Round 7 Risk Assessments

December 2024 to August 2025

Contents

National Risk Assessment: SERIOUS

RISK ASSESSMENT FOR AUSTRALIA: Polar bear (*Ursus maritimus*)

Class - Mammalia**, Order -** Carnivora**, Family -** Ursidae**, Genus -** *Ursus*.

SPECIES: *Ursus maritimus* (Phipps, 1774) **Synonyms:** *Thalarctos maritimus* (Phipps, 1774) *Ursus maritimus maritimus* (Phipps, 1774) *Ursus maritimus marinus* (Pallas, 1776) *Thalassarctos jenaensis* (Knottnerus-Meyer, 1908) *Thalassarctos eogroenlandicus* (Knottnerus-Meyer, 1908) *Thalassarctos labradorensis* (Knottnerus-Meyer, 1908) *Ursus polaris* (Shaw, 1792) *Ursus marinus* (Pallas, 1776) *Thalassarctos maritimus groenlandicus* (Birula, 1932) **Common Names:** Polar bear White Bear Ice Bear Nanuk	**Species description:** The polar bear is one of the largest land carnivores native to the Arctic region. The polar bear is a large stocky four-legged mammal with males reaching up to 2.5 to 2.6 metres in length and weighing up to 800 kilograms (BBC News, 2011; Polar Bear Specialist Group, 2025). Males are typically larger and heavier than females (females are half the size of males and weigh between 150 to 250 kilograms) (Polar Bear Specialist Group, 2025). The polar bear has an elongated neck, a relatively small head in comparison to its body, a short compact tail and lacks a shoulder hump (Gunderson, 2009). The polar bear has 2 layers of thick fur. These layers are made up of pigment free and transparent hollow cored hairs that scatters and reflects visible light and gives the polar bear a white appearance (Polar Bears International, 2022). These layers allow the polar bear to camouflage against the snow and ice (National Geographic, 2010). The polar bear is adapted to the extreme cold of the Arctic, with a thick layer of fat about 10 centimetres deep, dense fur, and black skin that helps absorb and retain heat from the sun. The polar bear must retain this layer of fat through the hunting of fur seals. The polar bear has an incredible sense of smell, often able to detect a seal from 1 kilometre away (Shaw, 2025). Polar bears have 4 large, powerful paws (measuring up to 30 centimetres), with a sharp claw on each of their toes, that allow them to walk on ice with relative ease and swim for long distances. They are excellent swimmers, capable of traveling long distances between ice floes in search of food. On each of the polar bear's paws they have black footpads that are covered in small soft bumps known as papillae. The polar bear uses the papillae to grip the ice and stop them from slipping. The polar bears paws are also covered in hairs to keep them warm (Polar Bears International, 2022). The species is sexually dimorphic with female polar bears often being much smaller in height and weight than the males. Polar bears can swim at speeds of 10 kilometres per hour and can swim as far as 100 kilometres offshore. Polar bears can run up to speeds of 40 kilometres per hour (Gill et al., 2024). Polar bears are aggressive mammals; from males defending females against other male competition to the female protecting her cubs (Oceana, 2025). Research completed by Wilder et al, analysed polar bear attacks on humans between 1870 to 2014 with data from Canada, Greenland, Norway, Russia and the United States. They showed that 7 out of 11 attacks against humans, during this period were from a female polar bear defending her cubs (Wilder et al., 2017).

	General information: Distribution: There are 19 subpopulations of polar bears that are recognised by the Polar Bear Specialist Group, with geographic variations in size and growth rates (Obbard et al., 2010; Stirling, 2009; WWF, 2017). This species is a resident to the following countries: Canada (particularly the provinces of Manitoba, Newfoundland and Labrador, Northwest Territories, Nunavut, Ontario, Québec and Yukon), Greenland, Norway (including Svalbard and Jan Mayen), Russian Federation (Yakutiya, Krasnoyarsk, West Siberia, North European Russia), and Alaska (United States of America). Vagrant polar bears may also be present in Iceland (Wiig et al., 2015). Habitat: The polar bear is "most common in the annual ice over the continental shelf and inter-island archipelagos that surround the polar basin" (Wiig et al., 2015) preferring coastal areas and interisland channels (Stirling, 2009). Some polar bears have continuous access to sea ice throughout the year. However, for others, between July to December when the sea ice is at its minimum extent, the polar bear is forced to spend several months on land (Russell, 1975; Wiig et al., 2015; Wilder et al., 2017). Once the land refreezes, the polar bears will return to the areas that were lost during the summer/autumn months. Diet: The polar bear is a carnivore, and its diet consists of marine mammals. The polar bear relies on sea ice as a platform for hunting, as seals use the ice for breeding, resting, and birthing (WWF Artic, 2023). The polar bear catches the seal by waiting at breathing holes or breaking through the ice (National Geographic, 2010; Stirling, 2009). The polar bear primarily feeds on ringed seals with the largest proportion of their hunting occurring during the spring and early summer. They also prey on bearded seals and harp seals with polar bears eating up to 45 kilograms of blubber in one sitting (Polar Bears International, 2024). Polar bears must hunt regularly to build up their fat stores (almost doubling in size) as when the sea ice melts, they will be unable to hunt (Penk, 2019). Once the sea ice melts and the polar is forced to be on land, the polar bear will primarily fast on stored fat reserves until the ice refreezes (Wiig et al., 2015). Polar bears may also resort to eating reindeer, fish, seabirds, vegetation and human garbage (GBIF, 2025; Polar Bear Range States, 2025a). In addition to hunting, polar bears are opportunistic feeders and will scavenge on the carcasses of whales and walruses (National Geographic, 2010). The polar bear is also known to consume plant material, although this constitutes a small portion of their diet (Russell, 1975). Reproduction: Polar bears are predominantly solitary creatures, except during the mating season or when a female is raising her cubs (Gunderson, 2009). Both males and females reach sexual maturity between the ages of 4 to 5, however, the male is unlikely to mate before he is 8 to 10 years old (Polar Bear Specialist Group, 2025). Female polar bears will raise their cubs alone without any assistance from the male. Mating typically occurs in the spring, with delayed implantation ensuring that the fertilized egg does not implant until the female has gained enough fat stores to support the pregnancy (Polar Bear Range States, 2025a). Around the end of October, a pregnant female will

