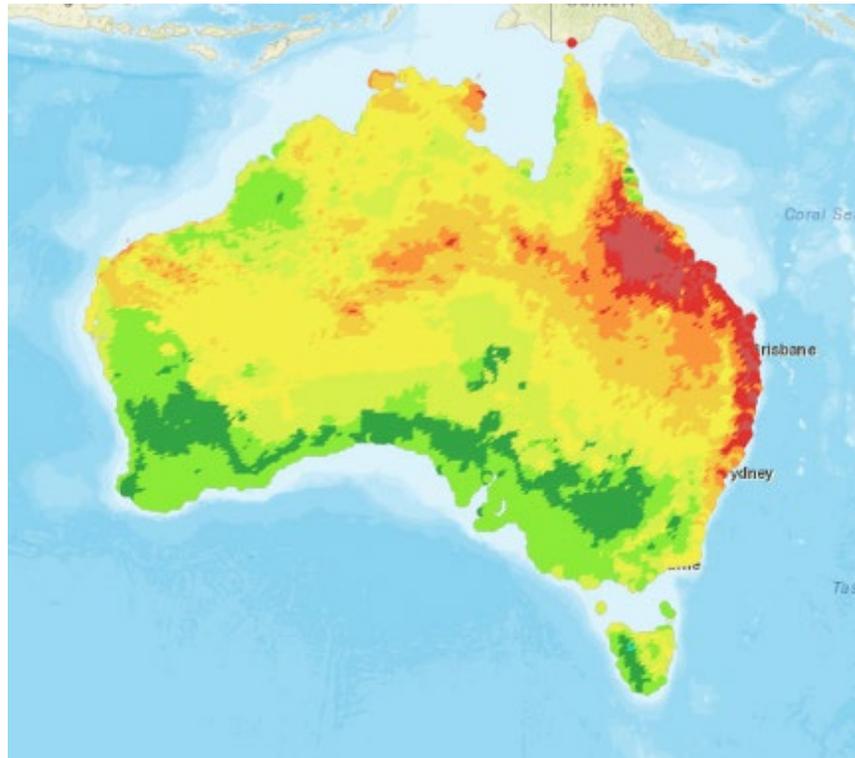*Figure 1 - World Distribution Map - IUCN Red List*

Figure 2 - World Distribution Map - Climatch

Climate match between world distribution of species and Australia:
Areas of Australia where the climate appears suitable for *Nasua nasua*
CMS = 5122

Score	Color	Count
0	●	0
1	●	3
2	●	1482
3	●	2697
4	●	3688
5	●	6244
6	●	2850
7	●	1302
8	●	574
9	●	393
10	●	3

Species: Nasua nasua (Brown-nosed Coati)
Algorithm: Closest Standard Score
1045 source features selected
19236 target features selected
Approximate selected area: 11,355,592 km²

Table 1: ABARES recalibration thresholds

Climate Match Score (CMS)	Current Bomford 2008 model classes (50 km)	Recalibrated classes to Climatch v2.0 (20 km)
1 (Very low)	< 100	< 691
2 (Low)	100-599	691-4137
3 (Moderate)	600-899	4138-6209
4 (High)	900-1699	6210-11735
5 (Very high)	1700-2699	11736-18642
6 (Extreme)	≥ 2700	≥ 18643

Table 2: Susceptible Australian Primary Production – Calculating Total Commodity Damage Score
The commodity value index scores in this table are derived from Australian Bureau of Statistics 2005 – 2006 data. The values will require updating if significant change has occurred in the value of the commodity (Bomford 2008).

Industry	Commodity Value Index 1 (CVI based on best available date)	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)	10			
Timber (includes native and plantation forests)	10			
Cereal grain (includes wheat, barley sorghum etc)	10			
Sheep (includes wool and sheep meat)	10			
Grapes	2	1	2	4
Vegetables	2	2	3	12
Poultry and eggs	2	2	3	12
Aquaculture(includes coastal mariculture)	2	1	4	8
Oilseeds (includes canola, sunflower etc)	2	2	2	8
Grain legumes (includes soybeans)	2	2	2	8
Sugarcane	2			
Cotton	2			
Other crops and horticulture (includes nuts tobacco and flowers etc)	1			
Pigs	2			
Other livestock (includes goats, deer, camels, rabbits)	1			
Bees (included honey, beeswax and pollination)	1			
Other fruit	2	2	2	8
Nuts	1			
Total Commodity Damage Score (TCDS)				60

NB The Commodity Value Index scores in this table are derived from Australian Bureau of Statistics 2005–2006 data and will need to be updated if these values change significantly.

Assess Potential Commodity Impact Scores for each primary production commodity listed in Table 9, based on species' attributes (diet, behaviour, ecology), excluding risk of spreading disease which is addressed in Question C9, and pest status worldwide as:

0. *Nil (species does not have attributes to make it capable of damaging this commodity)*
1. *Low (species has attributes making it capable of damaging this or similar commodities and has had the opportunity but no reports or other evidence that it has caused damage in any country or region*
2. *Moderate–serious (reports of damage to this or similar commodities exist 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)*
3. *Extreme (damage occurs 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).*

Climate Match to Commodity Score (0–5)

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

Table 3: Assigning species to EIC Threat Categories (shaded cells relate to assignment of reptiles and amphibians to EIC Threat Categories based on an assessed establishment risk and an allocated pest risk of extreme) – adapted from Bomford 2008

Establishment Risk	Pest Risk	Public Safety Risk	EIC Threat Category	Implication for any proposed import into Australia	Implication for keeping and movement in Australia
Extreme	Extreme	Highly, Moderately or Not Dangerous	EXTREME	Prohibited, unless sufficient risk management measures exist to reduce the potential risks to an acceptable level	Limited to those collections approved for keeping particular EXTREME Threat species
Extreme	Serious	Highly, Moderately or Not Dangerous	EXTREME		
Extreme	Moderate	Highly, Moderately or Not Dangerous	EXTREME		
Extreme	Low	Highly, Moderately or Not Dangerous	EXTREME		
Serious	Extreme	Highly, Moderately or Not Dangerous	EXTREME		
Serious	Serious	Highly, Moderately or Not Dangerous	EXTREME		
Moderate	Extreme	Highly, Moderately or Not Dangerous	EXTREME		
Serious	Moderate	Highly, Moderately or Not Dangerous	SERIOUS	Import restricted to those collections approved for keeping SERIOUS Threat species	Limited to those collections approved for keeping particular SERIOUS Threat species
Serious	Low	Highly, Moderately or Not Dangerous	SERIOUS		
Moderate	Serious	Highly, Moderately or Not Dangerous	SERIOUS		
Moderate	Moderate	Highly Dangerous	SERIOUS		
Moderate	Low	Highly Dangerous	SERIOUS		
Low	Extreme	Highly, Moderately or Not Dangerous	SERIOUS		
Low	Serious	Highly, Moderately or Not Dangerous	SERIOUS		
Low	Moderate	Highly Dangerous	SERIOUS		
Low	Low	Highly Dangerous	SERIOUS		
Moderate	Moderate	Moderately or Not Dangerous	MODERATE	Import restricted to those collections approved for keeping MODERATE Threat species	Limited to those collections approved for keeping particular MODERATE Threat species
Moderate	Low	Moderately or Not Dangerous	MODERATE		
Low	Moderate	Moderately or Not Dangerous	MODERATE		
Low	Low	Moderately Dangerous	MODERATE		
Low	Low	Not Dangerous	LOW	Import permitted	May be limited to those collections approved for keeping particular LOW Threat species
Any Value	Any Value	Unknown	EXTREME until proven otherwise	Prohibited, unless sufficient risk management measures exist to reduce the potential risks to an acceptable level	Limited to those collections approved for keeping particular EXTREME Threat species
Unknown	Any Value	Any Value	EXTREME until proven otherwise		
Any Value	Unknown	Any Value	EXTREME until proven otherwise		
Unassessed	Unassessed	Unassessed	EXTREME until proven otherwise		

Adapted from:	RISK ASSESSMENT for Australia – Brown-nosed Coati (*Nasua nasua*) Department of Agriculture and Food Western Australia March 2009	By: Jodi Buchecker	Date: Oct 2020

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National Risk Assessment: MODERATE

RISK ASSESSMENT FOR AUSTRALIA: **Okapi (*Okapia johnstoni*)**

Class - Mammalia**, Order -** Cetartiodactyla**, Family -** Giraffidae**, Genus -** *Okapia***.**

SPECIES:	Species description:
Okapia johnstoni (P.L. Sclater, 1901)	The okapi is a giraffid artiodactyl mammal native to the northeast of the Democratic Republic of Congo (DR Congo). Males have skin-covered horns while females have hair whorls on their heads. They are a very distinct and unique species, making them easily distinguishable from other species. Body length is between 2-2.2 metres and tail ranges between 30 and 42 centimetres. The okapi exhibits sexual dimorphism, with females slightly taller and heavier on average. Males range from 1.40-1.55 metres in height and 180-300 kilograms in weight, while females range from 1.42-1.59 metres and 225-356 kilograms.
Synonyms: None known	
Subspecies: Monotypic	**General information:**
Common Names: Okapi	Distribution extends across parts of central, northern and eastern DR Congo and up until the mid 1970's, Okapi were occasionally identified in the adjoining Semliki Forest in Western Uganda. The okapi has been introduced into the United States of America, Europe and Asia and is held in captivity in over 50 institutions around the world. There have been no recorded escapes or establishment of feral populations.
	Okapi are mainly found within the Ituri Forest and prefer very dense and closed tropical rainforests. While they usually remain in the thick vegetation, they also reside near riverbeds and use seasonally inundated areas where substrate is still wet. However, okapi do not occupy extensive swamp forest areas or savannah forest islands and actively avoid disturbed habitats around human settlements. The elevation of the area ranges between 600-1,500 metres above sea level with temperatures ranging between 21-32 degrees Centigrade. Males are known to migrate continuously, whereas females maintain a more sedentary life.
	Okapis are herbivores and are quite unique in being the only species of forest ungulate to depend on the understory foliage. They are known to feed on over a hundred species of plants and while they are diurnal, have been recorded feeding at night. Clay from riverbeds is also important to their diet, giving them minerals and salt that they may not be getting from vegetation. Okapis are ruminants and consume between 20 and 27 kilograms of vegetation each day. Like the giraffe, the okapi must spread its legs to get close enough to the ground to drink. Due to the remoteness and challenges of study within their natural environment there are limited studies on wild okapi behaviour and social habits. However, it is generally accepted that they are solitary and territorial, except for mothers with young. They are most

active during the afternoon and evening, spending this time in search of food, following paths worn through the forest foliage.

Okapi generally avoid individuals in adjacent home ranges, which for females is 3-5 kilometres and for males, over 10 kilometres. They have scent glands on their feet that spread sticky, tar-like territory markings to alert others of their home range. Territorial behaviours identified in captivity include males marking trees and bushes with urine, while crossing legs in a dance like movement. Females mark using common defecation sites and rubbing necks on trees. These behaviours will also occur during courtship. Okapis reach sexual maturity at 2 years of age. One offspring is normally produced following a gestation period of 425-491 days.

Longevity:
About 30 years in captivity.

Conservation status:
IUCN: Endangered
CITES: Not Listed.
The okapi is not listed in the CITES appendices and is listed as Endangered on the IUCN Red List. This is due to okapi population numbers being in severe decline since 1995, with an estimated rate of decline exceeding 50% over three generations (24 years). Projections estimate that the population decline will continue without effective conservation.

DATE OF ORIGINAL ASSESSMENT: 9/02/2018 **DATE OF CURRENT ASSESSMENT:** Oct 2020 (Jodi Buchecker) **EIC ENDORSEMENT:** 15/03/21 **Risk assessment model used for the assessment:** Bomford 2008, Mammals and Birds	**The risk assessment model:** Models for assessing the risk that exotic vertebrates could establish in Australia have been developed for mammals, birds (Bomford 2003, 2006, 2008), reptiles and amphibians (Bomford et al 2005, Bomford 2008). Developed by Dr Mary Bomford for the Bureau of Rural Sciences (BRS), the model uses criteria that have been demonstrated to have significant correlation between a risk factor and the establishment of populations of exotic species and the pest potential of those species that do establish. For example, a risk factor for establishment is similarity in climate (temperature and rainfall) within the species' distribution overseas and Australia. For pest potential, the species' overseas pest status is a risk factor. The model is published as 'Risk assessment models for the establishment of exotic vertebrates in Australia and New Zealand' (Bomford 2008) and is available online on the PestSmart website https://pestsmart.org.au/wp-content/uploads/sites/3/2020/06/Risk_Assess_Models_2008_FINAL.pdf **CLIMATE:** In 2021 a new version of the Climatch program used to assess similarity in climate was released by the Australian Bureau of Agricultural Resource Economics and Sciences (ABARES): CLIMATCH v2.0. The increase in resolution in this new version (from 50 km to 20 km) required recalibration of Climate Match Scores. See Table 1. Sixteen climate parameters (variables) of temperature and rainfall are used to estimate the extent of similarity between data from meteorological stations located within the species' world distribution and stations in Australia. Worldwide, data from approximately 19000 locations are available for analysis. The number of locations used in an analysis will vary

	according to the size of the species' distribution and the number of meteorological stations located within that distribution. To represent the climate match visually, the map of Australia is divided into 19236 grid squares, each measured in 0.2 degrees in both longitude and latitude. CLIMATCH v2.0 calculates a match for each Australian grid by comparing data from all meteorological stations within the species' distribution (excluding any populations in Australia) and allocating a score ranging from ten for the highest level match to zero for the poorest match. Levels of climate match are used in the risk assessment for questions B1 (scores are summed to give a cumulative score), C6, and C8. Climatch v2.0 can be accessed on the ABARES website, agriculture.gov.au/abares. The direct URL is https://climatch.cp1.agriculture.gov.au/.	

Bird and Mammal Model:

FACTOR	SCORE	DETAIL
STAGE A: RISKS POSED BY CAPTIVE OR RELEASED ANIMALS		
A1. Risk to people from individual escapees (0–2) *Assess the risk that individuals of the species could harm people. (NB, this question only relates to aggressive behaviour shown by escaped or released individual animals. Question C11 addresses the risk of harm from aggressive behaviour if the species establishes a wild population).* *Aggressive behaviour, size, plus the possession of organs capable of inflicting harm, such as sharp teeth, claws, spines, a sharp bill, or toxin-delivering apparatus may enable individual animals to harm people. Any known history of the species attacking, injuring or killing people should also be taken into account. Assume the individual is not protecting nest or young.*	1	*Animal that is unlikely to make an unprovoked attack, but which can cause serious injury (requiring hospitalisation) or fatality if cornered or handled.* Unlikely to make unproved attacks on people (okapi are flighty and shy) however, due to its size there is the potentially for the okapi to cause injury if cornered or handled.
A2. Risk to public safety from individual captive animals (0–2) *Assess the risk that irresponsible use of products obtained from captive individuals of the species (such as toxins) pose a public safety risk (excluding the safety of anyone entering the animals' cage/enclosure or otherwise coming within reach of the captive animals)*	0	*Nil or low risk (highly unlikely or not possible).*
STAGE A PUBLIC SAFETY RISK SCORE	1	**Moderately dangerous**

SUM A1 - A2 (0-4)		

STAGE B: PROBABILITY ESCAPED OR RELEASED INDIVIDUALS WILL ESTABLISH FREE-LIVING POPULATIONS		

Model 1: FOUR-FACTOR MODEL FOR BIRDS AND MAMMALS (BOMFORD 2008)

B1. Degree of climate match between species overseas range and Australia (1–6) *Map the selected mammal or bird species' overseas range, including its entire native and exotic (excluding Australia) ranges over the past 1000 years.* *Use CLIMATCH v2.0, CMS = sum of classes 6 – 10, see Table 1.*	1	*Very low climate match to Australia* Value X = 13 Climate Match Score = 1
B2. Exotic population established overseas (0–4) *An established exotic population means the introduced species must have bred outside of captivity and must currently maintain a viable free-living population where the animals are* *not being intentionally fed or sheltered, even though they may be living in a highly disturbed environment with access to non-natural food supplies or shelter.*	0	*No exotic populations established anywhere in the world.*
B3. Overseas range size score (0–2) < 1 = 0; 1– 70 = 1; >70 = 2 *Estimate the species overseas range size* including currently and the past 1000 years; natural and introduced range in millions of square kilometres*	0	*Overseas range less than 1 million km².* Approximately 0.5 million km²
B4. Taxonomic Class (0–1) Bird = 0; mammal = 1	1	*Mammal*
B. ESTABLISHMENT RISK SCORE SUM OF B1- B4 (1–13)	2	**Low establishment risk**

Model 2: Seven-Factor Model For Birds And Mammals (Bomford 2008)

B5. Diet score (0–1) Specialist = 0; generalist = 1	1	*Generalist with a broad diet of many food types.*

		The okapi is a browser of understory foliage and is known to consume over 100 species of flora.
B6. Habitat score (0–1) *Undisturbed or disturbed habitat*	1	*Can survive and breed in human-disturbed habitats (including grazing and agricultural lands, forests that are intensively managed or planted for timber harvesting and/or urban–suburban environments) without access to undisturbed (natural) habitats.* The okapi lives in a wide range of primary and older secondary forest types (IUCN).
B7. Migratory score (0–1) *Always migratory = 0; non-migratory = 1*	1	*Non-migratory.*
B. ESTABLISHMENT RISK SCORE **SUM OF B1- B7 (1–16)**	5	**Low establishment risk**
STAGE C: PROBABILITY AN ESTABLISHED SPECIES WILL BECOME A PEST		
C1. Taxonomic group (0–4)	2	*Mammal in one of the orders that have been demonstrated to have detrimental effects on prey abundance and/or habitat degradation (Artiodactyla).*
C2. Overseas range size including current and past 1000 years, natural and introduced range (0–2) *Estimate the species overseas range size (including current and past 1000 years, natural and introduced range) in millions of square kilometre*	0	*Overseas geographic range less than 10 million square kilometres.* Approximately 0.5 million km^2
C3. Diet and feeding (0–3)	3	*Mammal that is a primarily a grazer or browser.*
C4. Competition with native fauna for tree hollows (0–2)	0	*Does not use tree hollows.*
C5. Overseas environmental pest status (0–3) *Has the species been reported to cause declines in abundance of any native species of plant or animal or cause degradation to any natural communities in any country or region of the world?*	0	*Never reported as an environmental pest in any country or region.*
C6. Climate match to areas with susceptible native species or	1	*Species has no grid squares in highest four climate match classes (ie classes 10, 9, 8 and 7) that overlaps the distribution of any susceptible native species or communities, and has 1-346*

communities (0–5) Identify any native Australian animal or plant species or communities that could be susceptible to harm by the exotic species if it were to establish a wild population here.		*grid squares within the highest six climate match classes that overlaps the distribution of any susceptible native species or communities = 1*
C7. Overseas primary production pest status (0–3) *Has the species been reported to damage crops or other primary production in any country or region of the world?*	0	*No reports of damage to crops or other primary production in any country or region .*
C8. Climate match to susceptible primary production (0–5) *Assess Potential Commodity Impact Scores for each primary production commodity listed in Table 9, based on species' attributes (diet, behaviour, ecology), excluding risk of spreading disease which is addressed in Question C9. 0 = 0; 1-19 = 1; 20-49 = 2; 50-99 = 3; 100-149 = 4; ≥150 = 5*	1	Total Commodity Damage Score = 13 (see Table 2) The okapi may have impacts to several commodities but no evidence that it has caused any damage in any country.
C9. Spread disease (1–2) *Assess the risk that the species could play a role in the spread of disease or parasites to other animals*	1	*All mammals (likely or unknown effect on native species and on livestock and other domestic animals).*
C10. Harm to property (0–3) *Assess the risk that the species could inflict damage on buildings, vehicles, fences, roads, equipment or ornamental gardens by chewing or burrowing or polluting with droppings or nesting material.*	0	*$0.* No reports of any harm to property
C11. Harm to people (0–5) *Assess the risk that, if a wild population established, the species could cause harm to or annoy people. Aggressive behaviour, plus the possession of organs capable of inflicting harm, such as sharp teeth, tusks, claws, spines, a sharp bill, horns, antlers or toxin delivering organs may enable animals to harm people. Any known history of the species attacking,*	2	*Injuries, harm or annoyance likely to be minor and few people exposed: Low risk.* The okapi is unlikely to make unproved attacks on people (okapi are flighty and shy) however, due to its size and its aggressive behaviour displays (including kicking and head butting), there is the potentially for the okapi to cause injury if cornered or handled.

injuring or killing people should also be taken into account (see Stage A, Score A1).		
C. PEST RISK SCORE **SUM C 1 TO C 11 (1–37)**	10	**Moderate pest risk**
STAGE A. PUBLIC SAFETY RISK RANK – RISK TO PUBLIC SAFETY POSED BY CAPTIVE OR RELEASED INDIVIDUALS *0 = Not dangerous; 1 = Moderately dangerous; ≥ 2 = Highly dangerous*	1	Moderately dangerous
STAGE B. ESTABLISHMENT RISK RANK – RISK OF ESTABLISHING A WILD POPULATION MODEL 1: FOUR-FACTOR MODEL FOR BIRDS AND MAMMALS (BOMFORD 2008) *≤ 5 = low establishment risk; 6-8 = moderate establishment risk; 9-10 = serious establishment risk; ≥ 11-13 = extreme establishment risk*	2	Low establishment risk
STAGE B. ESTABLISHMENT RISK RANK – RISK OF ESTABLISHING A WILD POPULATION MODEL 2: SEVEN-FACTOR MODEL FOR BIRDS AND MAMMALS (BOMFORD 2008) *≤ 6 = low establishment risk; 7-11 = moderate establishment risk; 12-13 = serious establishment risk; ≥14 = extreme establishment risk*	5	Low establishment risk
STAGE C. PEST RISK RANK - RISK OF BECOMING A PEST FOLLOWING ESTABLISHMENT *< 9 = low pest risk; 9-14 = moderate pest risk; 15-19 = serious pest risk; > 19 = extreme pest risk*	10	Moderate pest risk