	create a maternity den to birth and raise cubs in. The den will allow the cubs access to a warm environment as they are unable to survive the intense cold (IFAW, 2025). After a gestation period of about eight months, the female gives birth to one to three cubs (Polar Bears International, 2024). Cubs are born between November and early January and are small, weighing less than 1 kilogram, and entirely dependent on their mother for warmth and nourishment (Polar Bear Range States, 2025a). The mother will use her fat stores to produce milk until the cubs are old enough to hunt (IFAW, 2025). The female will not eat or drink from when she comes ashore (around mid-July) until she leaves the den with her cubs. This can be a period of up to 8 months where she is entirely dependent on her fat stores (Stirling, 1982). The family will remain in the den for several months before emerging in the spring between the end of February and late April. Cubs are born blind and are raised by their mothers until they are old enough to fend for themselves, typically around 2 years of age (Polar Bear Range States, 2025a). **Longevity:** The maximum recorded longevity for this species in captivity is 43.8 years (AnAge, 2023). In the wild, this species can live between 25 to 30 years (National Geographic, 2010; Polar Bear Specialist Group, 2025). **Conservation status:** **IUCN:** Vulnerable **CITES:** Appendix II
DATE OF ORIGINAL ASSESSMENT: Feb 2025 (Aimee Carter, Win Kirkpatrick (DPIRD) and DCCEEW) **EIC ENDORSEMENT:** Aug 2025 **Risk assessment model used for the assessment:** Bomford 2008, Bird and Mammal Model	**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, 2006, 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.*	2	*Animal that sometimes attacks when unprovoked and/or is capable of causing serious injury (requiring hospitalisation) or fatality.* There are several incidents on public record of polar bear's injuring and killing people: - There are several reports of unprovoked polar bears mauling and severely injuring people (BBC News, 2018; Wendling, 2024). - There are also multiple reports on the BBC News website of unprovoked polar bears attacking and killing people (BBC News, 2020; BBC News, 2023; Matza, 2024). - Research completed by Wilder et al, analysed polar bear attacks on humans between 1870 to 2014 with data from Canada, Greenland, Norway, Russia and the United States. The group analysed 73 attacks, in which 20 people were killed and 63 were injured (Wilder et al., 2017). Polar bear scientist, Alysa McCall advised that polar bear attacks are rare and if one does attack it is usually because it is hungry, young and unwell (BBC News, 2011). Wilder et al., report that most attacks by polar bears are from bears that are in below average condition and nutritionally stressed (Wilder et al., 2017).

		Unfortunately, due to the climate crisis and the declining sea ice concentrations, polar bears are spending more time on land and are encountering humans on a more regular basis (WWF Artic, 2022).
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: RISK OF ESTABLISHMENT **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, Value X = sum of classes 6 – 10, see Table 1.*	1	*Very Low climate match to Australia* Value X = 7 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 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*	1	*Overseas range between 1 to 70 million square kilometres.* The overseas range covered by polar bear subpopulations, as of 2015, represents a total land and marine area of approximately 23 million km^2 (Polar Bear Range States, 2025b). The polar bear is a resident to the following countries: Canada (particularly the provinces of Manitoba, Newfoundland and Labrador, Northwest Territories, Nunavut, Ontario, Québec and Yukon), Greenland, Norway (including Svalbard and Jan Mayen), Russian Federation (Yakutiya, Krasnoyarsk, West Siberia, North European Russia), and Alaska (United States of America). Vagrant polar bears may also be present in Iceland.
B4. Taxonomic Class (0–1) *Bird = 0; mammal = 1*	1	*Mammal*
B. Establishment Risk Score **Sum of B1- B4 (1–13)**	3	**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* The polar bear is a carnivore, and its diet consists of marine mammals. The polar bear primarily feeds on ringed seals. They also prey on bearded seals and harp seals and can resort to eating reindeer, fish, seabirds, vegetation and human garbage (GBIF, 2025; Polar Pear Range States, 2025a). In addition, polar bears are opportunistic feeders and will scavenge on the carcasses of whales and walruses (National Geographic, 2010). The polar bear is also known to consume plant material, although this constitutes a very small portion of their diet (Russell, 1975).
B6. Habitat score (0–1) *Undisturbed or disturbed habitat*	0	*Undisturbed* The polar bear predominantly lives in an undisturbed habitat away from human populations. This is due to the remoteness and harsh conditions within the Artic where only a few human populations live. Polar bears also prefer to raise their young in dens buried beneath the snow. However, human encounters have increased as the sea ice melts, and polar bears wander through the communities looking for food. Programs such as the Polar Bear Alert Program (established in 1969 as the Polar Bear Control Program) in Churchill, Manitoba, Canada, have

		been established with the objective of “protecting people and property from the dangers posed by the presence of polar bears” and “preventing polar bears in the Churchill area from becoming conditioned to scavenging for food or developing other problem behaviours” (Manitoba Government A & B, 2025).
B7. Migratory score (0–1) *Always migratory = 0; non-migratory = 1*	1	*Facultative migrant* Polar bears are facultative migrants. The polar bear will often travel great distances within their home ranges which are often only a few hundred square kilometres. Polar bears have been found to come as far inland as 402 kilometres (Sea World, 2024). One satellite tracked polar bear travelled over 4,796 kilometres from Alaska's Prudhoe Bay to Greenland to Canada's Ellesmere Island and back (Polar Bears International, 2025).
B. ESTABLISHMENT RISK SCORE SUM OF B1- B7 (1–16)	5	**LOW establishment risk**
STAGE C: RISK OF BECOMING A PEST **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 kilometres*	1	*Overseas geographic range less than 10 million square kilometres.* The overseas range covered by polar bear subpopulations, as of 2015, represents a total land and marine area of approximately 23 million km^2 (Polar Bear Range States, 2025b). This species is a resident to the following countries: Canada (particularly the provinces of Manitoba, Newfoundland and Labrador, Northwest Territories, Nunavut, Ontario, Québec and Yukon), Greenland, Norway (including Svalbard and Jan Mayen), Russian Federation (Yakutiya, Krasnoyarsk, West Siberia, North European Russia), and Alaska (United States of America). Vagrant Polar bears may also be present in Iceland.
C3. Diet and feeding (0–3)	1	*Mammal that is a non-strict carnivore (mixed animal–plant matter in diet).*

		The polar bear is a carnivore, and its diet consists of marine mammals. The polar bear primarily feeds on ringed seals. They also prey on bearded seals and harp seals and can resort to eating reindeer, fish, seabirds, vegetation and human garbage (GBIF, 2025; Polar Bear Range States, 2025). In addition, polar bears are opportunistic feeders and will scavenge on the carcasses of whales and walruses (National Geographic, 2010). The polar bear is also known to consume plant material, although this constitutes a very small portion of their diet (Russell, 1975).
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.* No reports found that the polar bear has been reported to cause declines in abundance of any native species of plant or animal or cause degradation to any natural communities.
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.*	1	*The species has no grid squares within the highest four climate match classes (ie in classes 10, 9, 8 and 7) that overlap the distribution of any susceptible native species or communities, and has 1–345 grid squares within the highest six climate match classes that overlap the distribution of any susceptible native species or ecological communities = 1* Examples of susceptible native species or ecological communities (DAWE Protected Matters Search Tool) include: *Galaxias johnstoni* (Clarence Galazxias) – Endangered *Sarcophilus harrisii* (Tasmania Devil) – 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.* The polar bear is known to consume plant material, although this constitutes a small portion of their diet (Russell, 1975). This includes grasses such as Lyme grass seed heads, berries and kelp (Gormezano et al., 2013). However, this diet is not sustainable due to the polar bear's protein heavy and high fat diet (Learn, 2015).

		Polar bears have been reported to eat community's caribou caches (Keith and Arqviq, 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*	4	Total Commodity Damage Score = 116.40 (see Table 2) Note: Polar bears have been found to come as far inland as 402 kilometres (Sea World, 2024).
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 effects in native species and in livestock and other domestic animals).* The polar bear can suffer from morbillivirus and Trypanosoma cruzi (CABI Compendium, 2019). This virus and parasite, respectively, could infect humans and other domesticated animals. All species can play a role in the spread of diseases or parasites to other animals (native species and on livestock and other domestic animals) or to humans (zoonotic). For further information on the impacts of zoonotic diseases, the following links are available: Department of Agriculture, Fisheries and Forestry - Animal Import Risk Analysis Department of Agriculture, Fisheries and Forestry - Exotic Environmental Pest List Wildlife Health Australia - Fact Sheets
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	*$1.00 - $10 million* Damage to property can be serious with most property damage occurring at small semi-permanent hunting camps, industrial camps, and in communities (Clarkson et al, 1994). Other property such as fishing equipment, houses and even helicopters can also be damaged (Brewster, 2020). For example: Russia In 2019, there were reports of polar bears entering residential buildings searching for food (ABC News, 2019).

		<u>Greenland</u> In Greenland, a film crew member was attacked during the night. The bear broke through the window and bit the crew member (Löfgren, 2021). Compensation payments can be made to those who report property damage from a polar bear. For example: <u>Canada</u> In Baffin Bay, Canada, several communities have reported an increase in property damage over the ten years prior to 2005 (Dowsley, 2005). In Kugaaruk and Taloyoak, Canada, programs have been established to compensate hunters for equipment damaged by polar bears (Keith and Arqviq, 2006). In Nunavut, Canada, applicants can claim a maximum of $2,000 Canadian dollars (other amounts are reviewed on a case-by-case basis) for property damage by polar bears as long as prevention and mitigation strategies are in place (Department of Nunavut A & B, 2025). <u>United States of America</u> The *Marine Mammal Protection Act; Deterrence Guidelines* (2010), provides guidance and sets forth best practices to deter polar bears from "damaging private and public property and endangering the public".
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 moderate, severe, or fatal but few people at risk.* There are several incidents on public record of polar bear's injuring and killing people: - There are several reports of unprovoked polar bears mauling and severely injuring people (BBC News, 2018; Wendling, 2024). - There are also multiple reports on the BBC News website of unprovoked polar bears attacking and killing people (BBC News, 2020; BBC News, 2023; Matza, 2024). - Research completed by Wilder et al, analysed polar bear attacks on humans between 1870 to 2014 with data from Canada, Greenland, Norway, Russia and the United States. The group analysed 73 attacks, in which 20 people were killed and 63 were injured (Wilder et al., 2017).