ENVIRONMENT AND INVASIVES COMMITTEE THREAT CATEGORY	**MODERATE**

World distribution map (IUCN Red List) and World distribution map indicating where meteorological data was sourced for the climate analysis (see B1):

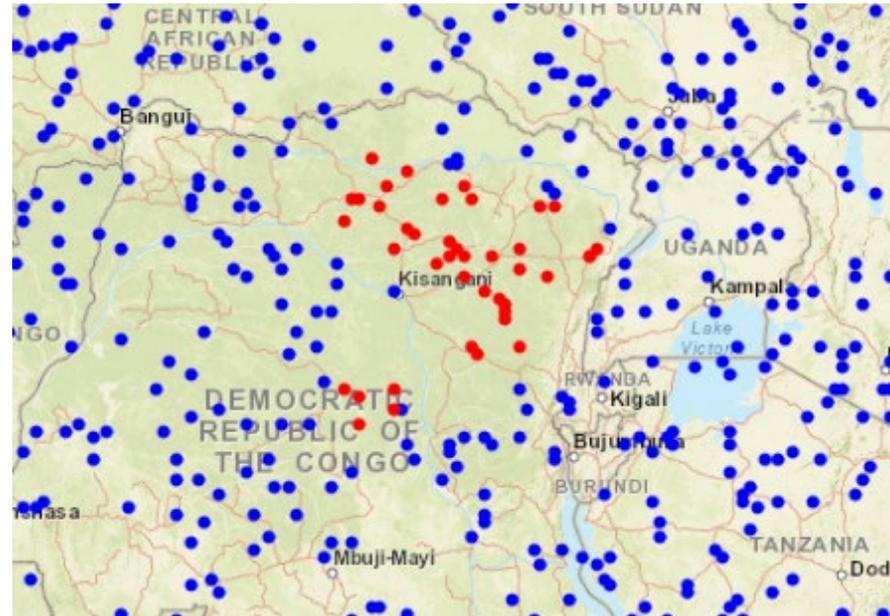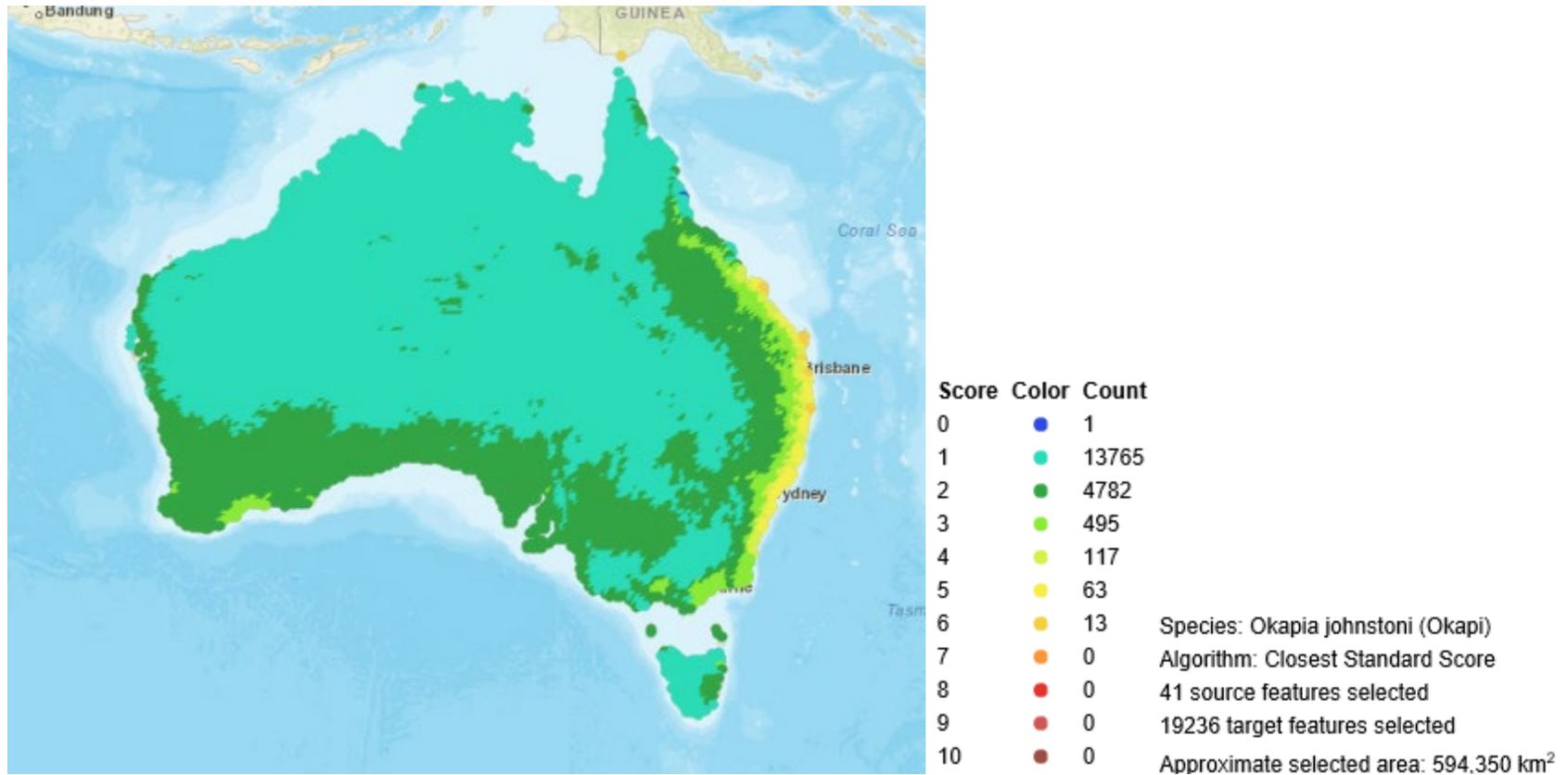*Figure 1 - World Distribution Map - IUCN Red List*

Figure 2 - World Distribution Map - Climatch

Climate match between world distribution of species and Australia:
Areas of Australia where the climate appears suitable for *Okapia johnstoni*
CMS = 13

Score	Color	Count
0	●	1
1	●	13765
2	●	4782
3	●	495
4	●	117
5	●	63
6	●	13
7	●	0
8	●	0
9	●	0
10	●	0

Species: Okapia johnstoni (Okapi)
Algorithm: Closest Standard Score
41 source features selected
19236 target features selected
Approximate selected area: 594,350 km²

Table 1: ABARES recalibration thresholds

Climate Match Score (CMS)	Current Bomford 2008 model classes (50 km)	Recalibrated classes to Climatch v2.0 (20 km)
1 (Very low)	< 100	< 691
2 (Low)	100-599	691-4137
3 (Moderate)	600-899	4138-6209
4 (High)	900-1699	6210-11735
5 (Very high)	1700-2699	11736-18642
6 (Extreme)	≥ 2700	≥ 18643

Table 2: Susceptible Australian Primary Production – Calculating Total Commodity Damage Score
The commodity value index scores in this table are derived from Australian Bureau of Statistics 2005 – 2006 data. The values will require updating if significant change has occurred in the value of the commodity (Bomford 2008).

Industry	Commodity Value Index 1 (CVI based on best available date)	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	1	1	10
Cereal grain (includes wheat, barley sorghum etc)	8			
Sheep (includes wool and sheep meat)	5			
Fruit (includes wine grapes)	4			
Vegetables	3			
Poultry and eggs	2			
Aquaculture (includes coastal mariculture)	2			
Oilseeds (includes canola, sunflower etc)	1			
Grain legumes (includes soybeans)	1			
Sugarcane	1	1	2	2
Cotton	1			
Other crops and horticulture (includes nuts tobacco and flowers etc)	1	1	1	1
Pigs	1			
Other livestock (includes goats, deer, camels, rabbits)	0.5			
Bees (included honey, beeswax and pollination)	0.5			
Total Commodity Damage Score (TCDS)				13

NB The Commodity Value Index scores in this table are derived from Australian Bureau of Statistics 2005–2006 data and will need to be updated if these values change significantly.

Assess Potential Commodity Impact Scores for each primary production commodity listed in Table 9, based on species' attributes (diet, behaviour, ecology), excluding risk of spreading disease which is addressed in Question C9, and pest status worldwide as:

0. *Nil (species does not have attributes to make it capable of damaging this commodity)*
1. *Low (species has attributes making it capable of damaging this or similar commodities and has had the opportunity but no reports or other evidence that it has caused damage in any country or region*
2. *Moderate–serious (reports of damage to this or similar commodities exist 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)*
3. *Extreme (damage occurs 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).*

Climate Match to Commodity Score (0–5)

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

Table 3: Assigning species to EIC Threat Categories (shaded cells relate to assignment of reptiles and amphibians to EIC Threat Categories based on an assessed establishment risk and an allocated pest risk of extreme) – adapted from Bomford 2008

Establishment Risk	Pest Risk	Public Safety Risk	EIC Threat Category	Implication for any proposed import into Australia	Implication for keeping and movement in Australia
Extreme	Extreme	Highly, Moderately or Not Dangerous	EXTREME	Prohibited, unless sufficient risk management measures exist to reduce the potential risks to an acceptable level	Limited to those collections approved for keeping particular EXTREME Threat species
Extreme	Serious	Highly, Moderately or Not Dangerous	EXTREME		
Extreme	Moderate	Highly, Moderately or Not Dangerous	EXTREME		
Extreme	Low	Highly, Moderately or Not Dangerous	EXTREME		
Serious	Extreme	Highly, Moderately or Not Dangerous	EXTREME		
Serious	Serious	Highly, Moderately or Not Dangerous	EXTREME		
Moderate	Extreme	Highly, Moderately or Not Dangerous	EXTREME		
Serious	Moderate	Highly, Moderately or Not Dangerous	SERIOUS	Import restricted to those collections approved for keeping SERIOUS Threat species	Limited to those collections approved for keeping particular SERIOUS Threat species
Serious	Low	Highly, Moderately or Not Dangerous	SERIOUS		
Moderate	Serious	Highly, Moderately or Not Dangerous	SERIOUS		
Moderate	Moderate	Highly Dangerous	SERIOUS		
Moderate	Low	Highly Dangerous	SERIOUS		
Low	Extreme	Highly, Moderately or Not Dangerous	SERIOUS		
Low	Serious	Highly, Moderately or Not Dangerous	SERIOUS		
Low	Moderate	Highly Dangerous	SERIOUS		
Low	Low	Highly Dangerous	SERIOUS		
Moderate	Moderate	Moderately or Not Dangerous	MODERATE	Import restricted to those collections approved for keeping MODERATE Threat species	Limited to those collections approved for keeping particular MODERATE Threat species
Moderate	Low	Moderately or Not Dangerous	MODERATE		
Low	Moderate	Moderately or Not Dangerous	MODERATE		
Low	Low	Moderately Dangerous	MODERATE		
Low	Low	Not Dangerous	LOW	Import permitted	May be limited to those collections approved for keeping particular LOW Threat species
Any Value	Any Value	Unknown	EXTREME until proven otherwise	Prohibited, unless sufficient risk management measures exist to reduce the potential risks to an acceptable level	Limited to those collections approved for keeping particular EXTREME Threat species
Unknown	Any Value	Any Value	EXTREME until proven otherwise		
Any Value	Unknown	Any Value	EXTREME until proven otherwise		
Unassessed	Unassessed	Unassessed	EXTREME until proven otherwise		

Adapted from:	Department Risk Analysis, Application to add *Okapia johnstoni* (Okapi) to the Environment Protection and Biodiversity Conservation Act 1999 *List of Specimens taken to be Suitable for Live Import,* May 2018 Terms of Reference, Preparing a draft assessment report and application to amend the *List of Specimens taken to be Suitable for Live Import* (Live Import List)	**By:** Jodi Buchecker	**Date:** Oct 2020

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National Risk Assessment: EXTREME

RISK ASSESSMENT FOR AUSTRALIA: Lion (*Panthera leo*)

Class - Mammalia, **Order** - Carnivora, **Family** - Felidae, **Genus** - *Panthera*.

SPECIES: *Panthera leo* (Linnaeus, 1758) **Synonyms:** *Felis leo* (Linnaeus, 1758) Central and West Africa, Asia Lion *Panthera leo persica* (Meyer, 1826) *Panthera leo senegalensis* (Meyer, 1826) *Panthera leo kamptzi* (Matschie, 1900) *Panthera leo azandica* (Allen, 1924) Southern and East Africa Lion *Panthera leo nubica* (de Blainville, 1843) *Panthera leo bleyenberghi* (Lönnberg, 1910) *Panthera leo krugeri* (Roberts, 1929) *Panthera leo somaliensis* (Noack, 1891) *Panthera leo massaica* (Neumann, 1900) *Panthera leo sabakiensis* (Lönnberg, 1910) *Panthera leo roosevelti* (Heller, 1914) *Panthera leo nyanzae* (Heller, 1914) *Panthera leo hollisteri* (Allen, 1924) *Panthera leo vernayi* (Roberts, 1948) *Panthera leo webbiensis* (Zukowsky, 1964)	**Species description:** Lions are large carnivorous felines native to a wide area of Africa and southwest Asia. Lions are large felines with a shoulder height of 1-1.2 metres and a body length of 1.4-2.5 metres. The black-tufted tail varies from 0.7-1 metre in length. Females weigh up to 182 kilograms, while males are typically larger and may weigh up to 272 kilograms (Long, 2003). The coat colour varies from buff to yellowish or reddish brown, with pale underparts. Males possess a long, hairy mane which may be light yellow to black (Long, 2003). The mane develops as males reach maturity and is unique to this species. Cubs have a similar appearance to adults but may have pale spot-like markings on their body. These marking will fade with age. **General information:** The lion historically occurred in Europe, much of Asia and the majority of Africa, although the species "range has declined, and today African Lions are limited to areas of Africa and the Gir Forest of India" (Long, 2003). The lion occupies a broad range of habitat and shows a preference for grassy plains, savannahs, open woodlands and scrub country (Nowak, 1999). Throughout the species range, it is absent only from tropical rainforests and the interior of the Sahara Desert. The species can survive in very arid environments and drinks regularly when water is available. However, lions can obtain their moisture requirements from prey and even some plants, such as melons (Bauer et al., 2008). African Lions may climb trees, but do not use tree hollows. Lions are carnivorous predators. Large mammals (such as Wildebeest (*Connochaetes taurinus*), Springbok (*Antidorcas marsupialis*) etc.) make up the bulk of their prey, but adults will opportunistically take almost any animal, including small rodents, ostriches (*Struthio camelus*) and their eggs, and tortoises (Long, 2003; Eloff, 1984). Although, lions actively hunt prey, they may also scavenge and displace other predators, such as the Spotted Hyaena (*Crocuta Crocuta*), from their kills. The feeding range of the lion is large with individuals travelling a range between 0.5-11.2 kilometres in one night (Long, 2003). The lion will feed on a variety of agricultural livestock species if the opportunity arises.

Subspecies: Two sub species: *Panthera leo leo* (Central and West Africa, Asia) (Linnaeus, 1758) *Panthera leo melanochaita* (Southern and East Africa) (Smith, 1842) **Common Names:** African Lion Lion	Lions are highly social animals. Related females remain together in prides, and related and unrelated males form coalitions competing for tenure over prides. The average pride contains 4 to 6 adults, and prides generally break into smaller groups when hunting (Bauer et al, 2008). Males reach sexual maturity at 2.5 years, while females mature earlier at 2 years of age. Lions may breed throughout the year, with peak breeding occurring during March-July. Females have multiple reproductive cycles per year, with oestrus lasting for approximately 4 days. The inter-birth interval is 11-25 months (Long, 2003). Gestation is typically, 100-119 days and between 1 to 6 young may be born. Young are born with their eyes closed, and these open within 2 weeks following birth (Long, 2003). Weaning occurs between 6 to 7 months. Lions pose a significant threat to human safety and may make unprovoked and fatal attacks on humans. In addition, the species is vulnerable to a variety of diseases which can be transferred to humans. The species is noted for preying on livestock, particularly if their native food sources are scarce and the economic impact of stock raiding can be significant (Long, 2003). Annual cattle loss due to lions in areas near Waza National Park, in Cameroon, were estimated to represent more than 22% of financial losses (Bauer, 2003 cited in Bauer, 2008). Consequently, lions are actively persecuted in livestock areas across Africa and are vulnerable to poisoned carcasses put out to eliminate predators (Bauer, 2008). **Longevity:** African Lions may live to 12-18 years in the wild and 13-30 years in captivity (Long, 2003). **Conservation status:** **IUCN:** The African Lion is currently listed as "vulnerable" under the IUCN Red List. Over the past two decades, the species population is suspected to have reduced by 30% due to indiscriminate killing in defence of life and livestock and depletion in primary prey resources (Bauer et al., 2008). **CITES:** African Lion population Listed as CITES Appendix II. Lion population within India is listed as CITES Appendix I.
DATE OF ORIGINAL ASSESSMENT: October 2011	**The risk assessment model:** Models for assessing the risk that exotic vertebrates could establish in Australia have been developed for mammals, birds (Bomford 2003, 2006, 2008), reptiles and amphibians (Bomford et al 2005, Bomford 2008). Developed by Dr Mary Bomford for the Bureau of Rural Sciences (BRS), the model uses criteria that have been demonstrated to

| DATE OF CURRENT ASSESSMENT: Oct 2020
(Jodi Buchecker)
EIC ENDORSEMENT: 15/03/21

Risk assessment model used for the assessment:
Bomford 2008, Mammals and Birds | have significant correlation between a risk factor and the establishment of populations of exotic species and the pest potential of those species that do establish. For example, a risk factor for establishment is similarity in climate (temperature and rainfall) within the species' distribution overseas and Australia. For pest potential, the species' overseas pest status is a risk factor. The model is published as 'Risk assessment models for the establishment of exotic vertebrates in Australia and New Zealand' (Bomford 2008) and is available online on the PestSmart website https://pestsmart.org.au/wp-content/uploads/sites/3/2020/06/Risk_Assess_Models_2008_FINAL.pdf

CLIMATE: In 2021 a new version of the Climatch program used to assess similarity in climate was released by the Australian Bureau of Agricultural Resource Economics and Sciences (ABARES): CLIMATCH v2.0. The increase in resolution in this new version (from 50 km to 20 km) required recalibration of Climate Match Scores. See Table 1. Sixteen climate parameters (variables) of temperature and rainfall are used to estimate the extent of similarity between data from meteorological stations located within the species' world distribution and stations in Australia. Worldwide, data from approximately 19000 locations are available for analysis. The number of locations used in an analysis will vary according to the size of the species' distribution and the number of meteorological stations located within that distribution. To represent the climate match visually, the map of Australia is divided into 19236 grid squares, each measured in 0.2 degrees in both longitude and latitude.
CLIMATCH v2.0 calculates a match for each Australian grid by comparing data from all meteorological stations within the species' distribution (excluding any populations in Australia) and allocating a score ranging from ten for the highest level match to zero for the poorest match. Levels of climate match are used in the risk assessment for questions B1 (scores are summed to give a cumulative score), C6, and C8. Climatch v2.0 can be accessed on the ABARES website, agriculture.gov.au/abares. The direct URL is https://climatch.cp1.agriculture.gov.au/. |

FACTOR	SCORE	DETAIL
Bird and Mammal Model:		
STAGE A: RISKS POSED BY CAPTIVE OR RELEASED ANIMALS		
A1. Risk to people from individual escapees (0–2) *Assess the risk that individuals of the species could harm people. (NB, this question only relates to aggressive behaviour shown by escaped or released individual animals. Question C11 addresses the risk of harm from aggressive behaviour if the species establishes a wild population).* *Aggressive behaviour, size, plus the possession of organs capable of inflicting harm, such as sharp teeth, claws, spines, a sharp bill, or toxin-delivering apparatus may enable individual animals to harm people. Any known history of the species attacking,*	2	*Animal that sometimes attacks when unprovoked and/or is capable of causing serious injury (requiring hospitalisation) or fatality.* Lions have been involved in hundreds of verified human fatalities.

injuring or killing people should also be taken into account. Assume the individual is not protecting nest or young.		
A2. Risk to public safety from individual captive animals (0–2) *Assess the risk that irresponsible use of products obtained from captive individuals of the species (such as toxins) pose a public safety risk (excluding the safety of anyone entering the animals' cage/enclosure or otherwise coming within reach of the captive animals)*	0	*Nil or low risk (highly unlikely or not possible).* The risk to public safety from irresponsible use of products obtained from this species is low.
STAGE A PUBLIC SAFETY RISK SCORE **SUM A1 – A2 (0-4)**	2	**Highly dangerous**
STAGE B: PROBABILITY ESCAPED OR RELEASED INDIVIDUALS WILL ESTABLISH FREE-LIVING POPULATIONS		
Model 1: Four-factor model for birds and mammals (Bomford **2008**)		
B1. Degree of climate match between species overseas range and Australia (1–6) *Map the selected mammal or bird species' overseas range, including its entire native and exotic (excluding Australia) ranges over the past 1000 years.* *Use CLIMATCH v2.0, CMS = sum of classes 6 – 10, see Table 1.*	5	*High climate match to Australia* Value X = 18,121 Climate Match Score = 5
B2. Exotic population established overseas (0–4) *An established exotic population means the introduced species must have bred outside of captivity and must currently maintain a viable free-living population where the animals are not being intentionally fed or sheltered, even though they may be living in a highly disturbed environment with access to non-natural food supplies or shelter.*	0	*No exotic populations ever established.* No populations are known to have established outside their native range.
B3. Overseas range size score (0–2) < 1 = 0; 1– 70 = 1; >70 = 2	1	*Overseas range size between 1-70 million km².*

Estimate the species overseas range size* including currently and the past 1000 years; natural and introduced range in millions of square kilometres		Current range is estimated at approximately 4 million km^2, but historical range is approximately 32 million km^2.
B4. Taxonomic Class (0–1) *Bird = 0; mammal = 1*	1	*Mammal*
B. ESTABLISHMENT RISK SCORE **SUM OF B1- B4 (1–13)**	7	**Moderate establishment risk**
Model 2: Seven-Factor Model For Birds And Mammals (Bomford 2008)		
B5. Diet score (0–1) *Specialist = 0; generalist = 1*	1	*Generalist with a broad diet of many food types.* *The lion is a generalist carnivore.*
B6. Habitat score (0–1) *Undisturbed or disturbed habitat*	1	*Can survive and breed in human-disturbed habitats (including grazing and agricultural lands, forests that are intensively managed or planted for timber harvesting and/or urban–suburban environments) without access to undisturbed (natural) habitats.* *Can live in disturbed habitats.*
B7. Migratory score (0–1) *Always migratory = 0; non-migratory = 1*	1	*Non-migratory*
B. ESTABLISHMENT RISK SCORE **SUM OF B1- B7 (1–16)**	10	**Moderate establishment risk**
STAGE C: PROBABILITY AN ESTABLISHED SPECIES WILL BECOME A PEST		
C1. Taxonomic group (0–4)	2	*Mammal in one of the orders that have been demonstrated to have detrimental effects on prey abundance and/or habitat degradation (Carnivora).*
C2. Overseas range size including current and past 1000 years, natural and introduced range (0–2) *Estimate the species overseas range size (including current and past 1000 years, natural and introduced range) in millions of square metre*	2	*Overseas geographic range greater than 30 million square kilometres.*

C3. Diet and feeding (0–3)	3	*Mammal that is a strict carnivore (eats only animal matter) and arboreal (climbs trees for any reason).*
C4. Competition with native fauna for tree hollows (0–2)	0	*Does not use tree hollows.*
C5. Overseas environmental pest status (0–3) *Has the species been reported to cause declines in abundance of any native species of plant or animal or cause degradation to any natural communities in any country or region of the world?*	0	*Never reported as an environmental pest in any country or region.*
C6. Climate match to areas with susceptible native species or communities (0–5) *Identify any native Australian animal or plant species or communities that could be susceptible to harm by the exotic species if it were to establish a wild population here.*	5	*The species has more than 138 grid squares within the highest two climate match classes and/or has more than 691 grid squares within the highest four climate match classes, that overlap the distribution of any susceptible native species or ecological communities = 5* Examples of susceptible native species or ecological communities (DAWE Protected Matters Search Tool) include: *Dasyurus viverrinus* (Eastern Quoll) – Endangered *Lathamus discolor* (Swift Parrot) – Critically Endangered
C7. Overseas primary production pest status (0–3) *Has the species been reported to damage crops or other primary production in any country or region of the world?*	2	*Moderate pest to primary production in any country or region.* Lions will prey on livestock particularly if their native food sources are scarce. The economic impact of stock raiding can be significant (Long, 2003). Annual cattle loss due to lions in areas near Waza National Park, in Cameroon, were estimated to represent more than 22% of financial losses (Bauer, 2003 cited in Bauer, 2008).
C8. Climate match to susceptible primary production (0–5) *Assess Potential Commodity Impact Scores for each primary production commodity listed in Table 9, based on species' attributes (diet, behaviour, ecology), excluding risk of spreading disease which is addressed in Question C9.*	5	Total Commodity Damage Score = 234 (see Table 2) Very high climate match score to susceptible primary production.

0 = 0; 1-19 = 1; 20-49 = 2; 50-99 = 3; 100-149 = 4; ≥150 = 5		
C9. Spread disease (1–2) *Assess the risk that the species could play a role in the spread of disease or parasites to other animals*	2	*All mammals (likely or unknown effect on native species and on livestock and other domestic animals).*
C10. Harm to property (0–3) *Assess the risk that the species could inflict damage on buildings, vehicles, fences, roads, equipment or ornamental gardens by chewing or burrowing or polluting with droppings or nesting material.*	1	*$1 - $10 million.* Harm to property is estimated to be less than $100,000 per year. No significant damage to property has been noted.
C11. Harm to people (0–5) *Assess the risk that, if a wild population established, the species could cause harm to or annoy people. Aggressive behaviour, plus the possession of organs capable of inflicting harm, such as sharp teeth, tusks, claws, spines, a sharp bill, horns, antlers or toxin delivering organs may enable animals to harm people. Any known history of the species attacking, injuring or killing people should also be taken into account (see Stage A, Score A1).*	5	*Injuries or harm moderate, severe or fatal and many people at risk: Extreme risk = 5.*
C. PEST RISK SCORE **SUM C 1 TO C 11 (1–37)**	27	**Extreme pest risk**
STAGE A. PUBLIC SAFETY RISK RANK – RISK TO PUBLIC SAFETY POSED BY CAPTIVE OR RELEASED INDIVIDUALS *0 = Not dangerous; 1 = Moderately dangerous; ≥ 2 = Highly dangerous*	2	Highly dangerous
STAGE B. ESTABLISHMENT RISK RANK – RISK OF ESTABLISHING A WILD POPULATION Model 1: Four-factor model for birds and mammals (Bomford 2008)	7	Moderate establishment risk

≤ 5 = low establishment risk; 6-8 = moderate establishment risk; 9-10 = serious establishment risk; ≥ 11-13 = extreme establishment risk		
STAGE B. ESTABLISHMENT RISK RANK – RISK OF ESTABLISHING A WILD POPULATION Model 2: Seven-factor model for birds and mammals (Bomford 2008) *≤ 6 = low establishment risk; 7-11 = moderate establishment risk; 12-13 = serious establishment risk; ≥14 = extreme establishment risk*	10	Moderate establishment risk
STAGE C. PEST RISK RANK - RISK OF BECOMING A PEST FOLLOWING ESTABLISHMENT *< 9 = low pest risk; 9-14 = moderate pest risk; 15-19 = serious pest risk; > 19 = extreme pest risk*	27	Extreme pest risk

ENVIRONMENT AND INVASIVES COMMITTEE THREAT CATEGORY	**EXTREME**

Past World distribution map, current World distribution map (IUCN Red List) and World distribution map indicating where meteorological data was sourced for the climate analysis (see B1):
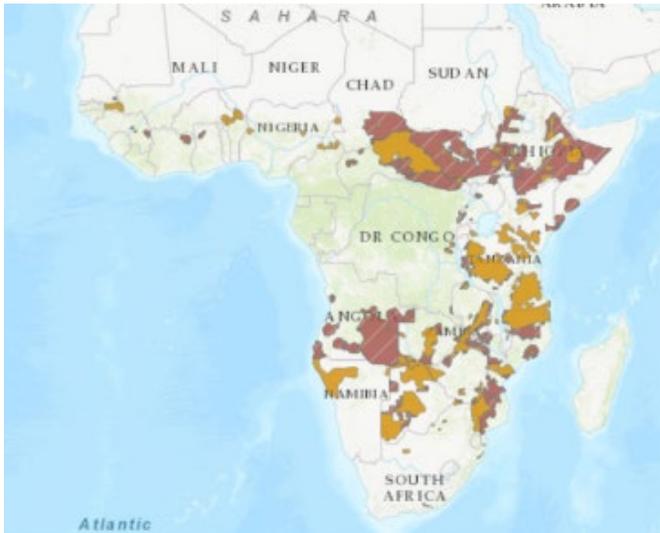

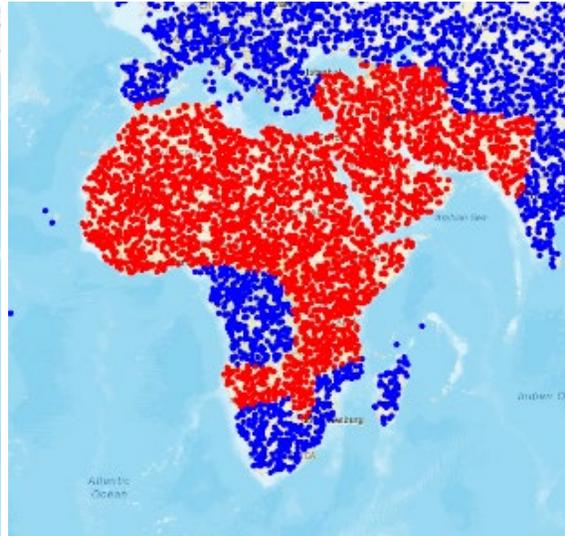*Figure 1 - World Distribution Map - IUCN Red List*

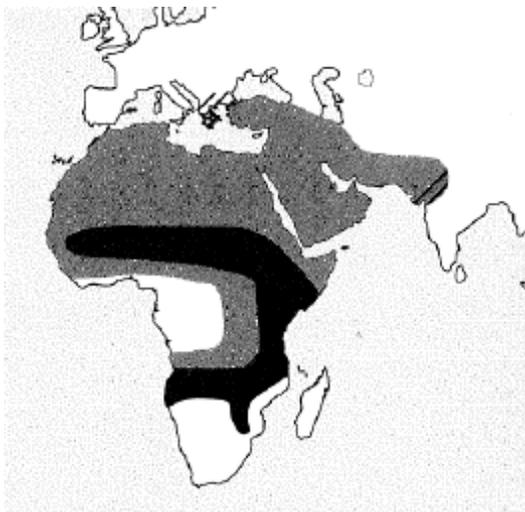*Figure 2 - World Distribution Map - Climatch*
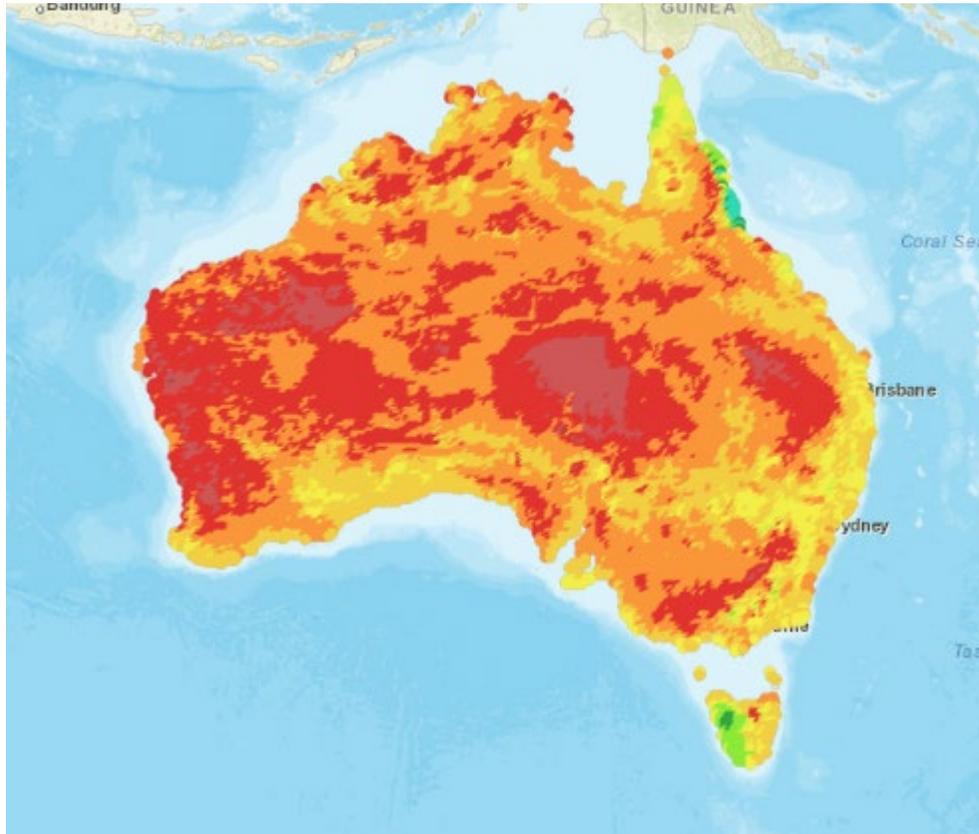

Figure 3 – Map of the Distribution of the Lion

Climate match between world distribution of species and Australia:
Areas of Australia where the climate appears suitable for *Panthera leo*
CMS = 18,121

Score	Color	Count	
0	●	0	
1	●	18	
2	●	19	
3	●	88	
4	●	117	
5	●	873	
6	●	3265	Species: Panthera leo (Lion)
7	●	8103	Algorithm: Closest Standard Score
8	●	5774	3372 source features selected
9	●	977	19236 target features selected
10	●	2	Approximate selected area: 32,349,475 km²

Table 1: ABARES recalibration thresholds

Climate Match Score (CMS)	Current Bomford 2008 model classes (50 km)	Recalibrated classes to Climatch v2.0 (20 km)
1 (Very low)	< 100	< 691
2 (Low)	100-599	691-4137
3 (Moderate)	600-899	4138-6209
4 (High)	900-1699	6210-11735
5 (Very high)	1700-2699	11736-18642
6 (Extreme)	≥ 2700	≥ 18643

Table 2: Susceptible Australian Primary Production – Calculating Total Commodity Damage Score
The commodity value index scores in this table are derived from Australian Bureau of Statistics 2005 – 2006 data. The values will require updating if significant change has occurred in the value of the commodity (Bomford 2008).

Industry	Commodity Value Index 1 (CVI based on best available date)	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	3	4	132
Timber (includes native and plantation forests)	10			
Cereal grain (includes wheat, barley sorghum etc)	8			
Sheep (includes wool and sheep meat)	5	3	4	60
Fruit (includes wine grapes)	4			
Vegetables	3			
Poultry and eggs	2	3	4	24
Aquaculture (includes coastal mariculture)	2			
Oilseeds (includes canola, sunflower etc)	1			
Grain legumes (includes soybeans)	1			
Sugarcane	1			
Cotton	1			
Other crops and horticulture (includes nuts tobacco and flowers etc)	1			
Pigs	1	3	4	12
Other livestock (includes goats, deer, camels, rabbits)	0.5	3	4	6
Bees (included honey, beeswax and pollination)	0.5			
Total Commodity Damage Score (TCDS)				234

NB The Commodity Value Index scores in this table are derived from Australian Bureau of Statistics 2005–2006 data and will need to be updated if these values change significantly.

Assess Potential Commodity Impact Scores for each primary production commodity listed in Table 9, based on species' attributes (diet, behaviour, ecology), excluding risk of spreading disease which is addressed in Question C9, and pest status worldwide as:

0. *Nil (species does not have attributes to make it capable of damaging this commodity)*
1. *Low (species has attributes making it capable of damaging this or similar commodities and has had the opportunity but no reports or other evidence that it has caused damage in any country or region*
2. *Moderate–serious (reports of damage to this or similar commodities exist 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)*
3. *Extreme (damage occurs 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).*

Climate Match to Commodity Score (0–5)

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

Table 3: Assigning species to EIC Threat Categories (shaded cells relate to assignment of reptiles and amphibians to EIC Threat Categories based on an assessed establishment risk and an allocated pest risk of extreme) – adapted from Bomford 2008

Establishment Risk	Pest Risk	Public Safety Risk	EIC Threat Category	Implication for any proposed import into Australia	Implication for keeping and movement in Australia
Extreme	Extreme	Highly, Moderately or Not Dangerous	EXTREME	Prohibited, unless sufficient risk management measures exist to reduce the potential risks to an acceptable level	Limited to those collections approved for keeping particular EXTREME Threat species
Extreme	Serious	Highly, Moderately or Not Dangerous	EXTREME		
Extreme	Moderate	Highly, Moderately or Not Dangerous	EXTREME		
Extreme	Low	Highly, Moderately or Not Dangerous	EXTREME		
Serious	Extreme	Highly, Moderately or Not Dangerous	EXTREME		
Serious	Serious	Highly, Moderately or Not Dangerous	EXTREME		
Moderate	Extreme	Highly, Moderately or Not Dangerous	EXTREME		
Serious	Moderate	Highly, Moderately or Not Dangerous	SERIOUS	Import restricted to those collections approved for keeping SERIOUS Threat species	Limited to those collections approved for keeping particular SERIOUS Threat species
Serious	Low	Highly, Moderately or Not Dangerous	SERIOUS		
Moderate	Serious	Highly, Moderately or Not Dangerous	SERIOUS		
Moderate	Moderate	Highly Dangerous	SERIOUS		
Moderate	Low	Highly Dangerous	SERIOUS		
Low	Extreme	Highly, Moderately or Not Dangerous	SERIOUS		
Low	Serious	Highly, Moderately or Not Dangerous	SERIOUS		
Low	Moderate	Highly Dangerous	SERIOUS		
Low	Low	Highly Dangerous	SERIOUS		
Moderate	Moderate	Moderately or Not Dangerous	MODERATE	Import restricted to those collections approved for keeping MODERATE Threat species	Limited to those collections approved for keeping particular MODERATE Threat species
Moderate	Low	Moderately or Not Dangerous	MODERATE		
Low	Moderate	Moderately or Not Dangerous	MODERATE		
Low	Low	Moderately Dangerous	MODERATE		
Low	Low	Not Dangerous	LOW	Import permitted	May be limited to those collections approved for keeping particular LOW Threat species
Any Value	Any Value	Unknown	EXTREME until proven otherwise	Prohibited, unless sufficient risk management measures exist to reduce the potential risks to an acceptable level	Limited to those collections approved for keeping particular EXTREME Threat species
Unknown	Any Value	Any Value	EXTREME until proven otherwise		
Any Value	Unknown	Any Value	EXTREME until proven otherwise		
Unassessed	Unassessed	Unassessed	EXTREME until proven otherwise		

Adapted from:	DPIPWE (2011) Pest Risk Assessment: African Lion (*Panthera leo*). Department of Primary Industries, Parks, Water and Environment. Hobart, Tasmania.	By: Jodi Buchecker	Date: Oct 2020

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National Risk Assessment: EXTREME

RISK ASSESSMENT FOR AUSTRALIA: **Hamadryas baboon (*Papio hamadryas*)**

Class - Mammalia, **Order** - Primates, **Family** - Cercopithecidae, **Genus** - *Papio*.

SPECIES: *Papio hamadryas* (Linnaeus, 1758) **Synonyms:** *Simia hamadryas* (Linnaeus, 1758) *Hamadryas aegyptiaca* (Gray, 1870) *Papio arabicus* (Thomas, 1900) *Papio brockmani* (Elliot, 1909) *Hamadryas chaeropitheus* (Lesson, 1840) *Simia cynamolgus* (Linnaeus, 1758) *Theropithecus nedjo* (Reichenbach, 1863) *Cynocephalus wagleri* (Agassiz, 1828) **Subspecies:** Monotypic **Common Names:** Hamadryas baboon Sacred baboon **Hybridisation:** This species has been reported to hybridise with the olive baboon (*Papio anubis*) where the ranges of the two overlaps, in a small area of northern Ethiopia (Richardson, 2009; Shefferly, 2004).	**Species description:** The hamadryas baboon is a large monkey with a dog-like face, pronounced brow ridges, relatively long limbs with short digits, coarse fur, and a relatively short tail with a tufted tip. The male has a heavy cape, bushy cheeks, and large canine teeth. While the male hamadryas baboon develops a silvery-grey coat, the juvenile and female are brown, with dark brown skin on the face and rump. The face is nearly bare, and the palms and soles of the feet are completely bare. The female hamadryas baboon develops a colourful and pronounced sexual swelling during oestrus, and the skin over the rump becomes bright red during pregnancy (Richardson, 2009). The hamadryas baboon is distinguished from other baboons by the male's long, silver-grey shoulder cape, and the pink or red rather than black face and rump. Hamadryas baboons exhibit sexual dimorphism, especially in body size. The males may have a body measurement of up to 80 centimetre and weigh between 20-30 kilograms and the females have a body length of 40–45 centimetres and weigh between 10–15 kilograms. The tail adds a further 40–60 centimetres to the length (Shefferly, 2004). Locomotion is quadrupedal and appears to be somewhat stiff-legged. The weight is born on the front extremities by the fingers (digitigrade) and is born by the hind feet across the entire sole of the foot (plantigrade). The thumb is relatively long, allowing precision grip and manipulation of objects (Shefferly, 2004). **General information:** This species occurs in north-east Africa. The hamadryas baboon is native to Djibouti, Eritrea, Ethiopia, Saudi Arabia, Somalia, Sudan and Yemen. It is principally found in Ethiopia, although its range extends from the Red Sea Hills and Suakin (Sudan) through Eritrea and Djibouti (especially in the Goda Mountains) to northern Somalia. The population in Ethiopia, may have even increased because of loss of predators and small-scale agriculture (Gippoliti and Ehardt, 2008). The hamadryas baboon is also found in the Red Sea Hills in the southwest Arabian Peninsula opposite the Horn of Africa. Historically, its range extended into Egypt, but not in recent time (post 1500 AD) (Gippoliti and Ehardt, 2008). The hamadryas baboon also occurs both in the Palearctic, along the Red Sea coast of Yemen and Saudi Arabia. The Palearctic populations of the hamadryas baboon have been present for the length of

recorded history in the region, but are thought to have been introduced by humans, possibly though a shipwreck, or through importation of these "sacred" baboons sometime during the past 4,000 years (Shefferly, 2004; Jolly, 1993; Nowak, 1999). There are no other records of this species establishing feral populations in any other country or region.

Although generally described as frugivorous, the hamadryas baboons is an opportunistic feeder, eating a wide variety of foods, including grasses, forbes, leaves, buds, flowers, seeds, eggs, insects, and meat. All baboons share the unique ability to subsist solely on grasses and forbes for extended periods of time. This allows them to exploit dry terrestrial habitats, like deserts, semi-deserts, steppes, and grasslands (Shefferly, 2004). Baboons may also hunt small mammals, including hares (*Lepus* species) and young gazelles (*Nanger soemmerringii*) (Wikipedia, 2012). These animals are motile, ranging several kilometres in any one day to find food (Melnick and Pearle, 1987).