		Polar Bear International scientist, Alysa McCall advised that polar bear attacks are rare and if one does attack it is usually because it is hungry, young and unwell (BBC News, 2011). Wilder et al report that most attacks by Polar bears are from bears that are in below average condition and nutritionally stressed (Wilder et al., 2017). Unfortunately, due to the climate crisis and the declining sea ice concentrations, polar bears are spending more time on land and are encountering humans on a more regular basis (WWF Arctic, 2022).
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*	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*	3	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	18	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 Climatch world distribution map indicating where meteorological data was sourced for the climate analysis (see B1):

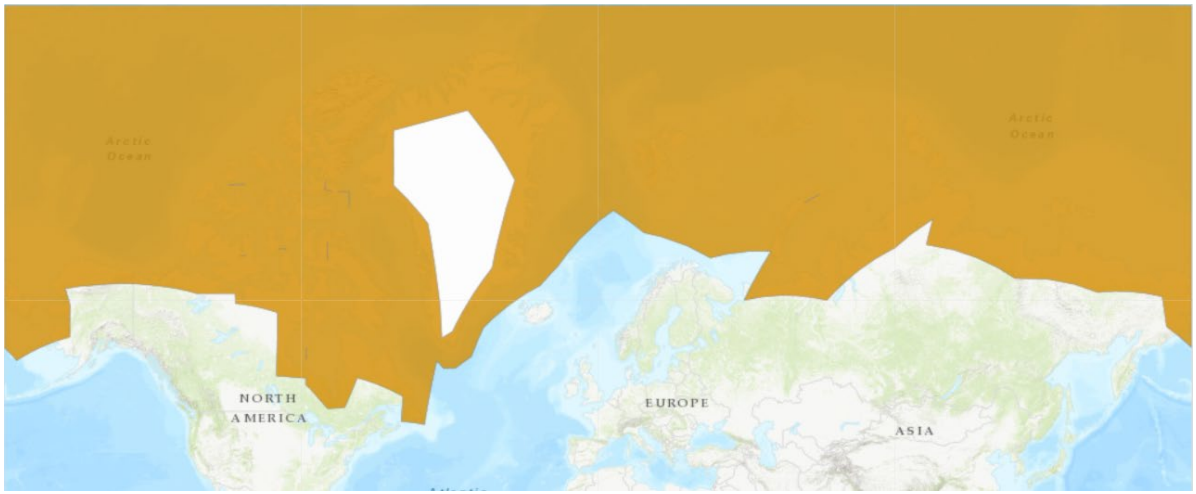


Figure 1 – IUCN Red List World Distribution Map

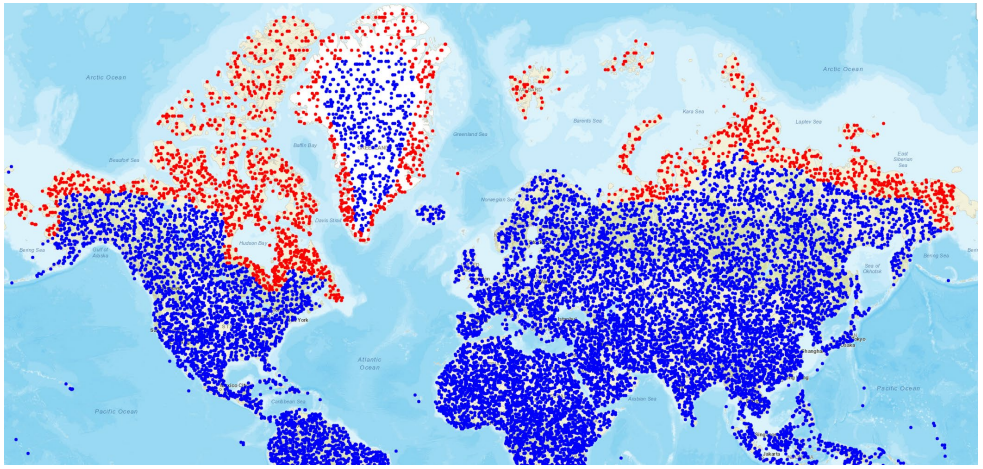
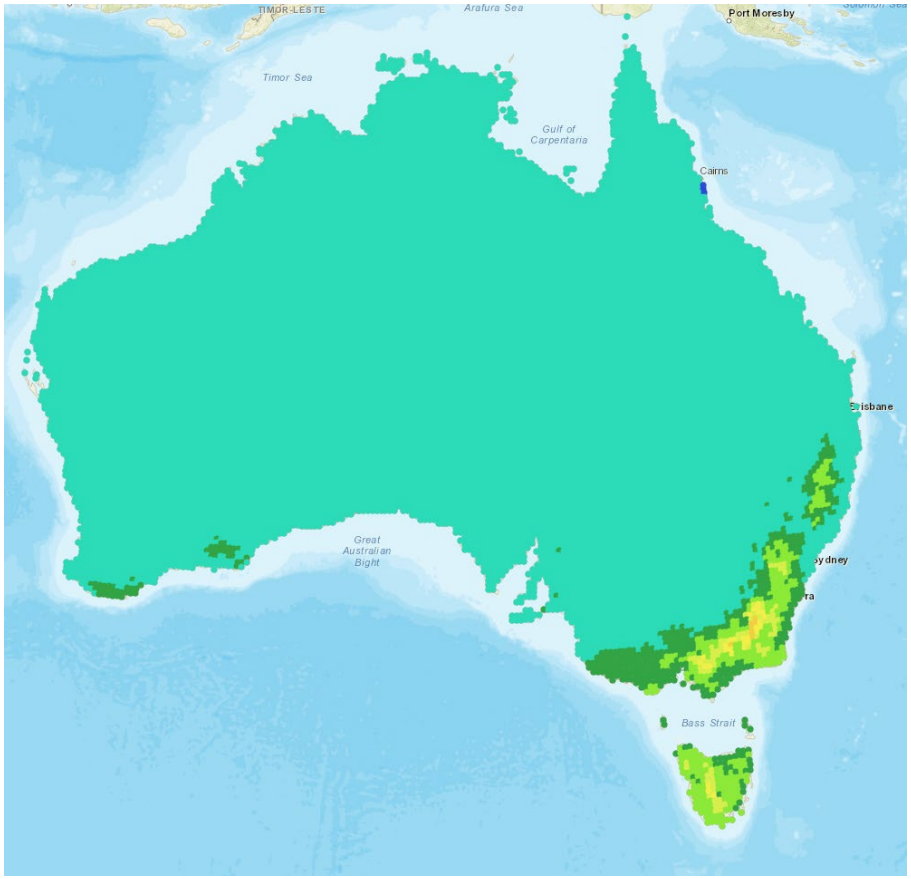


Figure 2- Climatch World Distribution Map

Climate match between world distribution of species and Australia:

Areas of Australia where the climate appears suitable for *Ursus maritimus*

Value X = 7



Score	Color	Count
0		3
1		18269
2		504
3		348
4		76
5		29
6		7
7		0
8		0
9		0
10		0

Species: Ursus maritimus (Polar Bear)
Algorithm: Closest Standard Score
2224 source features selected
19236 target features selected
Approximate selected area: 7,969,727 km^2

Table 1: ABARES recalibration thresholds

Climate Match Score (CMS)	Climatch (50 km) Closest Standard Match Sum Level 6 (Value X)	2021 Recalibrated Climatch v2.0 (20 km) Closest Standard Match Sum Level 6 (Value X)
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 2020 – 2021 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 products and beef)	13	2	2	52
Forestry (includes hardwood and softwood)	2			
Cereal grain (includes wheat, barley, sorghum, corn, oats etc)	10			
Sheep (includes wool and sheep meat)	5	2	2	20
Fruit and nuts (includes wine grapes)	5	1	2	10
Vegetables	3			
Poultry and eggs	3	1	2	6
Fisheries products	2	3	4	24
Oilseeds (includes canola, soybeans and sunflower etc)	2			
Grain legumes and pulses	1			
Sugarcane	1			
Cotton	1			
Other crops and horticulture (includes nurseries and flowers)	3			
Pigs	1	2	2	4
Other livestock (includes goats, deer, camels, rabbits)	0.1	2	2	0.4
Bees (includes honey and beeswax)	0.1			
Total Commodity Damage Score (TCDS)				116.40

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 (i.e. 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 (i.e. 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 (i.e. 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**		

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National Risk Assessment: MODERATE

RISK ASSESSMENT FOR AUSTRALIA: **Five *Eos* Lory Species (*Eos* Sp.)**

Class - Aves**, Order -** Passeriformes**, Family -** Fringillidae**, Genus -** *Eos***.**

SPECIES:

1. *Eos cyanogenia* (Bonaparte, 1850)
2. *Eos histrio* (Statius Muller, 1776)
3. *Eos reticulata* (Muller, 1841)
4. *Eos semilarvata* (Bonaparte, 1850)
5. *Eos squamata* (Boddaert, 1783)

Synonyms:

Nil

Subspecies:

1. ***Eos cyanogenia***
2. ***Eos histrio***
   Eos histrio challengeri (Salvadori, 1891)
   Eos histrio histrio (P. L. S. Muller, 1776)
   Eos histrio talautensis (A. B. Meyer & Wiglesworth, 1894)
3. ***Eos reticulata***
4. ***Eos semilarvata***
5. ***Eos squamata***

Species description:

1. *Eos cyanogenia* (Black-winged lory)

The black-winged lory is a medium sized parrot. Adults measure approximately 30 centimetres in length and weigh 167 grams (AnAge, 2023). The black-winged lory is characterised by its vivid and predominantly red plumage with a dark blue to purple stripe extending from the upper jawbone across the face covering the eye and ear-coverts. It has black feathers around the scapulars, upper wings, thighs, flanks and tail, with a red underwing and black trailing edge. It has an orange bill with a red iris and grey legs. It does not exhibit sexual dimorphism. Juveniles may exhibit dull colouration, particularly in the blue and black regions (BirdLife International, 2022; Collar, 2024; del Hoyo et al, 1997; Forshaw, 1977; Parr and Juniper, 2003; World Parrot Trust, 2025).

2. *Eos histrio* (Red-and-blue lory)

The red-and-blue lory is a small sized parrot known for its striking plumage and measures approximately 31 centimetres in length and weighing between 150 to 185 grams (World Parrot Trust, 2025). It does not exhibit sexual dimorphism. They are highly vocal and produce harsh screeches and calls. There are three subspecies for the red-and-blue lory:

E. h. histrio: has vivid colouration including an intense crimson head and upper body, distinct purplish-blue mantle and patch starting from the high crown with a broadline from the eye down to the neck to the mantle and black scapulars, flight feathers and thighs. The underside of the wings is red with the wing coverts tipped with black. The tail is reddish purple. It has an orange bill, red irises and grey legs. Juveniles have blue on their crown that reaches their nape below the eyes, with a less obvious breastband, brown eyes and dull lilac-coloured legs.

E. h. talautensis: same features as nominate however has less black with redder wing coverts and flight feathers. Juveniles display the same appearance as the adults.

E. h. challengeri: smaller in size compared to other subspecies. Adults have a narrower blue breastband with the blue band that comes from the eye not extending to the mantle (BirdLife International, 2016; Collar, 2024; del Hoyo et al, 1997; Forshaw, 1977; Parr and Juniper, 2003; World Parrot Trust, 2025).

3. *Eos reticulata* (Blue-streaked lory)

The blue-streaked lory is a medium-sized parrot. Adults measure approximately 31 centimetres in length (Collar, 2024). The blue-streaked lory has a broad blue stripe that starts from the back of the eye and goes down the neck to the mantle. The plumage, rump and back is mainly red however these are streaked with blue/purple feathers. The feathers on the wing and greater wing coverts are red with black tips. The upper tail is brownish-black and is a dull red underneath. The bill is red, legs are a grey-black and the iris is a reddish-brown with a ring of black feathers around the eye. It does not