Omnivorous species like the baboon will take a whole range and diversity of foods, including many crop species, and often utilise several different parts of these plants, rendering them vulnerable throughout their lifecycles (Sillero-Zubiri 2001). Baboons (*Papio* species) are often considered pests. They are known to raid crops in Africa (Shapirio and den Ouden, 2012; Shefferly 2004).

The hamadryas baboons' drinking activities depend on the season. During the wet seasons, they do not have to go far to find pools of water. During the dry seasons, hamadryas baboons frequent up to 3 permanent waterholes. Baboons will take siestas at the waterholes during mid-afternoon. Hamadryas baboons will also dig drinking holes only a short distance from natural waterholes (Kummer in Wikipedia, 2012).

The hamadryas baboon breeds seasonally with females reaching sexual maturity at about 4.3 years. The dominant male of a one-male unit does most of the mating (Wikipedia, 2012). The female hamadryas baboon usually gives birth to a single young, after a gestation period of 170 to 173 days. Breeding may take place at any time of year, but births typically peak between May and July or November and December in Ethiopia. Each female usually gives birth once every 15 to 24 months (Nowak, 1991). The average gestation period is 171 days. The newborn hamadryas baboon has black fur and pink skin and is suckled for up to 15 months (Nowak, 1991).

Like all baboons, the hamadryas baboon is primarily terrestrial, but will sleep in trees or on cliffs at night (Richardson, 2009). Social groups always return to one of a limited set of sleeping sites (cliffs or trees) at night.

Herpes B virus (*Cercopithecine herpesvirus 1*) infects a broad range of mammalian and avian species, including New World monkeys, Old World monkeys (including baboons), and humans (Hogan, 2012).

Many of the Cercopithecine species are natural carriers of closely related viruses (Hyashi et al, 2001). Herpesvirus papio 2 (*Herpesvirus papionis*) has been isolated from vervet monkeys (*Chlorocebus* species) and baboons, however, only baboons become clinically affected. Small vesicles, pustules and ulcers develop in the oral cavity, penis, prepuce, vulva and perineum. Secondary bacterial infections frequently lead to sterility. The disease is generally transmitted venereally. Transmission to humans or other animals has not been recorded (MAF NZ Biosecurity, 2011).

Yaba monkey tumour virus (*Yatapoxvirus yabapox*) most commonly infects macaques (*Macaca* species) but has also been found in other Old-World monkeys, including baboons. Tumours develop in the skin of monkeys and humans after subcutaneous or intradermal injection of Yaba monkey tumour virus. The virus causes subcutaneous tumours, especially on the plantar surfaces of the hands and feet, but the disease resolves within several weeks (Mansfield and King, 1998). It has been suggested that Yaba monkey tumour virus is transmitted by insects, but the method of transmission is uncertain. The virus causes a non-fatal disease of monkeys and baboons and is rarely transmitted to humans in which it is a self-limiting infection. The Yaba monkey tumour virus causes a mild disease only in humans and is not contagious from person to person (MAF NZ Biosecurity, 2011).

Haemogregarina is a parasite found mainly in cold-blooded vertebrates and has been observed in blood of some species of Old-World primates, such as macaques and baboons, but no illness has been associated with infection, and it is regarded as non-pathogenic (MAF NZ Biosecurity, 2011).

This species is generally tolerated and even sometimes actively fed by people. They often live around cities and garbage dumps, sometimes reaching pest proportions in settled areas, and showing little fear of humans (Nowak, 1991 in Richardson, 2009). Hamadryas baboons can be aggressive when confronted (Shapirio and den Ouden, 2012).

Longevity:
Lifespan in captivity has been recorded at 37 years (AnAge, 2011).

Conservation status:
IUCN:
The hamadryas baboon is not globally threatened and is listed as 'least concern' by the IUCN as this species is widespread and abundant. There are no major range-wide threats believed to be resulting in a significant decline.
CITES:

<table>
<tr>
<td></td>
<td>The hamadryas baboon is listed on Appendix II of the Convention on International Trade in Endangered Species of Wild Flora and Fauna (UNEP-WCMC, 2012). International trade in specimens of Appendix II species may be authorized by an export permit which is only granted if the relevant authorities are satisfied that trade will not be detrimental to the survival of the species in the wild.

This species occurs in protected areas in the proposed Yangudi Rassa National Park, the Harar Wildlife Sanctuary, and a number of Wildlife Reserves in the lower Awash valley (all in Ethiopia) and in northern Eritrea. A 'pure' subpopulation of this species is found in the Simien Mountains National Park (Ethiopia), while hamadryas baboon and olive baboon hybrids occur in the Awash National Park (Ethiopia).

The hamadryas baboon is listed on Class B of the African Convention on the Conservation of Nature and Natural Resources. Species in Class B are totally protected, but may be hunted, killed, captured or collected under special authorization granted by the competent authority.</td>
</tr>
<tr>
<td>**DATE OF ORIGINAL ASSESSMENT:** 21 November 2014
DATE OF CURRENT ASSESSMENT: Oct 2020
(Jodi Buchecker)
EIC ENDORSEMENT: 15/03/21

Risk assessment model used for the assessment:
Bomford 2008, Mammals and birds</td>
<td>**The risk assessment model:** Models for assessing the risk that exotic vertebrates could establish in Australia have been developed for mammals, birds (Bomford 2003, 2006, 2008), reptiles and amphibians (Bomford et al 2005, Bomford 2008). Developed by Dr Mary Bomford for the Bureau of Rural Sciences (BRS), the model uses criteria that have been demonstrated to have significant correlation between a risk factor and the establishment of populations of exotic species and the pest potential of those species that do establish. For example, a risk factor for establishment is similarity in climate (temperature and rainfall) within the species' distribution overseas and Australia. For pest potential, the species' overseas pest status is a risk factor.
The model is published as 'Risk assessment models for the establishment of exotic vertebrates in Australia and New Zealand' (Bomford 2008) and is available online on the PestSmart website https://pestsmart.org.au/wp-content/uploads/sites/3/2020/06/Risk_Assess_Models_2008_FINAL.pdf

CLIMATE: In 2021 a new version of the Climatch program used to assess similarity in climate was released by the Australian Bureau of Agricultural Resource Economics and Sciences (ABARES): CLIMATCH v2.0. The increase in resolution in this new version (from 50 km to 20 km) required recalibration of Climate Match Scores. See Table 1. Sixteen climate parameters (variables) of temperature and rainfall are used to estimate the extent of similarity between data from meteorological stations located within the species' world distribution and stations in Australia. Worldwide, data from approximately 19000 locations are available for analysis. The number of locations used in an analysis will vary according to the size of the species' distribution and the number of meteorological stations located within that distribution. To represent the climate match visually, the map of Australia is divided into 19236 grid squares, each measured in 0.2 degrees in both longitude and latitude. CLIMATCH v2.0 calculates a match for each Australian grid by comparing data from all meteorological stations within the species' distribution (excluding any populations in Australia) and allocating a score ranging from ten for the highest level match to zero for the poorest match. Levels of climate match are used in the risk assessment for questions B1 (scores are summed to give a cumulative score), C6, and C8. Climatch v2.0 can be accessed on the ABARES website, agriculture.gov.au/abares. The direct URL is https://climatch.cp1.agriculture.gov.au/.</td>
</tr>
</table>

FACTOR	SCORE	DETAIL
STAGE A: RISKS POSED BY CAPTIVE OR RELEASED ANIMALS		
A1. Risk to people from individual escapees (0–2) *Assess the risk that individuals of the species could harm people. (NB, this question only relates to aggressive behaviour shown by escaped or released individual animals. Question C11 addresses the risk of harm from aggressive behaviour if the species establishes a wild population).* *Aggressive behaviour, size, plus the possession of organs capable of inflicting harm, such as sharp teeth, claws, spines, a sharp bill, or toxin-delivering apparatus may enable individual animals to harm people. Any known history of the species attacking, injuring or killing people should also be taken into account. Assume the individual is not protecting nest or young.*	2	*Animal that sometimes attacks when unprovoked and/or is capable of causing serious injury (requiring hospitalisation) or fatality.* The hamadryas baboon is aggressive and can cause serious injury.
A2. Risk to public safety from individual captive animals (0–2) *Assess the risk that irresponsible use of products obtained from captive individuals of the species (such as toxins) pose a public safety risk (excluding the safety of anyone entering the animals' cage/enclosure or otherwise coming within reach of the captive animals)*	0	*Nil or low risk (highly unlikely or not possible).*
STAGE A PUBLIC SAFETY RISK SCORE **SUM A1 - A2 (0-4)**	2	**Highly dangerous**
STAGE B: PROBABILITY ESCAPED OR RELEASED INDIVIDUALS WILL ESTABLISH FREE-LIVING POPULATIONS		
Model 1: FOUR-FACTOR MODEL FOR BIRDS AND MAMMALS (BOMFORD 2008)		
B1. Degree of climate match between species overseas range and Australia (1–6)	4	*High climate match to Australia*

		Value X = 8,614 Climate Match Score = 4
Map the selected mammal or bird species' overseas range, including its entire native and exotic (excluding Australia) ranges over the past 1000 years. *Use CLIMATCH v2.0, CMS = sum of classes 6 – 10, see Table 1.*		
B2. Exotic population established overseas (0–4) *An established exotic population means the introduced species must have bred outside of captivity and must currently maintain a viable free-living population where the animals are not being intentionally fed or sheltered, even though they may be living in a highly disturbed environment with access to non-natural food supplies or shelter.*	4	*Exotic population established on a larger island (> 50,000 km^2) or anywhere on a continent (including elsewhere on the land mass where the natural distribution of the animal is, if this population is due to human introduction and is geographically separate from the natural range of the species).* The hamadryas baboon has an exotic population estimated to be around 268,000km^2.
B3. Overseas range size score (0–2) < 1 = 0; 1– 70 = 1; >70 = 2 *Estimate the species overseas range size* including currently and the past 1000 years; natural and introduced range in millions of square kilometres*	0	*Overseas range between 1 to 70 million km^2.* Overseas range estimated to be 7,736,730 km^2.
B4. Taxonomic Class (0–1) Bird=0; mammal = 1	1	*Mammal*
B. ESTABLISHMENT RISK SCORE **SUM OF B1- B4 (1–13)**	9	**Serious establishment risk**
Model 2: Seven-Factor Model For Birds And Mammals (Bomford 2008)		
B5. Diet score (0–1) Specialist = 0; generalist = 1	1	*Generalist with a broad diet of many food types.* The Hamadryas baboon is an opportunistic omnivore. Seasonally important foods that are consumed by the hamadryas baboon include grass, buds, invertebrates, and the fruits of desert plants.
B6. Habitat score (0–1) Undisturbed or disturbed habitat	1	*Can survive and breed in human-disturbed habitats (including grazing and agricultural lands, forests that are intensively managed or planted for timber*

		harvesting and/or urban–suburban environments) without access to undisturbed (natural) habitats. Following recent urban development in the mountains of south-western Saudi Arabia, local populations of Hamadryas baboon have increased in numbers around cities (Biquand et al., 1994).
B7. Migratory score (0–1) *Always migratory = 0; non-migratory = 1*	1	*Non-migratory.* The Hamadryas baboon is not a migrant. However, it appears to be seasonally migratory in at least some parts of its range in Ethiopia, where bands may move up into neighbouring mountainous areas (up to 3,300 metres in the Simien Mountains National Park, Ethiopia) in the wet season. Therefore, given conservative score of 1.
B. ESTABLISHMENT RISK SCORE **SUM OF B1- B7 (1–16)**	13	**Serious establishment risk**
STAGE C: PROBABILITY AN ESTABLISHED SPECIES WILL BECOME A PEST		
C1. Taxonomic group (0–4)	0	*Not in one of the mammal orders that have been demonstrated to have detrimental effects on prey abundance and/or habitat degradation.* The hamadryas baboon falls into the Primate Order.
C2. Overseas range size including current and past 1000 years, natural and introduced range (0–2) *Estimate the species overseas range size (including current and past 1000 years, natural and introduced range) in millions of square kilometres*	0	Overseas geographic range less than 10 million square kilometres. The hamadryas baboon overseas range is estimated to be 8 million km^2.
C3. Diet and feeding (0–3)	3	*Mammal that is primarily a grazer or browser.*
C4. Competition with native fauna for tree hollows (0–2)	0	*Does not use hollows.*

C5. Overseas environmental pest status (0–3) *Has the species been reported to cause declines in abundance of any native species of plant or animal or cause degradation to any natural communities in any country or region of the world?*	0	*Never reported as an environmental pest in any country or region.* Not recorded as being an environmental pest.
C6. Climate match to areas with susceptible native species or communities (0–5) *Identify any native Australian animal or plant species or communities that could be susceptible to harm by the exotic species if it were to establish a wild population here.*	5	*The species has more than 138 grid squares within the highest two climate match classes, and/or has more than 691 grid squares within the four highest climate match classes, that overlap the distribution of any susceptible native species or communities = 5* Examples of susceptible native species or ecological communities (DAWE Protected Matters Search Tool) include: *Pedionomus torquatus* (Plains-wanderer) – Endangered *Lathamus discolor* (Swift Parrot) – Critically Endangered
C7. Overseas primary production pest status (0–3) *Has the species been reported to damage crops or other primary production in any country or region of the world?*	3	*Major pest of primary production in any country or region.* Listed as "vermin" by the African Convention on the Conservation of Nature and Natural Resources.
C8. Climate match to susceptible primary production (0–5) *Assess Potential Commodity Impact Scores for each primary production commodity listed in Table 9, based on species' attributes (diet, behaviour, ecology), excluding risk of spreading disease which is addressed in Question C9.* *0 = 0; 1-19 = 1; 20-49 = 2; 50-99 = 3; 100-149 = 4; ≥150 = 5*	3	Total Commodity Damage Score = 84 (see Table 2)
C9. Spread disease (1–2)	2	*All mammals (likely or unknown effect on native species and on livestock and other domestic animals).*

Assess the risk that the species could play a role in the spread of disease or parasites to other animals		
C10. Harm to property (0–3) *Assess the risk that the species could inflict damage on buildings, vehicles, fences, roads, equipment or ornamental gardens by chewing or burrowing or polluting with droppings or nesting material.*	1	*$1 to $10 million.* Infrastructure would be required to prevent crop raiding.
C11. Harm to people (0–5) *Assess the risk that, if a wild population established, the species could cause harm to or annoy people. Aggressive behaviour, plus the possession of organs capable of inflicting harm, such as sharp teeth, tusks, claws, spines, a sharp bill, horns, antlers or toxin delivering organs may enable animals to harm people. Any known history of the species attacking, injuring or killing people should also be taken into account (see Stage A, Score A1).*	4	*Injuries or harm severe or fatal but few people at risk: Serious risk.* The hamadryas baboon is aggressive and can cause serious injury.
C. PEST RISK SCORE **SUM C 1 TO C 11 (1–37)**	21	**Extreme pest risk**
STAGE A. PUBLIC SAFETY RISK RANK – RISK TO PUBLIC SAFETY POSED BY CAPTIVE OR RELEASED INDIVIDUALS *0 = Not dangerous; 1 = Moderately dangerous; ≥ 2 = Highly dangerous*	2	Highly dangerous
STAGE B. ESTABLISHMENT RISK RANK – RISK OF ESTABLISHING A WILD POPULATION MODEL 1: FOUR-FACTOR MODEL FOR BIRDS AND MAMMALS (BOMFORD 2008) *≤ 5 = low establishment risk; 6-8 = moderate establishment risk; 9-10 = serious establishment risk; ≥ 11-13 = extreme establishment risk*	9	Serious establishment risk

STAGE B. ESTABLISHMENT RISK RANK – RISK OF ESTABLISHING A WILD POPULATION MODEL 2: SEVEN-FACTOR MODEL FOR BIRDS AND MAMMALS (BOMFORD 2008) ≤ 6 = low establishment risk; 7-11 = moderate establishment risk; 12-13 = serious establishment risk; ≥14 = extreme establishment risk	13	Serious establishment risk
STAGE C. PEST RISK RANK - RISK OF BECOMING A PEST FOLLOWING ESTABLISHMENT < 9 = low pest risk; 9-14 = moderate pest risk; 15-19 = serious pest risk; > 19 = extreme pest risk	21	Extreme pest risk

ENVIRONMENT AND INVASIVES COMMITTEE THREAT CATEGORY	**EXTREME**

World distribution map (IUCN Red List) and World distribution map indicating where meteorological data was sourced for the climate analysis (see B1):
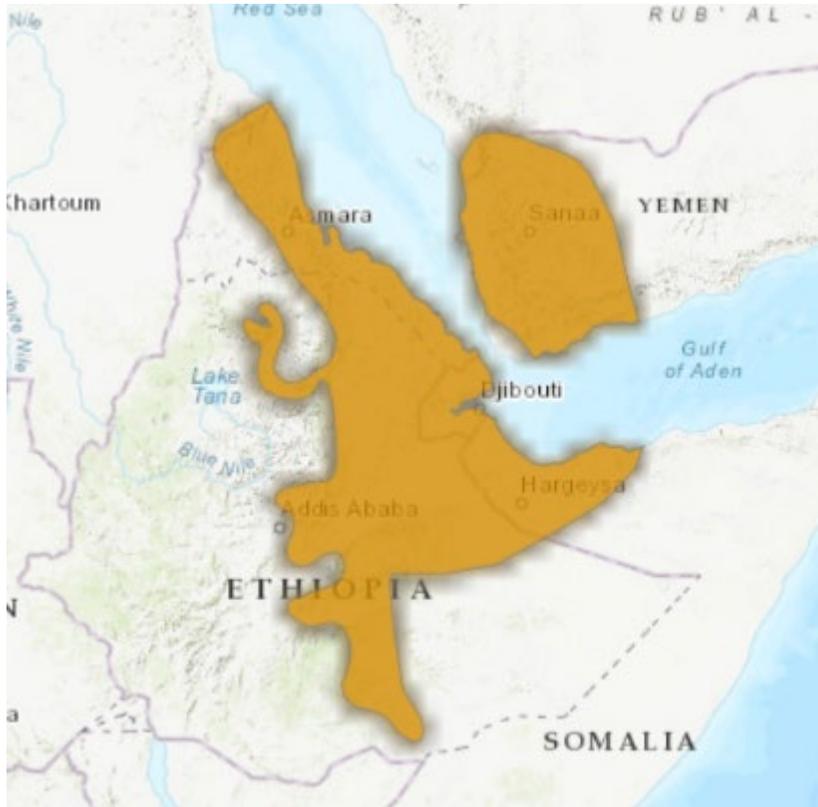

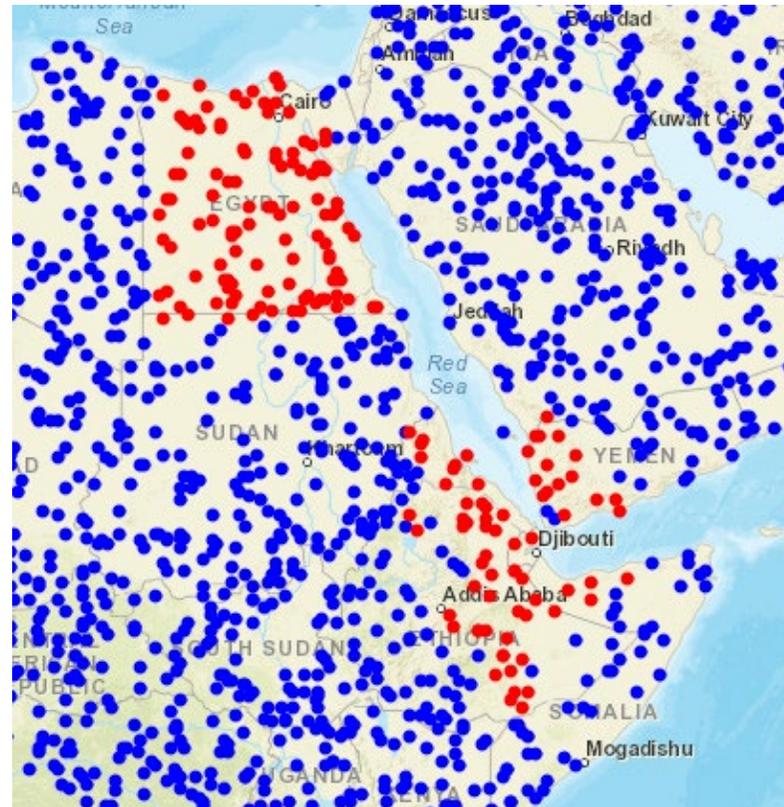*Figure 1 - World Distribution Map - IUCN Red List*
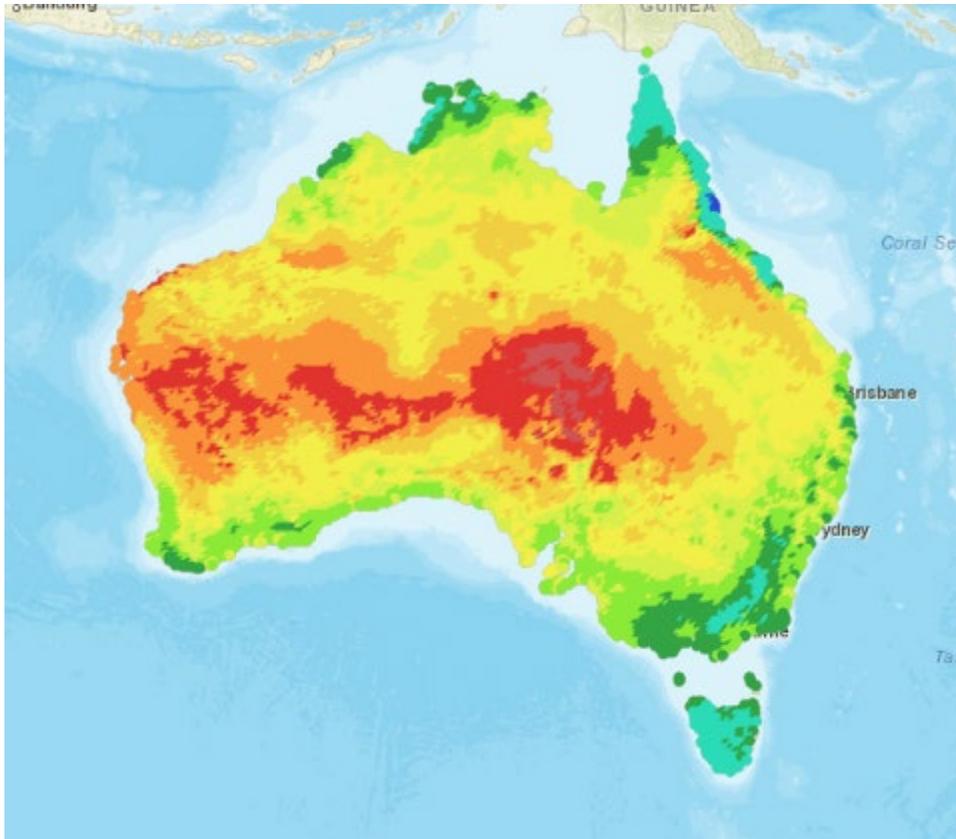

Figure 2 - World Distribution Map - Climatch

Climate match between world distribution of species and Australia:
Areas of Australia where the climate appears suitable for *Papio hamadryas*
CMS = 8,614

Score	Color	Count
0	●	5
1	●	488
2	●	780
3	●	1398
4	●	2514
5	●	5437
6	●	3876
7	●	2946
8	●	1549
9	●	243
10	●	0

Species: Papio hamadryas (Hamadryas Baboon)
Algorithm: Closest Standard Score
182 source features selected
19236 target features selected
Approximate selected area: 2,239,164 km²

Table 1: ABARES recalibration thresholds

Climate Match Score (CMS)	Current Bomford 2008 model classes (50 km)	Recalibrated classes to Climatch v2.0 (20 km)
1 (Very low)	< 100	< 691
2 (Low)	100-599	691-4137
3 (Moderate)	600-899	4138-6209
4 (High)	900-1699	6210-11735
5 (Very high)	1700-2699	11736-18642
6 (Extreme)	≥ 2700	≥ 18643

Table 2: Susceptible Australian Primary Production – Calculating Total Commodity Damage Score

The commodity value index scores in this table are derived from Australian Bureau of Statistics 2005 – 2006 data. The values will require updating if significant change has occurred in the value of the commodity (Bomford 2008).

Industry	Commodity Value Index 1 (CVI based on best available date)	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			
Cereal grain (includes wheat, barley sorghum etc)	8	1	2	16
Sheep (includes wool and sheep meat)	5			
Fruit (includes wine grapes)	4	3	3	36
Vegetables	3	2	3	18
Poultry and eggs	2	1	2	4
Aquaculture (includes coastal mariculture)	2			
Oilseeds (includes canola, sunflower etc)	1	1	2	1
Grain legumes (includes soybeans)	1	1	2	2
Sugarcane	1	1	3	3
Cotton	1			
Other crops and horticulture (includes nuts tobacco and flowers etc)	1	2	2	4
Pigs	1			
Other livestock (includes goats, deer, camels, rabbits)	0.5			
Bees (included honey, beeswax and pollination)	0.5			
Total Commodity Damage Score (TCDS)				84

NB The Commodity Value Index scores in this table are derived from Australian Bureau of Statistics 2005–2006 data and will need to be updated if these values change significantly.

Assess Potential Commodity Impact Scores for each primary production commodity listed in Table 9, based on species' attributes (diet, behaviour, ecology), excluding risk of spreading disease which is addressed in Question C9, and pest status worldwide as:

0. *Nil (species does not have attributes to make it capable of damaging this commodity)*
1. *Low (species has attributes making it capable of damaging this or similar commodities and has had the opportunity but no reports or other evidence that it has caused damage in any country or region*
2. *Moderate–serious (reports of damage to this or similar commodities exist 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)*
3. *Extreme (damage occurs 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).*

Climate Match to Commodity Score (0–5)

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

Table 3: Assigning species to EIC Threat Categories (shaded cells relate to assignment of reptiles and amphibians to EIC Threat Categories based on an assessed establishment risk and an allocated pest risk of extreme) – adapted from Bomford 2008

Establishment Risk	Pest Risk	Public Safety Risk	EIC Threat Category	Implication for any proposed import into Australia	Implication for keeping and movement in Australia
Extreme	Extreme	Highly, Moderately or Not Dangerous	EXTREME	Prohibited, unless sufficient risk management measures exist to reduce the potential risks to an acceptable level	Limited to those collections approved for keeping particular EXTREME Threat species
Extreme	Serious	Highly, Moderately or Not Dangerous	EXTREME		
Extreme	Moderate	Highly, Moderately or Not Dangerous	EXTREME		
Extreme	Low	Highly, Moderately or Not Dangerous	EXTREME		
Serious	Extreme	Highly, Moderately or Not Dangerous	EXTREME		
Serious	Serious	Highly, Moderately or Not Dangerous	EXTREME		
Moderate	Extreme	Highly, Moderately or Not Dangerous	EXTREME		
Serious	Moderate	Highly, Moderately or Not Dangerous	SERIOUS	Import restricted to those collections approved for keeping SERIOUS Threat species	Limited to those collections approved for keeping particular SERIOUS Threat species
Serious	Low	Highly, Moderately or Not Dangerous	SERIOUS		
Moderate	Serious	Highly, Moderately or Not Dangerous	SERIOUS		
Moderate	Moderate	Highly Dangerous	SERIOUS		
Moderate	Low	Highly Dangerous	SERIOUS		
Low	Extreme	Highly, Moderately or Not Dangerous	SERIOUS		
Low	Serious	Highly, Moderately or Not Dangerous	SERIOUS		
Low	Moderate	Highly Dangerous	SERIOUS		
Low	Low	Highly Dangerous	SERIOUS		
Moderate	Moderate	Moderately or Not Dangerous	MODERATE	Import restricted to those collections approved for keeping MODERATE Threat species	Limited to those collections approved for keeping particular MODERATE Threat species
Moderate	Low	Moderately or Not Dangerous	MODERATE		
Low	Moderate	Moderately or Not Dangerous	MODERATE		
Low	Low	Moderately Dangerous	MODERATE		
Low	Low	Not Dangerous	LOW	Import permitted	May be limited to those collections approved for keeping particular LOW Threat species
Any Value	Any Value	Unknown	EXTREME until proven otherwise	Prohibited, unless sufficient risk management measures exist to reduce the potential risks to an acceptable level	Limited to those collections approved for keeping particular EXTREME Threat species
Unknown	Any Value	Any Value	EXTREME until proven otherwise		
Any Value	Unknown	Any Value	EXTREME until proven otherwise		
Unassessed	Unassessed	Unassessed	EXTREME until proven otherwise		

Adapted from:	Jensz, K. and Finley, L. (2012) Species profile for *Papio hamadryus*. Latitude 42 Environmental Consultants Pty Ltd. Hobart, Tasmania. Tasmanian Government Risk Assessment Nov 2014	By: Jodi Buchecker	Date: Oct 2020

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National Risk Assessment: EXTREME

RISK ASSESSMENT FOR AUSTRALIA: **Red-billed Quelea (*Quelea quelea*)**

Class - Aves**, Order** - Passeriformes**, Family** - Ploceidae**, Genus** - *Quelea*.

SPECIES: *Quelea quelea* (Linnaeus, 1758) **Synonyms:** *Ploceus aethiopicus* (Sundevall, 1850) *Loxia lathamii* (Smith, 1836) *Quelea quelea spoliator* (Clancey, 1960) *Quelea quelea intermedia* (Reichenow, 1886) **Subspecies:** *Quelea quelea aethiopic* (Sundevall, 1850) *Quelea quelea lathamii* (Smith, 1836) *Quelea quelea quelea* (Linnaeus, 1758) **Common Names:** Red-billed Quelea Common Quelea African Weaver Bird African Weaver Finch Common Dioch	**Species description:** Red-billed queleas are approximately 12.5 centimetres long and weigh 15–20 grams. They are mostly brown, with conical, red bills and legs. Juveniles have a pale brown bill. During the breeding season, the females' bill colour changes from red to a waxy bright yellow and males have a bright red bill. Male breeding plumage is colourful and variable, comprising a facial mask ringed with pink or dull yellow (which ranges from black to white) and breast and crown plumage that varies from yellow to bright red. After the breeding season, males revert to plain brown plumage (Burton & Burton, 2002; Sinclair et al., 2005). **General information:** Red-billed queleas inhabit tropical and subtropical seasonally dry savannahs, grasslands, woodlands and croplands, at altitudes below 2,000 metres. During the breeding season, they prefer thorny or spiny vegetation such as *Acacia* savannahs and lowveld areas, generally at altitudes less than 1,000 metres (Mundy & Herremans, undated; Sinclair et al., 2005). Red-billed queleas can be ten times more abundant in agricultural lands compared with natural grasslands (Berruti, 2000). Individual queleas do not present a direct threat to human safety. However, huge flocks can devastate cereal crops and have serious impacts in poor parts of Africa. Red-billed queleas are generalist granivores, feeding on seeds from native annual grasses. They have also been known to feed on crushed maize from cattle feedlots. Red-billed quelea colonies feed intensively and each bird will consume its weight in seeds each day. They can move 48–64 kilometres in a single day to feed and then return to their roost at night (Burton & Burton, 2002). With the first rains, red-billed queleas migrate to dry areas that still have ungerminated grass seeds. As the rain-front progresses, the red-billed queleas move ahead of it and continue feeding in dry areas with grass seeds. When all dry areas have received rain, they migrate back to the first area that received rain. By that time, the grass seeds have germinated and produced more seeds. Caterpillars, grasshoppers and insects have also emerged. The queleas will then breed. If the season is favourable, they will move to new areas, starting a new breeding cycle each time (Cheke et al., 2007). During the breeding season, hatchlings are initially fed caterpillars, grasshoppers and other insects, before being fed grass seeds (Berruti, 2000; Cheke, undated; Erickson, 1979).

Black-faced Dioch Sudan Dioch	Red-billed queleas are nomadic birds, forming huge colonies up to 30 million individuals (Jungle Photos, 2006). The breeding season begins with the onset of seasonal rains. Nests are often built in *Acacia* trees in or near a swamp. A single colony may comprise millions of nests, with 500 nests per tree. Breeding colonies exhibit biological synchrony with millions of eggs hatching on the same day. If the dry season starts early, a breeding colony may be abandoned. Alternatively, if the rainy season is prolonged, then several more clutches of eggs are laid (Answers.com, 2008; Burton & Burton, 2002; Shugart, 2007). The red-billed quelea may breed several times in the same season, depending on local food supply with 1–2-year intervals between breeding seasons. They lay 1-5 eggs (an average of 3 are laid), with an incubation period between 10-12 days. **Longevity:** 2-3 years **Conservation status:** **IUCN:** The IUCN lists queleas as a Species of Least Concern (IUCN, 2004). **CITES:** Not Listed. The quelea ranks as one of the world's most abundant wild birds and has a breeding population in excess of 1.5 billion (Jungle Photos, 2006).
DATE OF ASSESSMENT: 5/09/2008 **DATE OF CURRENT ASSESSMENT:** Nov 2020 (Jodi Buchecker) **EIC ENDORSEMENT:** 15/03/21 **Risk assessment model used for the assessment:** Bomford 2006, Mammals and Birds	**The risk assessment model:** Models for assessing the risk that exotic vertebrates could establish in Australia have been developed for mammals, birds (Bomford 2003, 2006, 2008), reptiles and amphibians (Bomford et al 2005, Bomford 2008). Developed by Dr Mary Bomford for the Bureau of Rural Sciences (BRS), the model uses criteria that have been demonstrated to have significant correlation between a risk factor and the establishment of populations of exotic species and the pest potential of those species that do establish. For example, a risk factor for establishment is similarity in climate (temperature and rainfall) within the species' distribution overseas and Australia. For pest potential, the species' overseas pest status is a risk factor. The model is published as 'Risk assessment models for the establishment of exotic vertebrates in Australia and New Zealand' (Bomford 2008) and is available online on the PestSmart website https://pestsmart.org.au/wp-content/uploads/sites/3/2020/06/Risk_Assess_Models_2008_FINAL.pdf **CLIMATE**: In 2021 a new version of the Climatch program used to assess similarity in climate was released by the Australian Bureau of Agricultural Resource Economics and Sciences (ABARES): CLIMATCH v2.0. The increase in resolution in this new version (from 50 km to 20 km) required recalibration of Climate Match Scores. See Table 1. Sixteen climate parameters (variables) of temperature and rainfall are

| | used to estimate the extent of similarity between data from meteorological stations located within the species' world distribution and stations in Australia. Worldwide, data from approximately 19000 locations are available for analysis. The number of locations used in an analysis will vary according to the size of the species' distribution and the number of meteorological stations located within that distribution. To represent the climate match visually, the map of Australia is divided into 19236 grid squares, each measured in 0.2 degrees in both longitude and latitude.
CLIMATCH v2.0 calculates a match for each Australian grid by comparing data from all meteorological stations within the species' distribution (excluding any populations in Australia) and allocating a score ranging from ten for the highest level match to zero for the poorest match. Levels of climate match are used in the risk assessment for questions B1 (scores are summed to give a cumulative score), C6, and C8. Climatch v2.0 can be accessed on the ABARES website, agriculture.gov.au/abares. The direct URL is https://climatch.cp1.agriculture.gov.au/. |
|---|---|

Bird and Mammal Model:

FACTOR	SCORE	DETAIL
STAGE A: RISKS POSED BY CAPTIVE OR RELEASED ANIMALS		
A1. Risk to people from individual escapees (0–2) *Assess the risk that individuals of the species could harm people. (NB, this question only relates to aggressive behaviour shown by escaped or released individual animals. Question C11 addresses the risk of harm from aggressive behaviour if the species establishes a wild population).* *Aggressive behaviour, size, plus the possession of organs capable of inflicting harm, such as sharp teeth, claws, spines, a sharp bill, or toxin-delivering apparatus may enable individual animals to harm people. Any known history of the species attacking, injuring or killing people should also be taken into account. Assume the individual is not protecting nest or young.*	0	*All other animals posing a lower risk of harm to people (ie animals 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).*
A2. Risk to public safety from individual captive animals (0–2) *Assess the risk that irresponsible use of products obtained from captive individuals of the species (such as toxins) pose a public safety risk (excluding the safety of anyone entering the animals' cage/enclosure or otherwise coming within reach of the captive animals)*	0	*Nil or low risk (highly unlikely or not possible).*

STAGE A PUBLIC SAFETY RISK SCORE **SUM A1 – A2 (0-4)**	0	**Not dangerous**

STAGE B: PROBABILITY ESCAPED OR RELEASED INDIVIDUALS WILL ESTABLISH FREE-LIVING POPULATIONS

Model 1: FOUR-FACTOR MODEL FOR BIRDS AND MAMMALS (BOMFORD 2008)

B1. Degree of climate match between species overseas range and Australia (1–6) *Map the selected mammal or bird species' overseas range, including its entire native and exotic (excluding Australia) ranges over the past 1000 years.* *Use CLIMATCH v2.0, CMS = sum of classes 6 – 10, see Table 1.*	5	*Very high climate match to Australia* Value X = 13,693 Climate Match Score = 5
B2. Exotic population established overseas (0–4) *An established exotic population means the introduced species must have bred outside of captivity and must currently maintain a viable free-living population where the animals are not being intentionally fed or sheltered, even though they may be living in a highly disturbed environment with access to non-natural food supplies or shelter.*	4	*Exotic population established on a larger island (> 50 000 km^2) or anywhere on a continent (including elsewhere on the land mass where the natural distribution of the animal is, if this population is due to human introduction and is geographically separate from the natural range of the species).* A self-perpetuating population on Réunion has been recorded. The birds have been present on the island since 2001, but how they reached the island is unknown, (although the cage-bird trade is suspected). Red-billed quelea have recently invaded the Western Cape of South Africa and bred there (Oschadleus, 2009).
B3. Overseas range size score (0–2) < 1 = 0; 1– 70 = 1; >70 = 2 *Estimate the species overseas range size* including currently and the past 11000 years; natural and introduced range in millions of square k1ilometres*	0	*Overseas range between 1 to 70 km^2.* Overseas range size of 12,701,906 km^2.
B4. Taxonomic Class (0–1)	1	*Bird.*

Bird=0; mammal = 1		
B. ESTABLISHMENT RISK SCORE **SUM OF B1- B4 (1–13)**	10	**Serious establishment risk**
Model 2: Seven-Factor Model For Birds And Mammals (Bomford 2008)		
B5. Diet score (0–1) *Specialist = 0; generalist = 1*	1	*Generalist with a broad diet of many food types.* The red-billed quelea has a generalist diet of grass seeds, cereals, grains and insects.
B6. Habitat score (0–1) *Undisturbed or disturbed habitat*	1	*Can survive and breed in human-disturbed habitats (including grazing and agricultural lands, forests that are intensively managed or planted for timber harvesting and/or urban–suburban environments) without access to undisturbed (natural) habitats.* Red-billed queleas adapt very well to human agricultural environments.
B7. Migratory score (0–1) *Always migratory = 0; non-migratory = 1*	1	*Facultative migrant in its native range.* The red-billed quelea is not always migratory and has been considered as being an opportunistic migrant (Long, 1995). In some areas the red-billed quelea is a resident but large-scale movements occur throughout range. In Western Africa, regular migration follows rain fronts (Birds of the World).
B. ESTABLISHMENT RISK SCORE **SUM OF B1- B7 (1–16)**	13	**Serious establishment risk**
STAGE C: PROBABILITY AN ESTABLISHED SPECIES WILL BECOME A PEST		
C1. Taxonomic group (0–4)	2	*Bird in one of the taxa that are particularly prone to cause agricultural damage (Ploceidae).*
C2. Overseas range size including current and past 1000 years, natural and introduced range (0–2) *Estimate the species overseas range size (including current and past 1000 years, natural and introduced range) in millions of square kilometres*	1	*Overseas geographic range 10–30 million square kilometres.* Overseas range size of the red-billed quelea is estimated to be 12,701,906 km^2.

C3. Diet and feeding (0–3)	0	*Not a mammal.*
C4. Competition with native fauna for tree hollows (0–2)	0	*Does not use tree hollows.*
C5. Overseas environmental pest status (0–3) *Has the species been reported to cause declines in abundance of any native species of plant or animal or cause degradation to any natural communities in any country or region of the world?*	1	*Minor environmental pest in any country or region.* The red-billed quelea is a minor environmental pest throughout eastern and southern Africa. The red-billed quelea causes damage to trees when high numbers congregate at roosts, denuding trees and breaking branches (Greyling, 1995). The red-billed quelea may be influential in the destruction and creation of *Acacia* bush, as their nitrogen-rich droppings promote grass growth but also raise fertility levels above those tolerated by trees. Negative environmental impacts occur as a result of the control methods used against the red-billed quelea.
C6. Climate match to areas with susceptible native species or communities (0–5) *Identify any native Australian animal or plant species or communities that could be susceptible to harm by the exotic species if it were to establish a wild population here.*	5	*The species has more than 138 grid squares within the highest two climate match classes, and/or has more than 691 grid squares within the four highest climate match classes, that overlap the distribution of any susceptible native species or communities = 5* Examples of susceptible native species or ecological communities (DAWE Protected Matters Search Tool) include: Brigalow (*Acacia harpophylla* dominant and co-dominant) – Least Concern *Poephila cincta* (Southern Black-throated Finch) – Least Concern
C7. Overseas primary production pest status (0–3) *Has the species been reported to damage crops or other primary production in any country or region of the world?*	3	*Major pest of primary production in any country or region.* Major pest of primary production in eastern and southern Africa.
C8. Climate match to susceptible primary production (0–5) *Assess Potential Commodity Impact Scores for each primary production commodity listed in Table 9, based on species' attributes (diet, behaviour, ecology), excluding risk of spreading disease which is addressed in Question C9.*	5	Total Commodity Damage Score = 165 (see Table 2)

0 = 0; 1-19 = 1; 20-49 = 2; 50-99 = 3; 100-149 = 4; ≥150 = 5		
C9. Spread disease (1–2) *Assess the risk that the species could play a role in the spread of disease or parasites to other animals*	2	*All birds (likely or unknown effect on native species and on livestock and other domestic animals).*
C10. Harm to property (0–3) *Assess the risk that the species could inflict damage on buildings, vehicles, fences, roads, equipment or ornamental gardens by chewing or burrowing or polluting with droppings or nesting material.*	0	*$0.*
C11. Harm to people (0–5) *Assess the risk that, if a wild population established, the species could cause harm to or annoy people. Aggressive behaviour, plus the possession of organs capable of inflicting harm, such as sharp teeth, tusks, claws, spines, a sharp bill, horns, antlers or toxin delivering organs may enable animals to harm people. Any known history of the species attacking, injuring or killing people should also be taken into account (see Stage A, Score A1).*	2	*Injuries, harm or annoyance likely to be minor and few people exposed: Low risk.* The red-billed quelea can be considered as a social nuisance.
C. PEST RISK SCORE **SUM C 1 TO C 11 (1–37)**	21	**Extreme pest risk**
STAGE A. PUBLIC SAFETY RISK RANK – RISK TO PUBLIC SAFETY POSED BY CAPTIVE OR RELEASED INDIVIDUALS *0 = Not dangerous; 1 = Moderately dangerous; ≥ 2 = Highly dangerous*	0	Not dangerous
STAGE B. ESTABLISHMENT RISK RANK – RISK OF ESTABLISHING A WILD POPULATION MODEL 1: FOUR-FACTOR MODEL FOR BIRDS AND MAMMALS (BOMFORD 2008)	10	Serious establishment risk