Eos squamata squamata (Boddaert, 1783) *Eos squamata riciniata (*Bechstein, 1811) *Eos squamata obiensis* (Rothschild, 1899) **Common Names:** **1. *Eos cyanogenia*** Black-winged Lory Biak Red Lory Blue-cheeked Lory **2. *Eos histrio*** Red-and-blue Lory **3. *Eos reticulata*** Blue-streaked Lory Blue-necked lory **4. *Eos semilarvata*** Blue Eared Lory Ceram lory Half-masked lory Seram lory **5. *Eos squamata*** Violet-necked Lory Moluccan Red Lory Violet-headed Lory Violet-naped Lory Wallace's Violet-necked Lory	exhibit sexual dimorphism. Juveniles have blue spots on its mantle instead of streaks and a brown bill (BirdLife International, 2019; Collar, 2024; del Hoyo et al, 1997; Forshaw, 1977; Parr and Juniper, 2003; World Parrot Trust, 2025). **4. *Eos semilarvata* (Blue eared lory)** The blue eared lory is the smallest member of the *Eos* genus. Adults measure approximately 24 centimetres in length and weigh 170 grams (Collar, 2024). The blue eared lory has a vibrant red mantle, nape, crown and breast; purplish abdomen-patch and undertail coverts; purple/blue coloration on the upper cheeks, chin and ear-coverts and purple/blue band down the side of its neck. The primary feathers are black with a red speculum and its secondary feathers are red with black tips. It has a red/brown tail, red orange eyes and grey/black legs. It does not exhibit sexual dimorphism. Juveniles are generally paler and duller in colour; the blue colouration around the face is limited to the ear coverts and under the eye; scapular feathers are brown/grey edged with pale blue and the eye is orange/brown; the abdomen is red but with some feathers edged soft blue. This species is often found in pairs or small-sized flocks where they communicate using a series of loud calls (BirdLife International, 2019; Collar, 2024; del Hoyo et al, 1997; Forshaw, 1977; Parr and Juniper, 2003; World Parrot Trust, 2025). **5. *Eos squamata* (Violet-necked lory)** The violet-necked lory is a medium-sized parrot. Adults measure approximately 27-28 centimetres in length and a weigh 110 grams (Collar, 2024). One of its most defining features is the violet colouration that adorns the nape of its neck. It does not exhibit sexual dimorphism. The species is often found in pairs or small groups of up to 10 individuals. There are three subspecies for the violet-necked lory (Riley, 1997b): ***E. s. squamata:*** violet colouration extends as a band around the neck, varying in width for each individual. The abdomen to undertail coverts are dark purple with the scapulars being a soft purple tipped in black. The greater wing coverts and flight feathers are red with wide black tips and the underwing coverts and undersides of flight feathers are red with black tips on primaries. The tail is purple/red. *E. s. squamata* has an orange/brown bill with orange eyes and grey legs. The difference with the juvenile *E. s. squamata* is that the feathers on their mantle and underparts are margined darker and they have a brown eye. ***E. s. riciniata:*** *E. s. riciniata* adults have a very visible purple/grey neck band extending up to their hind crown and from their throat to upper breast. Some *E. s. riciniata* will also have a violet/grey crown. *E. s. riciniata* has a red nape, and scapulars with a red border on their lower breast. Some *E. s. riciniata* adults may have entirely purple underparts. The difference with the juvenile *E. s. riciniata* is that the feathers on their mantle and underparts are margined darker and they have a brown eye. ***E. s. obiensis*:** With similar features to *E. s. riciniata*, however the scapulars in *E. s. obiensis* is black and not red. *E. s. obiensis* has a varying neck band of purple/grey and its throat to upper abdomen is red in colour. The difference with the juvenile *E. s. obiensis* is that the feathers on their mantle and underparts are margined darker and they have a brown eye (BirdLife International, 2024; Collar, 2024; del Hoyo et al, 1997; Forshaw, 1977; Parr and Juniper, 2003; World Parrot Trust, 2025). **General information:**

	1. *Eos cyanogenia* (Black-winged lory) Endemic to the Geelvink Islands of Papua and Islands of Biak-Supiori Indonesia and can be found at ranges between 0-460 metres above sea level (Birdlife International, 2022). It is reported to be highly nomadic however, this may be only on a short-term basis without seasonal influence (Collar, 2024; del Hoyo et al, 1997). The species is typically found in humid inland and lowland forests, as well as in coastal coconut plantations. The species primarily feeds on nectar, fruits, seeds, and some flowers. It is a social bird, often seen in small flocks (with flocks as large as 60 reported), and it exhibits high levels of activity. Breeding season in the wild occurs during the wet season between June to July, with the female typically laying two eggs (BirdLife International, 2022; Collar, 2024; del Hoyo et al, 1997; Forshaw, 1977; Parr and Juniper, 2003; World Parrot Trust, 2025). **2. *Eos histrio* (Red-and-blue lory)** Endemic to the Talaud and Sangihe Islands off northern Sulawesi, Indonesia. The subspecies *E. h. histrio* known to inhabit the Sangihe Islands is extinct (Riley, 2002; Szabo et al, 2012) and *E. h. challengeri*, known to inhabit Miangas island, is possibly extinct (Collar, 2024). It can be found at elevations ranging from 0- 500 metres above sea level (BirdLife International, 2016). It inhabits forests, often visiting agricultural areas such as coconut plantations to feed on the fruit. They are primarily frugivorous, consuming a variety of fruits, nectar, pollen and occasionally insects. It is a social bird and often seen in small flocks of up to 8 birds (with flocks as large as 400 reported during the roosting season). Breeding season occurs between April to June (although nesting has been suspected in the months of November and December (Riley, 1997a)) with the female typically laying two eggs. Although not migratory, flocks regularly make short seasonal movements and may roost on offshore islands (BirdLife International, 2016; Collar; 2024; del Hoyo et al, 1997; Forshaw, 1977; Parr and Juniper, 2003; World Parrot Trust, 2025). **3. *Eos reticulata* (Blue-streaked lory)** Restricted to the Banda Sea Islands Endemic Bird Area, Indonesia, where the majority are found on the Tanimbar Islands of Yamdena and Larat (Bird Life International, 2019). It has potentially been introduced to Babar, Damar, Kai Kecil and Kai Kesar (Collar, 2024; Collar and Boesman, 2019; Trainor, 2007). It is one of the lesser-known birds of the *Eos* species and can be found in disturbed and human-modified habitats such as mangroves, sago plantations, coconut groves and plantations. It also inhabits secondary forests along the coast and primary forests inland. Their diet mainly consists of nectar from native plants, supplemented by fruits such as berries and soft seeds. In captivity, the female lays two eggs (BirdLife International, 2019; Collar, 2024; del Hoyo et al, 1997; Forshaw, 1977; Parr and Juniper, 2003; World Parrot Trust, 2025). **4. *Eos semilarvata* (Blue eared lory)** Endemic to the island of Seram, Indonesia (Reeve et al, 2014), where they are found above 1,200 m asl. They have been known to occasionally visit elevations around 800 metres above sea level (Collar, 2024). It inhabits forests within mountain areas and primarily feeds on nectar and tree heather (BirdLife International, 2019; Collar, 2024; del Hoyo et al, 1997; Forshaw, 1977; Parr and Juniper, 2003; World Parrot Trust, 2025). **5. *Eos squamata* (Violet-necked lory)**