≤ 5 = low establishment risk; 6-8 = moderate establishment risk; 9-10 = serious establishment risk; ≥ 11-13 = extreme establishment risk		
STAGE B. ESTABLISHMENT RISK RANK – RISK OF ESTABLISHING A WILD POPULATION **MODEL 2: SEVEN-FACTOR MODEL FOR BIRDS AND MAMMALS (BOMFORD 2008)** *≤ 6 = low establishment risk; 7-11 = moderate establishment risk; 12-13 = serious establishment risk; ≥14 = extreme establishment risk*	13	Serious establishment risk
STAGE C. PEST RISK RANK - RISK OF BECOMING A PEST FOLLOWING ESTABLISHMENT *< 9 = low pest risk; 9-14 = moderate pest risk; 15-19 = serious pest risk; > 19 = extreme pest risk*	21	Extreme pest risk

ENVIRONMENT AND INVASIVES COMMITTEE THREAT CATEGORY	**EXTREME**

World distribution map (IUCN Red List) and World distribution map indicating where meteorological data was sourced for the climate analysis (see B1):
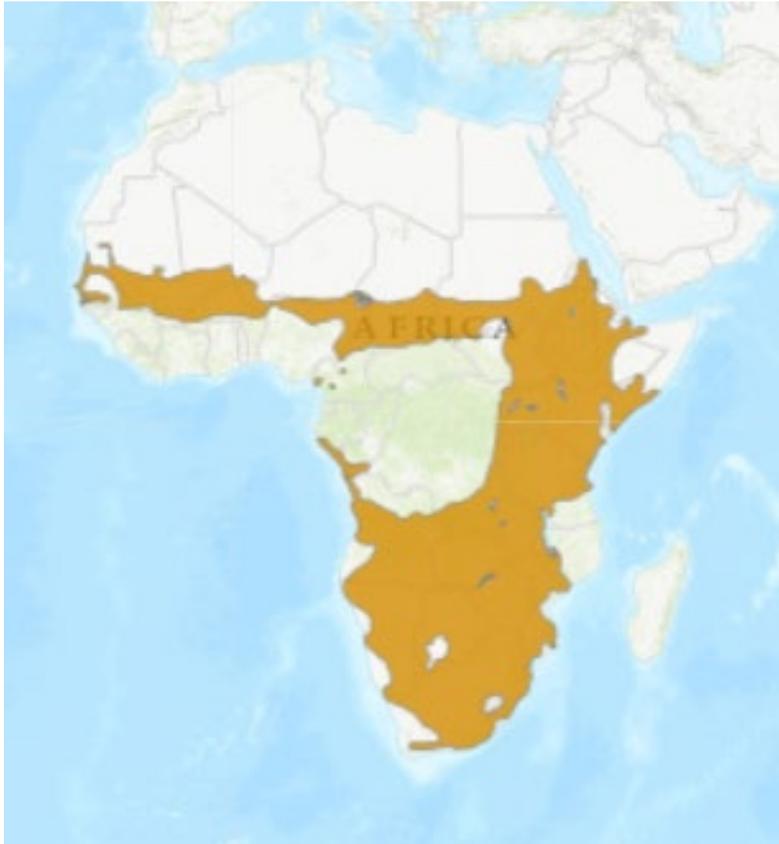

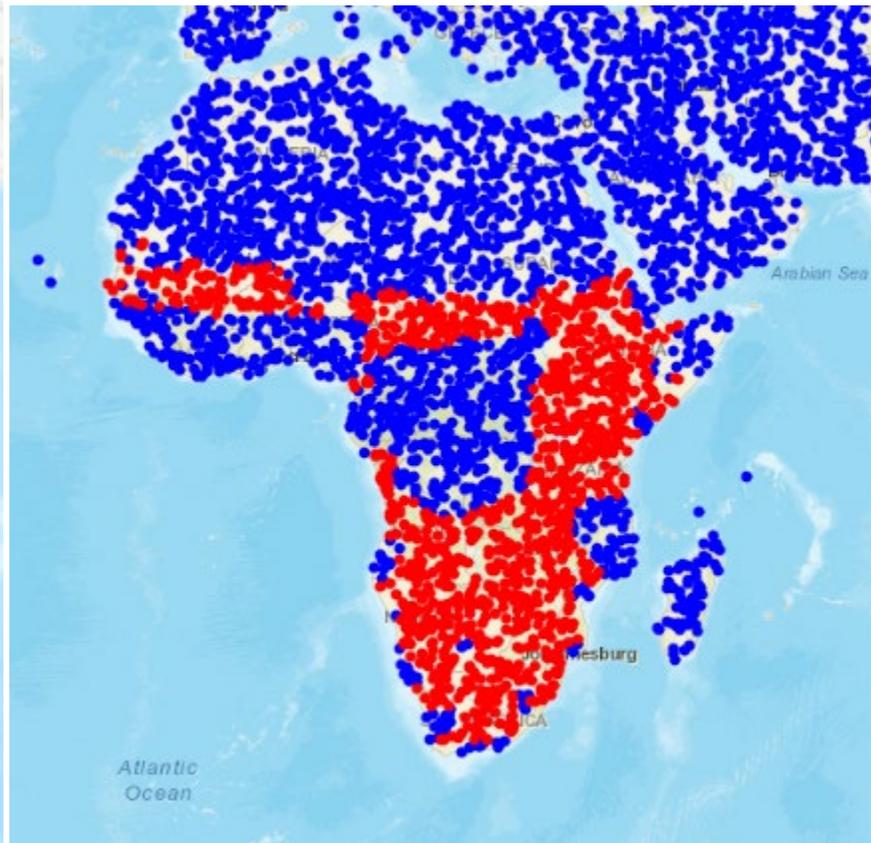*Figure 1 - World Distribution Map - IUCN Red List*
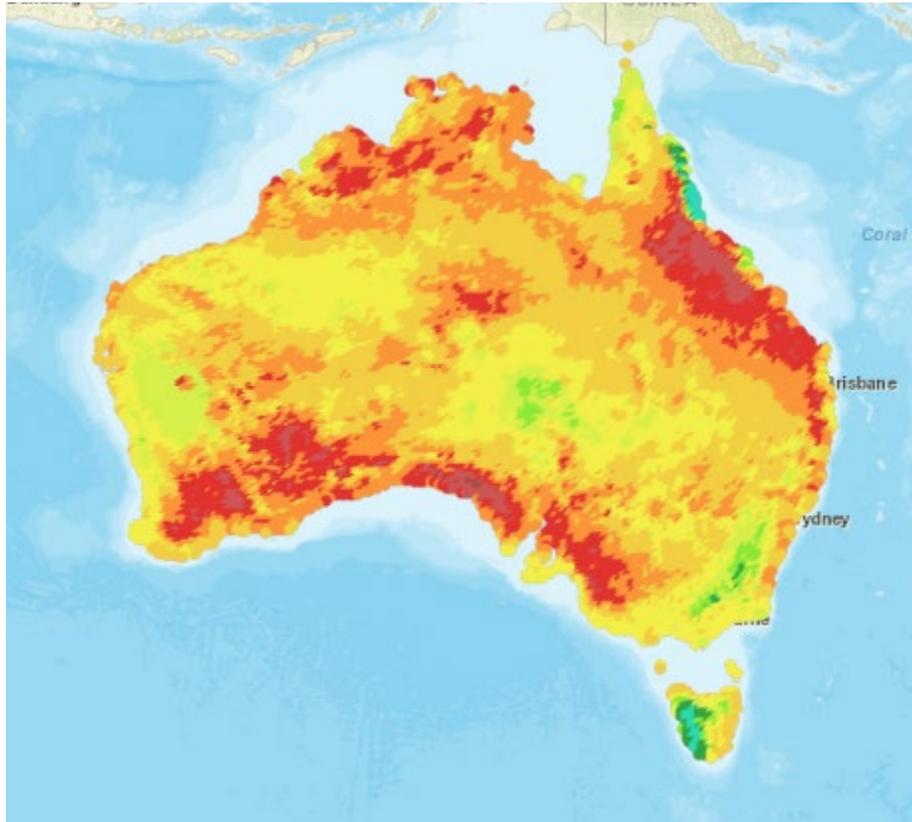
Figure 2 - World Distribution Map - Climatch

Climate match between world distribution of species and Australia:
Areas of Australia where the climate appears suitable for *Quelea quelea*
CMS = 13,697

Score	Color	Count
0		0
1		47
2		61
3		202
4		1037
5		4192
6		6842
7		4475
8		1918
9		453
10		9

Species: Quelea quelea (red-billed quelea)
Algorithm: Closest Standard Score
1117 source features selected
19236 target features selected
Approximate selected area: 12,701,906 km^2

Table 1: ABARES recalibration thresholds

Climate Match Score (CMS)	Current Bomford 2008 model classes (50 km)	Recalibrated classes to Climatch v2.0 (20 km)
1 (Very low)	< 100	< 691
2 (Low)	100-599	691-4137
3 (Moderate)	600-899	4138-6209
4 (High)	900-1699	6210-11735
5 (Very high)	1700-2699	11736-18642
6 (Extreme)	≥ 2700	≥ 18643

Table 2: Susceptible Australian Primary Production – Calculating Total Commodity Damage Score
The commodity value index scores in this table are derived from Australian Bureau of Statistics 2005 – 2006 data. The values will require updating if significant change has occurred in the value of the commodity (Bomford 2008).

Industry	Commodity Value Index 1 (CVI based on best available date)	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			
Cereal grain (includes wheat, barley sorghum etc)	8	3	5	120
Sheep (includes wool and sheep meat)	5			
Fruit (includes wine grapes)	4			
Vegetables	3			
Poultry and eggs	2			
Aquaculture (includes coastal mariculture)	2			
Oilseeds (includes canola, sunflower etc)	1	3	5	15
Grain legumes (includes soybeans)	1	3	5	15
Sugarcane	1			
Cotton	1			
Other crops and horticulture (includes nuts tobacco and flowers etc)	1	3	5	15
Pigs	1			
Other livestock (includes goats, deer, camels, rabbits)	0.5			
Bees (included honey, beeswax and pollination)	0.5			
Total Commodity Damage Score (TCDS)				165

NB The Commodity Value Index scores in this table are derived from Australian Bureau of Statistics 2005–2006 data and will need to be updated if these values change significantly.

Assess Potential Commodity Impact Scores for each primary production commodity listed in Table 9, based on species' attributes (diet, behaviour, ecology), excluding risk of spreading disease which is addressed in Question C9, and pest status worldwide as:

0. *Nil (species does not have attributes to make it capable of damaging this commodity)*
1. *Low (species has attributes making it capable of damaging this or similar commodities and has had the opportunity but no reports or other evidence that it has caused damage in any country or region*
2. *Moderate–serious (reports of damage to this or similar commodities exist 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)*
3. *Extreme (damage occurs 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).*

Climate Match to Commodity Score (0–5)

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

Table 3: Assigning species to EIC Threat Categories (shaded cells relate to assignment of reptiles and amphibians to EIC Threat Categories based on an assessed establishment risk and an allocated pest risk of extreme) – adapted from Bomford 2008

Establishment Risk	Pest Risk	Public Safety Risk	EIC Threat Category	Implication for any proposed import into Australia	Implication for keeping and movement in Australia
Extreme	Extreme	Highly, Moderately or Not Dangerous	EXTREME	Prohibited, unless sufficient risk management measures exist to reduce the potential risks to an acceptable level	Limited to those collections approved for keeping particular EXTREME Threat species
Extreme	Serious	Highly, Moderately or Not Dangerous	EXTREME		
Extreme	Moderate	Highly, Moderately or Not Dangerous	EXTREME		
Extreme	Low	Highly, Moderately or Not Dangerous	EXTREME		
Serious	Extreme	Highly, Moderately or Not Dangerous	EXTREME		
Serious	Serious	Highly, Moderately or Not Dangerous	EXTREME		
Moderate	Extreme	Highly, Moderately or Not Dangerous	EXTREME		
Serious	Moderate	Highly, Moderately or Not Dangerous	SERIOUS	Import restricted to those collections approved for keeping SERIOUS Threat species	Limited to those collections approved for keeping particular SERIOUS Threat species
Serious	Low	Highly, Moderately or Not Dangerous	SERIOUS		
Moderate	Serious	Highly, Moderately or Not Dangerous	SERIOUS		
Moderate	Moderate	Highly Dangerous	SERIOUS		
Moderate	Low	Highly Dangerous	SERIOUS		
Low	Extreme	Highly, Moderately or Not Dangerous	SERIOUS		
Low	Serious	Highly, Moderately or Not Dangerous	SERIOUS		
Low	Moderate	Highly Dangerous	SERIOUS		
Low	Low	Highly Dangerous	SERIOUS		
Moderate	Moderate	Moderately or Not Dangerous	MODERATE	Import restricted to those collections approved for keeping MODERATE Threat species	Limited to those collections approved for keeping particular MODERATE Threat species
Moderate	Low	Moderately or Not Dangerous	MODERATE		
Low	Moderate	Moderately or Not Dangerous	MODERATE		
Low	Low	Moderately Dangerous	MODERATE		
Low	Low	Not Dangerous	LOW	Import permitted	May be limited to those collections approved for keeping particular LOW Threat species
Any Value	Any Value	Unknown	EXTREME until proven otherwise	Prohibited, unless sufficient risk management measures exist to reduce the potential risks to an acceptable level	Limited to those collections approved for keeping particular EXTREME Threat species
Unknown	Any Value	Any Value	EXTREME until proven otherwise		
Any Value	Unknown	Any Value	EXTREME until proven otherwise		
Unassessed	Unassessed	Unassessed	EXTREME until proven otherwise		

Adapted from:	Anna Markula, Martin Hannan-Jones and Steve Csurhes (First published 2009, updated 2016) 'Red-billed quelea Risk Assessment' for Queensland Government	By: Jodi Buchecker	Date: Nov 2020

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National Risk Assessment: MODERATE

RISK ASSESSMENT FOR AUSTRALIA: **Black-capped capuchin (*Sapajus apella*)**

Class - Mammalia**, Order** - Primates**, Family** - Cebidae**, Genus** - *Sapajus***.**

SPECIES:	Species description:
Sapajus apella (Linnaeus, 1758)	The black-capped capuchin is a medium-sized arboreal primate. The black-capped capuchin is recognized by its characteristic head coloration, a black or dark brown cap with dark sideburns. On either side of the dark cap on the head there are tufts of dark fur. The shoulders are paler than the back, which ranges from shades of yellow to red-brown and is darkest in the middle of the back. The legs, hands, and tail are darker than the rest of its fur. The face can range from brown to pink (Groves, 2001 cited in Gron, 2009). There is significant variation in face colour, even among members of the same group but adult males tend to be darker than females (Emmons & Freer, 1997 cited in Gron, 2009).
Synonyms:	
Cebus apella (Linnaeus, 1758)	
Sapajus macrocephalus (Spix, 1823)	
Cebus apella fatuellus (Linnaeus, 1766)	
Cebus apella macrocephalus (Spix, 1823)	
Cebus apella peruanus (Thomas, 1901)	
Cebus apella tocantinus (Lönnberg, 1939)	Adult males have an average head-body length of 444 millimetres and females average 390 millimetres. The tail is relatively short, thick and is similar in length to the length of the body. The tail assists the black-capped capuchin with stability and facilitates its ability to change direction. Wild adult males average 3.65 kilograms, and wild adult females average 2.52 kilograms. Captive capuchins may be considerably heavier, with males averaging 6.09 kilograms and females 3.19 kilograms (Jack, 2007).
Cebus capillatus (Gray, 1865)	
Cebus cirrifer (É. Geoffroy Saint-Hilaire, 1812)	
Cebus crassiceps (Pucheran, 1857)	
Cebus cristatus (Cuvier, 1829)	
Cebus frontatus (Kuhl, 1820)	**General information:**
Cebus leucogenys (Gray, 1866)	The heart of the black-capped capuchin's home range is the northwestern half of Brazil and the Amazon basin, extending as far west as the eastern foothills of the Andes Mountain chain south into Peru. The southern limit in Brazil appears to be limited by the bush savannah of central Brazil (Rylands et al., 2005). The black-capped capuchin inhabits a wide variety of tropical and sub-tropical vegetation communities and is flexible in its choice of habitat (Rylands *et al.*, 2008). It is common in a wide range of forest and woodland habitat including high rain forest, low rain forest, riverbank high forest, mountain savannah forest, liana forest, marsh forest and mangrove forest (Rylands et al.*,* 2008). They are typically found in the lower to mid-canopy and understorey (Fragaszy et al., 2004).
Cebus lunatus (Kuhl, 1820)	
Cebus monachus (Cuvier, 1820)	
Cebus niger (É. Geoffroy Saint-Hilaire, 1812)	
Cebus subcristatus (Gray, 1865)	
Simia variegata (Humboldt, 1812)	
Cebus azarae (Rengger, 1830)	The black-capped capuchin is omnivorous. Its diet contains a large variety of insects, fruits, leaves, nectar, nuts, and pith. Foods exploited by black-capped capuchins vary widely with habitat as well as with the seasons (Gron, 2009). In the dry season, when food is often scarce, the black-capped capuchin
Cebus versuta (Elliot, 1910)	
Cebus apella magnus (Pusch, 1941)	
Cebus apella maranonis (Pusch, 1941)	

Cebus apella chacoensis (Pusch, 1941)
Cebus libidinosus juruanus (Lönnberg, 1939)
Cebus apella morrulus (Pusch, 1941)
Cebus libidinosus pallidus (Gray, 1866)
Cebus libidinosus paraguayanus (Fischer, 1829)
Cebus libidinosus sagitta (Pusch, 1941)

Subspecies:
Guianan Brown Capuchin
Cebus apella apella (Linnaeus, 1758)
Sapajus apella apella (Linnaeus, 1758)

Margarita Capuchin
Cebus apella margaritae (Hollister, 1914)
Sapajus apella margaritae (Hollister, 1914)
(Rylands *et al*. 2005)

Common Names:
Tufted Capuchin
Black-capped Capuchin
Guianan Black-capped capuchin
Black-capped Capuchin
Margarita Island Capuchin

Known hybrids:
Natural hybrids of the black-capped capuchin and other capuchin species (Humboldt's white-fronted capuchin (*Cebus albifrons*), Colombian white-faced capuchin (*Cebus capucinus*) and Wedge-

relies on palm nuts and pith. Other animal prey consumed by the black-capped capuchin includes vertebrates such as frogs, lizards and birds (Gron, 2009).

The black-capped capuchin is diurnal. Capuchins spend most of the day foraging in groups for food, with a rest in the middle of the day. Depending on habitat, home range size of the black-capped capuchin ranges from 0.5 square kilometres (Robinson & Janson, 1986 cited in Gron, 2009) to 9 square kilometres (Spironello, 2001 cited in Gron, 2009). Average daily travel distance for a black-capped capuchin is around 2.1 kilometres (Janson in prep. cited in Robinson & Janson, 1986 cited in Gron, 2009). Black-capped capuchins are considered a pest in tropical conifer plantation forestry. In Brazil, the black-capped capuchin feeds on the bark of the introduced species loblolly pine (*Pinus taeda*) and slash pine (*Pinus elliottii*). During their feeding, the black-capped capuchin will often ring bark and kill the upper crowns of pines. Similar damage has been observed in plantations of the Brazilian pine, *Araucaria angustifolia* (FAO, 2007).

Capuchins will feed on agricultural crops, including orchard fruits, sugar cane (*Saccharum officinarum*), maize (*Zea mays*) and cassava (*Manihot esculenta*), particularly where their habitat has been fragmented or where natural fruit sources are low (Rocha et al., 2007; de Freitas et al., 2008).

Black-capped capuchin groups are often small, numbering in the teens or lower twenties with only 1 to several adult males and around the same number of adult females (Izawa, 1980; Defler, 1982). Birth season varies by locale and reflects the differential rainfall, food availability and photoperiod of the habitat (Carosi et al., 2005). In the wild, females attain reproductive maturity at around 4 years of age but in captivity this number is around 5 years. In captivity, males are fertile by about 4.5 years of age (Fragaszy & Adams-Curtis, 1998; Carosi et al. 2005). Females bear 1 young (twin births have been recorded) every 2 years. Because females produce offspring only about once every 2 years, it is assumed that complete weaning takes place into the second year as having a dependent infant precludes reproduction at the 1 year mark (Gron, 2009).

Black-capped capuchins are not regarded as a serious threat to human safety. However, they are capable of unprovoked attacks, and their sharp teeth may cause injuries requiring medical care. Capuchins have the capacity to transmit a number of diseases to humans.