	Endemic to Indonesia on the North Moluccas and the West Papuan islands with each of the subspecies spread across different islands. *E. s. squamata* can be found in the West Papuan islands, and Schildpad islands. *E.s. riciniata* can be found in North Moluccas, from Morotai to Bacan and Damar and in the Widi islands. *E. s. obiensis* is found in in North Moluccas, from Obi and Bisa. It inhabits lowland and montane forests up to 1,200 metres above sea level (Collar, 2024). It is found in both disturbed (cultivated crops, such as coconut plantations) and undisturbed habitats, such as mangroves. Its diet consists of flowering sago palm, unripe figs and nectar from the *Erythrina* flowers. The violet-necked lory is a nomadic migrant often with daily movements between the main islands to smaller offshore islets. In captivity, females lays two eggs (BirdLife International, 2019; Collar, 2024; del Hoyo et al, 1997; Forshaw, 1977; Parr and Juniper, 2003; World Parrot Trust, 2025). **Longevity:** **1. *Eos cyanogenia* (Black-winged lory)** The maximum recorded longevity for this species in captivity is 18.1 years (AnAge, 2023). In the wild, the generation length is around 7 years (Birdlife International, 2022). **2. *Eos histrio* (Red-and-blue lory)** The maximum recorded longevity for this species in captivity is 15.2 years (AnAge, 2023). In the wild, the generation length is around 7 years (Birdlife International, 2016). **3. *Eos reticulata* (Blue-streaked lory)** The maximum recorded longevity for this species in captivity is 16.6 years (AnAge, 2023). In the wild, the generation length is around 7 years (Birdlife International, 2019). **4. *Eos semilarvata* (Blue eared lory)** No record provided on AnAge. In the wild the generation length is around 6.8 years (Birdlife International, 2019). **5. *Eos squamata* (Violet-necked lory)** The maximum recorded longevity for this species in captivity is 16.5 years (AnAge, 2023). In the wild, the generation length is around 6.3 years (Birdlife International, 2024). **Conservation status:** **IUCN** • Least Concern - *Eos squamata* • Near Threatened - *Eos cyanogenia, Eos reticulata, Eos semilarvata* • Endangered - *Eos histrio* **CITES** • CITES: Appendix II - *Eos squamata, Eos cyanogenia, Eos reticulata, Eos semilarvata*

	• CITES: Appendix I - *Eos histrio*
DATE OF ORIGINAL ASSESSMENT: Feb 2025 (Aimee Carter, Kelly Mulligan (DCCEEW), Jess Lyons (DCCEEW), Veronica Blazely (DCCEEW)) **EIC ENDORSEMENT:** Aug 2025 **Risk assessment model used for the assessment:** Bomford 2008, Bird and Mammal Model	**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, 2006, 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*	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).*

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.*		Low risk of harm to people. Although lories are medium sized birds their small beaks and lack of talons make them unable to inflict serious harm or damage.
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	***All species are* NOT dangerous**
STAGE B: RISK OF ESTABLISHMENT **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, Value X = sum of classes 6 – 10, see Table 1.*	2	*Due to there being less than 12 weather stations in Climatch for all Eos species, all scores have been increased by one as recommended by Bomford (2008).* ***Eos cyanogenia* (Black-winged lory)** *Low climate match to Australia* Value X = 0 (CMS = 1) Climate Match Score = 2
	2	***Eos histrio* (Red-and-blue lory)** *Low climate match to Australia* Value X = 0 (CMS = 1) Climate Match Score = 2
	2	***Eos reticulata* (Blue-streaked lory)**

		Low climate match to Australia Value X = 0 (CMS = 1) Climate Match Score = 2
	2	***Eos semilarvata* (Blue eared lory)** *Low climate match to Australia* Value X = 0 (CMS = 1) Climate Match Score = 2
	2	***Eos squamata* (Violet-necked lory)** *Low climate match to Australia* Value X = 0 (CMS = 1) Climate Match Score = 2
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	***Eos cyanogenia* (Black-winged lory)** – *No exotic population ever established.*
	0	***Eos histrio* (Red-and-blue lory)** – *No exotic population ever established.*
	2	***Eos reticulata* (Blue-streaked lory)** – *Exotic populations only established on small islands (< 50 000 km2; Tasmania is 67,800 km^2).* Potentially introduced to Babar, Damar, Kai Kecil and Kai Kesar (Collar, 2024; Collar & Boesman, 2019; Trainor, 2007). There are no weather stations on these islands to input into Climatch.
	0	***Eos semilarvata* (Blue eared lory)** – *No exotic population ever established.*
	0	***Eos squamata* (Violet-necked lory)** – *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	***Eos cyanogenia* (Black-winged lory)** *Overseas geographic range less than 10 million square kilometres.* Overseas range estimated in Climatch: ~5,000 km^2. Extent of occurrence reported to be around 10,800km^2 (BirdLife, 2024).
	0	***Eos histrio* (Red-and-blue lory)** *Overseas geographic range less than 10 million square kilometres.* Overseas range estimated in Climatch: ~700 km^2
	0	***Eos reticulata* (Blue-streaked lory)** *Overseas geographic range less than 10 million square kilometres.* Overseas range estimated in Climatch: ~2,000km^2 with potential introductions to Babar, Damar, Kai Kecil and Kai Kesar (Collar, 2024; Collar and Boesman, 2019; Trainor, 2007). There are no weather stations on these islands to input into Climatch.