Longevity:
In captivity, individuals have reached an age of 45 years, although life expectancy for individuals in wild populations is only 15 to 25 years (Gron, 2009).

cappped capuchin (*Cebus olivaceus*) are known to occur (Torres de Caballero, 1976). Hybridisation for the pet trade is considered common (Ceballus-Mago *et al.*, 2010).	**Conservation status:** **IUCN:** currently listed as a species of 'Least Concern' under the IUCN Red List (Rylands *et al.,* 2008). **CITES:** listed on Appendix II of CITES.
DATE OF ORIGINAL ASSESSMENT: March 2011 **DATE OF CURRENT ASSESSMENT:** Nov 2020 (Jodi Buchecker) **EIC ENDORSEMENT:** 15/03/21 **Risk assessment model used for the assessment:** Bomford 2008, Mammals and Birds	**The risk assessment model:** Models for assessing the risk that exotic vertebrates could establish in Australia have been developed for mammals, birds (Bomford 2003, 2006, 2008), reptiles and amphibians (Bomford et al 2005, Bomford 2008). Developed by Dr Mary Bomford for the Bureau of Rural Sciences (BRS), the model uses criteria that have been demonstrated to have significant correlation between a risk factor and the establishment of populations of exotic species and the pest potential of those species that do establish. For example, a risk factor for establishment is similarity in climate (temperature and rainfall) within the species' distribution overseas and Australia. For pest potential, the species' overseas pest status is a risk factor. The model is published as 'Risk assessment models for the establishment of exotic vertebrates in Australia and New Zealand' (Bomford 2008) and is available online on the PestSmart website https://pestsmart.org.au/wp-content/uploads/sites/3/2020/06/Risk_Assess_Models_2008_FINAL.pdf **CLIMATE**: In 2021 a new version of the Climatch program used to assess similarity in climate was released by the Australian Bureau of Agricultural Resource Economics and Sciences (ABARES): CLIMATCH v2.0. The increase in resolution in this new version (from 50 km to 20 km) required recalibration of Climate Match Scores. See Table 1. Sixteen climate parameters (variables) of temperature and rainfall are used to estimate the extent of similarity between data from meteorological stations located within the species' world distribution and stations in Australia. Worldwide, data from approximately 19000 locations are available for analysis. The number of locations used in an analysis will vary according to the size of the species' distribution and the number of meteorological stations located within that distribution. To represent the climate match visually, the map of Australia is divided into 19236 grid squares, each measured in 0.2 degrees in both longitude and latitude. CLIMATCH v2.0 calculates a match for each Australian grid by comparing data from all meteorological stations within the species' distribution (excluding any populations in Australia) and allocating a score ranging from ten for the highest level match to zero for the poorest match. Levels of climate match are used in the risk assessment for questions B1 (scores are summed to give a cumulative score), C6, and C8. Climatch v2.0 can be accessed on the ABARES website, agriculture.gov.au/abares. The direct URL is https://climatch.cp1.agriculture.gov.au/.

Bird and Mammal Model:		
FACTOR	**SCORE**	**DETAIL**

STAGE A: RISKS POSED BY CAPTIVE OR RELEASED ANIMALS		
A1. Risk to people from individual escapees (0–2) *Assess the risk that individuals of the species could harm people. (NB, this question only relates to aggressive behaviour shown by escaped or released individual animals. Question C11 addresses the risk of harm from aggressive behaviour if the species establishes a wild population).* *Aggressive behaviour, size, plus the possession of organs capable of inflicting harm, such as sharp teeth, claws, spines, a sharp bill, or toxin-delivering apparatus may enable individual animals to harm people. Any known history of the species attacking, injuring or killing people should also be taken into account. Assume the individual is not protecting nest or young.*	1	*Animal that can make unproved 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.* Black-capped capuchins are not regarded as dangerous but are capable of minor injuries.
A2. Risk to public safety from individual captive animals (0–2) *Assess the risk that irresponsible use of products obtained from captive individuals of the species (such as toxins) pose a public safety risk (excluding the safety of anyone entering the animals' cage/enclosure or otherwise coming within reach of the captive animals)*	0	*Nil or low risk (highly unlikely or not possible).* The risk to public safety from irresponsible use of products obtained from black-capped capuchins is low.
STAGE A PUBLIC SAFETY RISK SCORE ≥ 2 = Highly Dangerous 1 = Moderately Dangerous 0 = Not Dangerous **SUM A1 - A2 (0-4)**	1	**Moderately dangerous**

STAGE B: PROBABILITY ESCAPED OR RELEASED INDIVIDUALS WILL ESTABLISH FREE-LIVING POPULATIONS		
Model 1: FOUR-FACTOR MODEL FOR BIRDS AND MAMMALS (BOMFORD 2008)		
B1. Degree of climate match between species overseas range and Australia (1–6) *Map the selected mammal or bird species' overseas range, including its entire native and exotic (excluding Australia) ranges over the past 1000 years.* *Use CLIMATCH v2.0, CMS = sum of classes 6 – 10, see Table 1.*	1	*Very low climate match to Australia* Value X = 1 Climate Match Score = 417
B2. Exotic population established overseas (0–4) *An established exotic population means the introduced species must have bred outside of captivity and must currently maintain a viable free-living population where the animals are not being intentionally fed or sheltered, even though they may be living in a highly disturbed environment with access to non-natural food supplies or shelter.*	2	*Exotic populations only established on small islands (< 50 000 km^2; Tasmania is 67 800 km^2).* One record for first introduction to the Canaries in 2011 (EASIN, 2020)
B3. Overseas range size score (0–2) < 1 = 0; 1– 70 = 1; >70 = 2 *Estimate the species overseas range size* including currently and the past 1000 years; natural and introduced range in millions of square kilometres*	1	*Overseas range class of 1-70 million km^2.* The black-capped capuchin has an estimated range of 5 million km^2 which includes current and past 1,000 years, natural and introduced range. The black-capped capuchin is widely distributed throughout the Amazonian basin with a disjunct population occurring on the Venezuelan Island of Margarita.
B4. Taxonomic Class (0–1) Bird=0; mammal = 1	1	*Mammal*
B. ESTABLISHMENT RISK SCORE **SUM OF B1- B4 (1–13)**	5	**Low establishment risk**

Model 2: Seven-Factor Model For Birds And Mammals (Bomford 2008)

B5. Diet score (0–1) *Specialist = 0; generalist = 1*	1	*Generalist with a broad diet of many food types.* The black-capped capuchin is a generalist omnivore with a primarily frugivorous and insectivorous diet.
B6. Habitat score (0–1) *Undisturbed or disturbed habitat*	1	*Can survive and breed in human-disturbed habitats (including grazing and agricultural lands, forests that are intensively managed or planted for timber harvesting and/or urban–suburban environments) without access to undisturbed (natural) habitats.* The black-capped capuchin inhabits moist subtropical or tropical forest. It has also been seen in the dry forest, gallery forest and disturbed and secondary forest. In northwest Argentina these monkeys live in Montane Forest at an elevation of 200- 1,100 metres. This species prefers the under storey and mid-canopy of the forest but often descends from the trees to forge and play. The black-capped capuchin can live in disturbed habitats. The black-capped capuchin has the widest range and broadest habitat tolerances of any other *Sapajus* species (Forbes, Mackeith and Perberdy, 1984; Kinzey, 1989; Nowwak, 1991; Rowe, 1996).
B7. Migratory score (0–1) *Always migratory = 0; non-migratory = 1*	1	*Non-migratory.*
B. ESTABLISHMENT RISK SCORE **SUM OF B1- B7 (1–16)**	8	**Moderate establishment risk**

STAGE C: PROBABILITY AN ESTABLISHED SPECIES WILL BECOME A PEST		
C1. Taxonomic group (0–4)	0	*Not in one of the mammal orders that have been demonstrated to have detrimental effects on prey abundance and/or habitat degradation.*
C2. Overseas range size including current and past 1000 years, natural and introduced range (0–2) *Estimate the species overseas range size (including current and past 1000 years, natural and introduced range) in millions of square kilometre*	0	*Overseas geographic range class less than 10 million square kilometres.* The range of black-capped capuchins is estimated at 6.5 million km^2.

C3. Diet and feeding (0–3)	1	*Mammal that is a non-strict carnivore (mixed animal-plant matter in diet).* Brown capuchins are omnivorous, with a diet that consists of fruits, insects, leaves, nectar, nuts, and pith. Brown capuchins also eat small vertebrates such as birds, amphibians, lizards, and small primates (Gron, 2009).
C4. Competition with native fauna for tree hollows (0–2)	0	*Does not use tree hollows.* Black-capped capuchins do not use tree hollows but instead sleep in the forks of large trees (Gron, 2009).
C5. Overseas environmental pest status (0–3) *Has the species been reported to cause declines in abundance of any native species of plant or animal or cause degradation to any natural communities in any country or region of the world?*	0	*Never reported as an environmental pest in any country or region.* No black-capped capuchin populations are known to have caused environmental harm.
C6. Climate match to areas with susceptible native species or communities (0–5) *Identify any native Australian animal or plant species or communities that could be susceptible to harm by the exotic species if it were to establish a wild population here.*	3	*The species has 1-62 grid squares within the highest two climate match classes (ie in classes 10 and 9), and/or has 69-200 grid squares within the highest four climate match classes that overlap the distribution of any susceptible native species or ecological communities = 3* Examples of susceptible native species or ecological communities include (DAWE Protected Matters Search Tool): *Mixophyes balbus* (Stuttering Frog) – Vulnerable *Litoria aurea* (Green and Gold Bell frog) – Near Threatened
C7. Overseas primary production pest status (0–3) *Has the species been reported to damage crops or other primary production in any country or region of the world?*	1	*Minor pest of primary production in any country or region.* Black-capped capuchins may impact tropical plantation forestry and horticulture.

C8. Climate match to susceptible primary production (0–5) *Assess Potential Commodity Impact Scores for each primary production commodity listed in Table 9, based on species' attributes (diet, behaviour, ecology), excluding risk of spreading disease which is addressed in Question C9.* *0 = 0; 1-19 = 1; 20-49 = 2; 50-99 = 3; 100-149 = 4; ≥150 = 5*	0	Total Commodity Damage Score = 0 (see Table 2) Less than 1% of susceptible commodities are produced in areas where the species has a climate match within the highest eight climate match classes (ie classes 10,9,8,7,6,5,4 and 3) = 0.
C9. Spread disease (1–2) *Assess the risk that the species could play a role in the spread of disease or parasites to other animals*	2	*All mammals (likely or unknown effect on native species and on livestock and other domestic animals).*
C10. Harm to property (0–3) *Assess the risk that the species could inflict damage on buildings, vehicles, fences, roads, equipment or ornamental gardens by chewing or burrowing or polluting with droppings or nesting material.*	0	*$0.* No records that the black-capped capuchin will damage property as they are a small animal.
C11. Harm to people (0–5) *Assess the risk that, if a wild population established, the species could cause harm to or annoy people. Aggressive behaviour, plus the possession of organs capable of inflicting harm, such as sharp teeth, tusks, claws, spines, a sharp bill, horns, antlers or toxin delivering organs may enable animals to harm people. Any known history of the species attacking, injuring or killing people should also be taken into account (see Stage A, Score A1).*	2	*Low; injuries, harm or annoyance likely to be minor and few people exposed.* Black-capped capuchins have the potential to cause harm to people through biting and the transmission of disease. However, any injuries or harm are likely to be minor.
C. PEST RISK SCORE **SUM C 1 TO C 11 (1–37)**	9	**Moderate pest risk**
STAGE A. PUBLIC SAFETY RISK RANK – RISK TO PUBLIC SAFETY POSED BY CAPTIVE OR RELEASED INDIVIDUALS	1	Moderately dangerous

0 = Not dangerous; 1 = Moderately dangerous; ≥ 2 = Highly dangerous		
STAGE B. ESTABLISHMENT RISK RANK – RISK OF ESTABLISHING A WILD POPULATION MODEL 1: FOUR-FACTOR MODEL FOR BIRDS AND MAMMALS (BOMFORD 2008) *≤ 5 = low establishment risk; 6-8 = moderate establishment risk; 9-10 = serious establishment risk; ≥ 11-13 = extreme establishment risk*	5	Low establishment risk
STAGE B. ESTABLISHMENT RISK RANK – RISK OF ESTABLISHING A WILD POPULATION MODEL 2: SEVEN-FACTOR MODEL FOR BIRDS AND MAMMALS (BOMFORD 2008) *≤ 6 = low establishment risk; 7-11 = moderate establishment risk; 12-13 = serious establishment risk; ≥14 = extreme establishment risk*	8	Moderate establishment risk
STAGE C. PEST RISK RANK - RISK OF BECOMING A PEST FOLLOWING ESTABLISHMENT *< 9 = low pest risk; 9-14 = moderate pest risk; 15-19 = serious pest risk; > 19 = extreme pest risk*	9	Moderate pest risk

ENVIRONMENT AND INVASIVES COMMITTEE THREAT CATEGORY	**MODERATE**

World distribution map (IUCN Red List) and World distribution map indicating where meteorological data was sourced for the climate analysis (see B1):

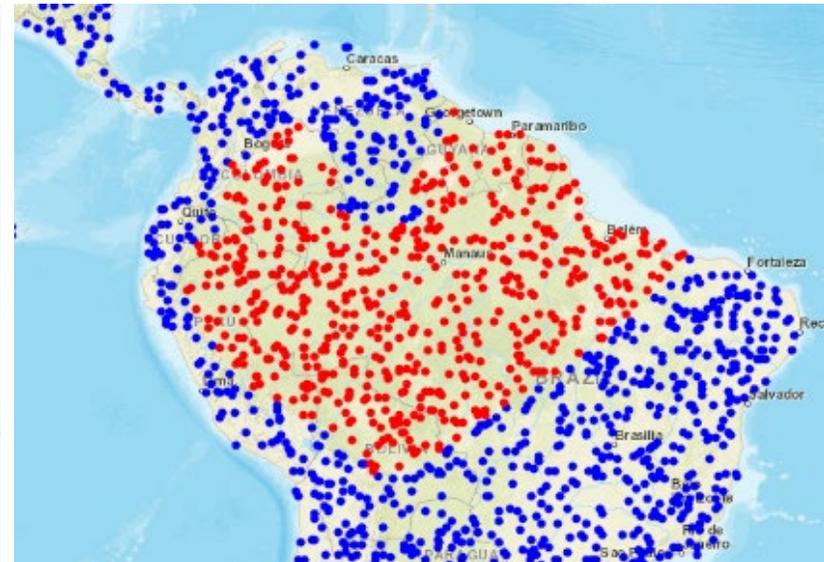*Figure 1 - World Distribution Map - IUCN Red List*

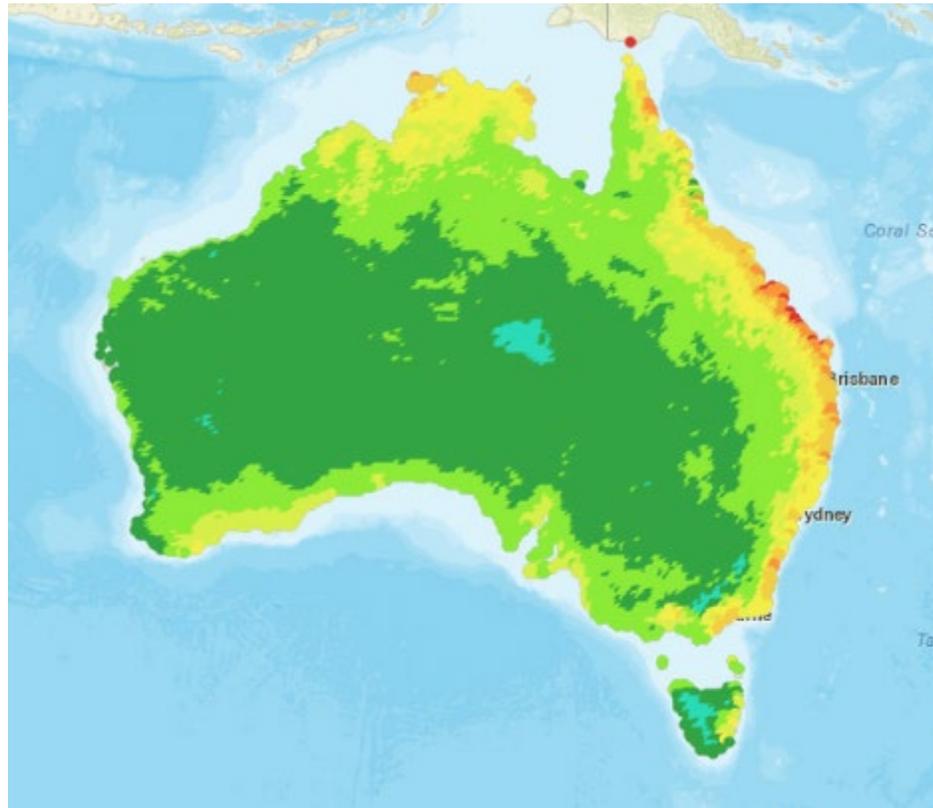*Figure 2 - World Distribution Map - Climatch*

Climate match between world distribution of species and Australia:
Areas of Australia where the climate appears suitable for *Sapajus apella*
CMS = 417

Score	Color	Count
0		0
1		212
2		10817
3		5235
4		1566
5		989
6		330
7		76
8		11
9		0
10		0

Species: Sapajus apella (Brown Capuchin)
Algorithm: Closest Standard Score
572 source features selected
19236 target features selected
Approximate selected area: 6,781,943 km²

Table 1: ABARES recalibration thresholds

Climate Match Score (CMS)	Current Bomford 2008 model classes (50 km)	Recalibrated classes to Climatch v2.0 (20 km)
1 (Very low)	< 100	< 691
2 (Low)	100-599	691-4137
3 (Moderate)	600-899	4138-6209
4 (High)	900-1699	6210-11735
5 (Very high)	1700-2699	11736-18642
6 (Extreme)	≥ 2700	≥ 18643

Table 2: Susceptible Australian Primary Production – Calculating Total Commodity Damage Score
The commodity value index scores in this table are derived from Australian Bureau of Statistics 2005 – 2006 data. The values will require updating if significant change has occurred in the value of the commodity (Bomford 2008).

Industry	Commodity Value Index 1 (CVI based on best available date)	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	2	0	0
Cereal grain (includes wheat, barley sorghum etc)	8			
Sheep (includes wool and sheep meat)	5			
Fruit (includes wine grapes)	4	2	0	0
Vegetables	3			
Poultry and eggs	2	2	0	0
Aquaculture (includes coastal mariculture)	2			
Oilseeds (includes canola, sunflower etc)	1			
Grain legumes (includes soybeans)	1			
Sugarcane	1			
Cotton	1			
Other crops and horticulture (includes nuts tobacco and flowers etc)	1	2	0	0
Pigs	1			
Other livestock (includes goats, deer, camels, rabbits)	0.5			
Bees (included honey, beeswax and pollination)	0.5			
Total Commodity Damage Score (TCDS)				0

NB The Commodity Value Index scores in this table are derived from Australian Bureau of Statistics 2005–2006 data and will need to be updated if these values change significantly.

Assess Potential Commodity Impact Scores for each primary production commodity listed in Table 9, based on species' attributes (diet, behaviour, ecology), excluding risk of spreading disease which is addressed in Question C9, and pest status worldwide as:

0. *Nil (species does not have attributes to make it capable of damaging this commodity)*
1. *Low (species has attributes making it capable of damaging this or similar commodities and has had the opportunity but no reports or other evidence that it has caused damage in any country or region*
2. *Moderate–serious (reports of damage to this or similar commodities exist 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)*
3. *Extreme (damage occurs 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).*

Climate Match to Commodity Score (0–5)

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

Table 3: Assigning species to EIC Threat Categories (shaded cells relate to assignment of reptiles and amphibians to EIC Threat Categories based on an assessed establishment risk and an allocated pest risk of extreme) – adapted from Bomford 2008

Establishment Risk	Pest Risk	Public Safety Risk	EIC Threat Category	Implication for any proposed import into Australia	Implication for keeping and movement in Australia
Extreme	Extreme	Highly, Moderately or Not Dangerous	EXTREME	Prohibited, unless sufficient risk management measures exist to reduce the potential risks to an acceptable level	Limited to those collections approved for keeping particular EXTREME Threat species
Extreme	Serious	Highly, Moderately or Not Dangerous	EXTREME		
Extreme	Moderate	Highly, Moderately or Not Dangerous	EXTREME		
Extreme	Low	Highly, Moderately or Not Dangerous	EXTREME		
Serious	Extreme	Highly, Moderately or Not Dangerous	EXTREME		
Serious	Serious	Highly, Moderately or Not Dangerous	EXTREME		
Moderate	Extreme	Highly, Moderately or Not Dangerous	EXTREME		
Serious	Moderate	Highly, Moderately or Not Dangerous	SERIOUS	Import restricted to those collections approved for keeping SERIOUS Threat species	Limited to those collections approved for keeping particular SERIOUS Threat species
Serious	Low	Highly, Moderately or Not Dangerous	SERIOUS		
Moderate	Serious	Highly, Moderately or Not Dangerous	SERIOUS		
Moderate	Moderate	Highly Dangerous	SERIOUS		
Moderate	Low	Highly Dangerous	SERIOUS		
Low	Extreme	Highly, Moderately or Not Dangerous	SERIOUS		
Low	Serious	Highly, Moderately or Not Dangerous	SERIOUS		
Low	Moderate	Highly Dangerous	SERIOUS		
Low	Low	Highly Dangerous	SERIOUS		
Moderate	Moderate	Moderately or Not Dangerous	MODERATE	Import restricted to those collections approved for keeping MODERATE Threat species	Limited to those collections approved for keeping particular MODERATE Threat species
Moderate	Low	Moderately or Not Dangerous	MODERATE		
Low	Moderate	Moderately or Not Dangerous	MODERATE		
Low	Low	Moderately Dangerous	MODERATE		
Low	Low	Not Dangerous	LOW	Import permitted	May be limited to those collections approved for keeping particular LOW Threat species
Any Value	Any Value	Unknown	EXTREME until proven otherwise	Prohibited, unless sufficient risk management measures exist to reduce the potential risks to an acceptable level	Limited to those collections approved for keeping particular EXTREME Threat species
Unknown	Any Value	Any Value	EXTREME until proven otherwise		
Any Value	Unknown	Any Value	EXTREME until proven otherwise		
Unassessed	Unassessed	Unassessed	EXTREME until proven otherwise		

Adapted from:	DPIPWE (2011) Pest Risk Assessment: Black-tufted capuchin monkey (*Cebus apella*). Department of Primary Industries, Parks, Water and Environment. Hobart, Tasmania.	By: Jodi Buchecker	Date: Nov 2020

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National Risk Assessment: LOW

RISK ASSESSMENT FOR AUSTRALIA: **Silvery Marmoset (*Mico argentatus*)**

Class - Mammalia**, Order -** Primate**, Family -** Callitrichidae**, Genus -** *Mico***.**

SPECIES:	Species description:
Mico argentatus (Linnaeus, 1771) The species was formerly in the genus Callithrix (along with all other marmosets, now divided between three or four distinct genera), but is now almost-universally placed in the genus *Mico*, which was previously treated as a subgenus of Callithrix. **Synonyms:** *Callithrix argentata* (Hershkovitz, 1977) **Common Names:** Silvery Marmoset	The silvery marmoset is a small monkey native to the Amazon Basin in South America. The average head-to-body length, excluding the tail is 21 centimetres. The tail by itself adds another 30-32 centimetres (Petter and Desbordes, 2010). Adults weigh between 273–435 grams. The silvery marmoset is the only marmoset with a body that is silver grey in colour and a tail that is dark brown. They have bare, yellow to pink faces and ears, a trait shared with several other marmoset species. Their hands end in sharp claws which gouge tree bark to access and consume the sticky sap inside. **General information:** Silvery marmosets are distributed in a small part of the monsoonal lowland tropics of northeastern Brazil, less than 100 metres above sea-level. In this monsoonal climate the annual average temperature is above 26 degrees Celsius, and the annual rainfall is 2,800-3,100 millimetres. Silvery marmosets are not dependent on waterways and, as an arboreal species, inhabit a range of forest types, including primary forest, secondary forest, open forest, and remnant forest patches in savannah that are sited away from water bodies. The silvery marmoset avoids the high daily temperatures and the risk of encountering predators by not crossing open grasslands in the absence of tree cover (Albernaz and Magnusson, 1999). In temperate climates the survival of silvery marmosets is expected to be limited by a lack of invertebrate prey rather than by cold. Home ranges for individual groups of silvery marmosets are between 4 and 35 hectares, (Digby et al, 2007), with the size depending on availability and distribution of food and secondary-growth patches. Home ranges of several groups may sometimes overlap. In the wild the species does not migrate, hibernate or aestivate. Silvery marmosets are omnivorous and eat fruits, flowers, nectar, plant exudates (gums, saps, latex) and animals (including frogs, snails, lizards, spiders and insects). Silvery marmosets have morphological and behavioural adaptation for gouging tree trunks, branches and vines of certain species to stimulate the flow of gum, which forms a notable component of their diet (Coimbra-Filho and Mittermeier, 1976; Rylands, 1984). In the wild, silvery marmosets live in extended family groups of between 4 and 15 individuals. They have a high reproductive potential compared with other primates however, their reproductive output is limited by high infant mortality rates and suppression of reproduction in socially subordinate individuals (Digby et al, 2007). Silvery

	marmosets have 2 breeding seasons per year. However, in both the wild and in captivity only the dominant female of the group will successfully produce one to four offspring per a breeding season. Of those offspring, only 1 or 2 will survive to adulthood. **Longevity:** About 16 years both in the wild and in captivity (Hakeem, 1996). **Conservation status:** **IUCN:** considers the species to be of Least Concern and in the genus *Mico*. **CITES:** lists the silvery marmoset as *Callithrix argentata* (with *Mico argentatus* as a synonym) under Appendix II (Garbano, 2015 and 2018).
DATE OF ORIGINAL ASSESSMENT: 20 June 2019 **DATE OF CURRENT ASSESSMENT:** Oct 2020 (Jodi Buchecker) **EIC ENDORSEMENT:** 15/03/21 **Risk assessment model used for the assessment:** Bomford 2008, Mammals and Birds	**The risk assessment model:** Models for assessing the risk that exotic vertebrates could establish in Australia have been developed for mammals, birds (Bomford 2003, 2006, 2008), reptiles and amphibians (Bomford et al 2005, Bomford 2008). Developed by Dr Mary Bomford for the Bureau of Rural Sciences (BRS), the model uses criteria that have been demonstrated to have significant correlation between a risk factor and the establishment of populations of exotic species and the pest potential of those species that do establish. For example, a risk factor for establishment is similarity in climate (temperature and rainfall) within the species' distribution overseas and Australia. For pest potential, the species' overseas pest status is a risk factor. The model is published as 'Risk assessment models for the establishment of exotic vertebrates in Australia and New Zealand' (Bomford 2008) and is available online on the PestSmart website https://pestsmart.org.au/wp-content/uploads/sites/3/2020/06/Risk_Assess_Models_2008_FINAL.pdf **CLIMATE**: In 2021 a new version of the Climatch program used to assess similarity in climate was released by the Australian Bureau of Agricultural Resource Economics and Sciences (ABARES): CLIMATCH v2.0. The increase in resolution in this new version (from 50 km to 20 km) required recalibration of Climate Match Scores. See Table 1. Sixteen climate parameters (variables) of temperature and rainfall are used to estimate the extent of similarity between data from meteorological stations located within the species' world distribution and stations in Australia. Worldwide, data from approximately 19000 locations are available for analysis. The number of locations used in an analysis will vary according to the size of the species' distribution and the number of meteorological stations located within that distribution. To represent the climate match visually, the map of Australia is divided into 19236 grid squares, each measured in 0.2 degrees in both longitude and latitude. CLIMATCH v2.0 calculates a match for each Australian grid by comparing data from all meteorological stations within the species' distribution (excluding any populations in Australia) and allocating a score ranging from ten for the highest level match to zero for the poorest match. Levels of climate match are used in the risk assessment for questions B1 (scores are summed to give a cumulative score), C6, and C8. Climatch v2.0 can be accessed on the ABARES website, agriculture.gov.au/abares. The direct URL is https://climatch.cp1.agriculture.gov.au/.

Bird and Mammal Model:

FACTOR	SCORE	DETAIL
STAGE A: RISKS POSED BY CAPTIVE OR RELEASED ANIMALS		
A1. Risk to people from individual escapees (0–2) *Assess the risk that individuals of the species could harm people. (NB, this question only relates to aggressive behaviour shown by escaped or released individual animals. Question C11 addresses the risk of harm from aggressive behaviour if the species establishes a wild population).* *Aggressive behaviour, size, plus the possession of organs capable of inflicting harm, such as sharp teeth, claws, spines, a sharp bill, or toxin-delivering apparatus may enable individual animals to harm people. Any known history of the species attacking, injuring or killing people should also be taken into account. Assume the individual is not protecting nest or young.*	0	*All other animals posing a lower risk of harm to people (ie animals 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).* Silvery marmosets have small sharp claws, sharp teeth and are capable of inflicting minor wounds on humans. However, the very small size of the animals prevents serious injuries.
A2. Risk to public safety from individual captive animals (0–2) *Assess the risk that irresponsible use of products obtained from captive individuals of the species (such as toxins) pose a public safety risk (excluding the safety of anyone entering the animals' cage/enclosure or otherwise coming within reach of the captive animals)*	0	*Nil or low risk (highly unlikely or not possible).*
STAGE A PUBLIC SAFETY RISK SCORE **SUM A1 - A2 (0-4)**	0	**Not dangerous**
STAGE B: PROBABILITY ESCAPED OR RELEASED INDIVIDUALS WILL ESTABLISH FREE-LIVING POPULATIONS		
Model 1: FOUR-FACTOR MODEL FOR BIRDS AND MAMMALS (BOMFORD 2008)		
B1. Degree of climate match between species overseas range and Australia (1–6)	1	*Very low climate match to Australia*

		Value X = 0 Climate Match Score = 1
Map the selected mammal or bird species' overseas range, including its entire native and exotic (excluding Australia) ranges over the past 1000 years. *Use CLIMATCH v2.0, CMS = sum of classes 6 – 10, see Table 1.*		
B2. Exotic population established overseas (0–4) *An established exotic population means the introduced species must have bred outside of captivity and must currently maintain a viable free-living population where the animals are not being intentionally fed or sheltered, even though they may be living in a highly disturbed environment with access to non-natural food supplies or shelter.*	0	*No exotic populations ever established.*
B3. Overseas range size score (0–2) < 1 = 0; 1– 70 = 1; >70 = 2 *Estimate the species overseas range size* including currently and the past 1000 years; natural and introduced range in millions of square kilometres*	0	*Overseas range less than 1 million km^2.* The silvery marmoset is located in northeastern Brazil primarily in lowland tropics less than 100 metres above sea-level, in a monsoonal climate. The extent of occurrence is more than 20,000 km² and the area of occupation is more than 2,000 km².
B4. Taxonomic Class (0–1) Bird = 0; mammal = 1	1	*Mammal.*
B. ESTABLISHMENT RISK SCORE SUM OF B1- B4 (1–13)	2	**Low establishment risk**
Model 2: Seven-Factor Model For Birds And Mammals (Bomford 2008)		
B5. Diet score (0–1) Specialist = 0; generalist = 1	1	*Generalist with a broad diet of many food types.* The silvery marmoset eats fruits, flowers, nectar, plant exudates (gums, saps, latex) and animals (including frogs, snails, lizards, spiders and insects).
B6. Habitat score (0–1) Undisturbed or disturbed habitat	1	*Can survive and breed in human-disturbed habitats (including grazing and agricultural lands, forests that are intensively managed or planted for timber harvesting and/or urban–suburban environments) without access to undisturbed (natural) habitats.*

		The silvery marmoset is found in a range of forest types, including primary forest, secondary forest, open forest, and remnant forest patches in savannah.
B7. Migratory score (0–1) *Always migratory = 0; non-migratory = 1*	1	*Non-migratory*
B. ESTABLISHMENT RISK SCORE **SUM OF B1- B7 (1–16)**	5	**Low establishment risk**
STAGE C: PROBABILITY AN ESTABLISHED SPECIES WILL BECOME A PEST		
C1. Taxonomic group (0–4)	0	Mico argentatus is not a member of any of the identified taxonomic groups.
C2. Overseas range size including current and past 1000 years, natural and introduced range (0–2) *Estimate the species overseas range size (including current and past 1000 years, natural and introduced range) in millions of square kilometre*	0	*Overseas geographic range less than 10 million square kilometres.* The extent of occurrence is more than 20,000 km² and the area of occupation is more than 2,000 km².
C3. Diet and feeding (0–3)	1	*Mammal that is a non-strict carnivore (mixed animal–plant matter in diet).* The silvery marmoset eats fruits, flowers, nectar, plant exudates (gums, saps, latex) and animals (including frogs, snails, lizards, spiders and insects).
C4. Competition with native fauna for tree hollows (0–2)	0	*Does not use tree hollows.* In captivity nest-boxes are routinely provided for callitrichids, but animals in the wild do not normally use cavities for either sleeping or breeding.
C5. Overseas environmental pest status (0–3) *Has the species been reported to cause declines in abundance of any native species of plant or animal or cause degradation to any natural communities in any country or region of the world?*	0	*Never reported as an environmental pest in any country or region.* The only wild introduced populations of the silvery marmoset are deliberate re-introduction to their former range for conservation purposes.

C6. Climate match to areas with susceptible native species or communities (0–5) *Identify any native Australian animal or plant species or communities that could be susceptible to harm by the exotic species if it were to establish a wild population here.*	0	*The species has no grid squares within the highest six climate match classes (ie in classes 10, 9, 8, 7, 6 and 5) that overlap the distribution of any susceptible native species or communities = 0*
C7. Overseas primary production pest status (0–3) *Has the species been reported to damage crops or other primary production in any country or region of the world?*	0	*No reports of damage to crops or other primary production in any country or region.* The silvery marmoset has not been identified in literature as a primary production pest.
C8. Climate match to susceptible primary production (0–5) *Assess Potential Commodity Impact Scores for each primary production commodity listed in Table 9, based on species' attributes (diet, behaviour, ecology), excluding risk of spreading disease which is addressed in Question C9.* *0 = 0; 1-19 = 1; 20-49 = 2; 50-99 = 3; 100-149 = 4; ≥150 = 5*	1	Total Commodity Damage Score = 14, Low (see Table 2) The silvery marmoset has attributes making it capable of damaging primary production commodities and has had the opportunity in its native range. However, there have been no reports in literature advising that the silvery marmoset has caused primary production damage in any country or region.
C9. Spread disease (1–2) *Assess the risk that the species could play a role in the spread of disease or parasites to other animals*	2	*All mammals (likely or unknown effect on native species and on livestock and other domestic animals).*
C10. Harm to property (0–3) *Assess the risk that the species could inflict damage on buildings, vehicles, fences, roads, equipment or ornamental gardens by chewing or burrowing or polluting with droppings or nesting material.*	1	*$0.* Callitrichids have small sharp claws, sharp teeth and are capable of digging holes in wooden structures in search of sap. However, the very small size of the animals restricts the amount of damage to property or ecosystems. The limited potential range of this species within Australia, according to the Climatch modelling, indicates limited interaction between this species and the environment or property. Hence the score of 1.
C11. Harm to people (0–5)	2	*Very low risk.*

Assess the risk that, if a wild population established, the species could cause harm to or annoy people. Aggressive behaviour, plus the possession of organs capable of inflicting harm, such as sharp teeth, tusks, claws, spines, a sharp bill, horns, antlers or toxin delivering organs may enable animals to harm people. Any known history of the species attacking, injuring or killing people should also be taken into account (see Stage A, Score A1).		Silvery marmosets have small sharp claws, sharp teeth and are capable of inflicting minor wounds on humans. However, the very small size of the animals prevents serious injuries.
C. PEST RISK SCORE **SUM C 1 TO C 11 (1–37)**	7	**Low pest risk**
STAGE A. PUBLIC SAFETY RISK RANK – RISK TO PUBLIC SAFETY POSED BY CAPTIVE OR RELEASED INDIVIDUALS *0 = Not dangerous; 1 = Moderately dangerous; ≥ 2 = Highly dangerous*	0	Not dangerous
STAGE B. ESTABLISHMENT RISK RANK – RISK OF ESTABLISHING A WILD POPULATION MODEL 1: FOUR-FACTOR MODEL FOR BIRDS AND MAMMALS (BOMFORD 2008) *≤ 5 = low establishment risk; 6-8 = moderate establishment risk; 9-10 = serious establishment risk; ≥ 11-13 = extreme establishment risk*	2	Low establishment risk
STAGE B. ESTABLISHMENT RISK RANK – RISK OF ESTABLISHING A WILD POPULATION MODEL 2: SEVEN-FACTOR MODEL FOR BIRDS AND MAMMALS (BOMFORD 2008) *≤ 6 = low establishment risk; 7-11 = moderate establishment risk; 12-13 = serious establishment risk; ≥14 = extreme establishment risk*	5	Low establishment risk
STAGE C. PEST RISK RANK - RISK OF BECOMING A PEST FOLLOWING ESTABLISHMENT	7	Low pest risk

< 9 = low pest risk; 9-14 = moderate pest risk; 15-19 = serious pest risk; > 19 = extreme pest risk		

ENVIRONMENT AND INVASIVES COMMITTEE THREAT CATEGORY	**LOW**

World distribution map (IUCN Red List) and World distribution map indicating where meteorological data was sourced for the climate analysis (see B1):

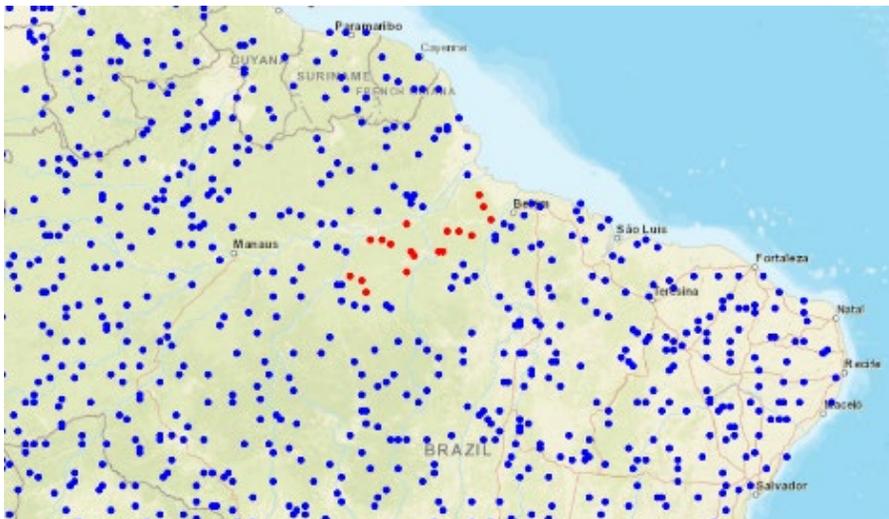*Figure 1- World Distribution Map - IUCN Red List*

Figure 2 - World Distribution Map - Climatch

Climate match between world distribution of species and Australia:
Areas of Australia where the climate appears suitable for *Mico argentatus*
CMS = 0

Score	Color	Count
0	●	5
1	●	18722
2	●	502
3	●	7
4	●	0
5	●	0
6	●	0
7	●	0
8	●	0
9	●	0
10	●	0

Species: Mico argentatus (Silvery Marmoset)
Algorithm: Closest Standard Score
18 source features selected
19236 target features selected
Approximate selected area: 283,870 km²

Table 1: ABARES recalibration thresholds

Climate Match Score (CMS)	Current Bomford 2008 model classes (50 km)	Recalibrated classes to Climatch v2.0 (20 km)
1 (Very low)	< 100	< 691
2 (Low)	100-599	691-4137
3 (Moderate)	600-899	4138-6209
4 (High)	900-1699	6210-11735
5 (Very high)	1700-2699	11736-18642
6 (Extreme)	≥ 2700	≥ 18643

Table 2: Susceptible Australian Primary Production – Calculating Total Commodity Damage Score

The commodity value index scores in this table are derived from Australian Bureau of Statistics 2005 – 2006 data. The values will require updating if significant change has occurred in the value of the commodity (Bomford 2008).

Industry	Commodity Value Index 1 (CVI based on best available date)	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*	1	1	10
Cereal grain (includes wheat, barley sorghum etc)	*8*			
Sheep (includes wool and sheep meat)	*5*			
Fruit (includes wine grapes)	*4*	1	1	4
Vegetables	*3*			
Poultry and eggs	*2*			
Aquaculture(includes coastal mariculture)	*2*			
Oilseeds (includes canola, sunflower etc)	*1*			
Grain legumes (includes soybeans)	*1*			
Sugarcane	*1*			
Cotton	*1*			
Other crops and horticulture (includes nuts tobacco and flowers etc)	*1*			
Pigs	*1*			
Other livestock (includes goats, deer, camels, rabbits)	*0.5*			
Bees (included honey, beeswax and pollination)	*0.5*			
Total Commodity Damage Score (TCDS)				14

NB The Commodity Value Index scores in this table are derived from Australian Bureau of Statistics 2005–2006 data and will need to be updated if these values change significantly.

Assess Potential Commodity Impact Scores for each primary production commodity listed in Table 9, based on species' attributes (diet, behaviour, ecology), excluding risk of spreading disease which is addressed in Question C9, and pest status worldwide as:

0. *Nil (species does not have attributes to make it capable of damaging this commodity)*
1. *Low (species has attributes making it capable of damaging this or similar commodities and has had the opportunity but no reports or other evidence that it has caused damage in any country or region*
2. *Moderate–serious (reports of damage to this or similar commodities exist 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)*
3. *Extreme (damage occurs 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).*

Climate Match to Commodity Score (0–5)

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

Table 3: Assigning species to EIC Threat Categories (shaded cells relate to assignment of reptiles and amphibians to EIC Threat Categories based on an assessed establishment risk and an allocated pest risk of extreme) – adapted from Bomford 2008

Establishment Risk	Pest Risk	Public Safety Risk	EIC Threat Category	Implication for any proposed import into Australia	Implication for keeping and movement in Australia
Extreme	Extreme	Highly, Moderately or Not Dangerous	EXTREME	Prohibited, unless sufficient risk management measures exist to reduce the potential risks to an acceptable level	Limited to those collections approved for keeping particular EXTREME Threat species
Extreme	Serious	Highly, Moderately or Not Dangerous	EXTREME		
Extreme	Moderate	Highly, Moderately or Not Dangerous	EXTREME		
Extreme	Low	Highly, Moderately or Not Dangerous	EXTREME		
Serious	Extreme	Highly, Moderately or Not Dangerous	EXTREME		
Serious	Serious	Highly, Moderately or Not Dangerous	EXTREME		
Moderate	Extreme	Highly, Moderately or Not Dangerous	EXTREME		
Serious	Moderate	Highly, Moderately or Not Dangerous	SERIOUS	Import restricted to those collections approved for keeping SERIOUS Threat species	Limited to those collections approved for keeping particular SERIOUS Threat species
Serious	Low	Highly, Moderately or Not Dangerous	SERIOUS		
Moderate	Serious	Highly, Moderately or Not Dangerous	SERIOUS		
Moderate	Moderate	Highly Dangerous	SERIOUS		
Moderate	Low	Highly Dangerous	SERIOUS		
Low	Extreme	Highly, Moderately or Not Dangerous	SERIOUS		
Low	Serious	Highly, Moderately or Not Dangerous	SERIOUS		
Low	Moderate	Highly Dangerous	SERIOUS		
Low	Low	Highly Dangerous	SERIOUS		
Moderate	Moderate	Moderately or Not Dangerous	MODERATE	Import restricted to those collections approved for keeping MODERATE Threat species	Limited to those collections approved for keeping particular MODERATE Threat species
Moderate	Low	Moderately or Not Dangerous	MODERATE		
Low	Moderate	Moderately or Not Dangerous	MODERATE		
Low	Low	Moderately Dangerous	MODERATE		
Low	Low	Not Dangerous	LOW	Import permitted	May be limited to those collections approved for keeping particular LOW Threat species
Any Value	Any Value	Unknown	EXTREME until proven otherwise	Prohibited, unless sufficient risk management measures exist to reduce the potential risks to an acceptable level	Limited to those collections approved for keeping particular EXTREME Threat species
Unknown	Any Value	Any Value	EXTREME until proven otherwise		
Any Value	Unknown	Any Value	EXTREME until proven otherwise		
Unassessed	Unassessed	Unassessed	EXTREME until proven otherwise		

Adapted from:	Department Risk Analysis, Application to add *Mico argentatus* (Silvery Marmoset) to the Environment Protection and Biodiversity Conservation Act 1999 *List of Specimens taken to be Suitable for Live Import,* September 2019	By: Jodi Buchecker	Date: Oct 2020

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