	0	***Eos semilarvata* (Blue eared lory)** *Overseas geographic range less than 10 million square kilometres.* Overseas range estimated in Climatch: ~13,000 km^2
	0	***Eos squamata* (Violet-necked lory)** *Overseas geographic range less than 10 million square kilometres.* Overseas range estimated in Climatch: ~36,000 km^2
B4. Taxonomic Class (0–1) *Bird = 0; mammal = 1*	0	*Bird*
B. Establishment Risk Score **Sum of B1- B4 (1–13)**	2 2 4 2 2	***Eos cyanogenia* (Black-winged lory) – LOW establishment risk** ***Eos histrio* (Red-and-blue lory) – LOW establishment risk** ***Eos reticulata* (Blue-streaked lory) – LOW establishment risk** ***Eos semilarvata* (Blue eared lory) – LOW establishment risk** ***Eos squamata* (Violet-necked lory) – 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.* Primarily frugivorous and nectivorous with a diverse diet consisting of a nectar, fruits, seeds and flowers. Some species, such as the red lory, also eat insects (del Hoyo et al., 1997; Forshaw, 1977; Gelis, 2011; Parr & Juniper, 2003; World of Parrots Trust, 2025). All *Eos* species have a brush-tipped tongue which helps them in the aid of harvesting the nectar and pollen (Gelis, 2011).
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.* Most of *Eos* species have been recorded utilising cultivated areas and adapting to manmade environments such as plantations.
B7. Migratory score (0–1) *Always migratory = 0; non-migratory = 1*	0	***Eos cyanogenia* (Black-winged lory)** – *migratory, t*his species is nomadic (del Hoyo et al., 1997).
	1	***Eos histrio* (Red-and-blue lory)** – *non-migratory.*
	1	***Eos reticulata* (Blue-streaked lory)** – *non-migratory.*

	0	***Eos semilarvata* (Blue eared lory)** – *migratory,* this species is an altitudinal migrant (Birdlife International, 2019).
	0	***Eos squamata* (Violet-necked lory)** – *migratory,* this species is nomadic (Birdlife International, 2024).
B. ESTABLISHMENT RISK SCORE SUM OF B1- B7 (1–16)	4 5 6 4 4	1. ***Eos cyanogenia* (Black-winged lory) – LOW establishment risk** 2. ***Eos histrio* (Red-and-blue lory) – LOW establishment risk** 3. ***Eos reticulata* (Blue-streaked lory) – LOW establishment risk** 4. ***Eos semilarvata* (Blue eared lory) – LOW establishment risk** 5. ***Eos squamata* (Violet-necked lory) – LOW establishment risk**
STAGE C: RISK OF BECOMING A PEST **Probability an established species will become a pest**		
C1. Taxonomic group (0–4)	3	*Bird in one of the taxa that are particularly prone to cause agricultural damage (Psittaciformes) = 2.* *Bird in one of the families likely to hybridise with native species (Psittacidae) = 1.*
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.* ***Eos cyanogenia* (Black-winged lory)** Overseas range estimated in Climatch: ~5,000 km^2
	0	***Eos histrio* (Red-and-blue lory)** Overseas range estimated in Climatch: ~700 km^2
	0	***Eos reticulata* (Blue-streaked lory)** Overseas range estimated in Climatch: ~2,000 km^2
	0	***Eos semilarvata* (Blue eared lory)** Overseas range estimated in Climatch: ~13,000 km^2
	0	***Eos squamata* (Violet-necked lory)** Overseas range estimated in Climatch: ~36,000 km^2
C3. Diet and feeding (0–3)	0	*Not a mammal.* Primarily frugivorous and nectivorous with a diverse diet consisting of a nectar, fruits, seeds and flowers. Some species, such as the red lory, also eat insects (del Hoyo et al, 1997; Forshaw, 1977; Gelis, 2011; Parr and Juniper, 2003; World of Parrots Trust, 2025). All *Eos* species have a brush-tipped tongue which helps them in the aid of harvesting the nectar and pollen (Gelis, 2011).

C4. Competition with native fauna for tree hollows (0–2)	2	*Can nest or shelter in tree hollows.* The violet-necked lory has been reported as investigating cavities for a nest or shelter within a tree hollow (Lambert, 1993). Riley (1997a) reported that a red-and-blue lories nest was in Beo, Karakelong, (the main island of the Talaud Islands), "in a hole in the main trunk caused by a main side branch having broken off from the tree". The blue-streaked lory has also been reported as a hole-nesting parrot (Trainor, 2007).
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 records of the species being a pest, causing damage to the environment or agriculture were found in the literature. However, although it is not reported as an environmental pest, the species does play an important role in pollination within its ecosystem.
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.*	1	*All species have 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 ecological communities = 0 (1).* Plus 1 due to less than 12 weather stations on Climatch. No examples of susceptible native species or ecological communities included from the DCCEEW Protected Matters Search Tool, due to the minimal grid square selection.
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*	3	*Due to there being less than 12 weather stations on the Climatch for all species, all commodity scores have been increased by one to not underestimate the impact on Australia's primary production commodity. Commodity Impact Score increased from 2 to 3.* Total Commodity Damage Score = 44.20 (see Table 2)
C9. Spread disease (1–2)	2	*All birds (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		Collar et al., (2015) reported that "Parrots regularly carry undetected pathogens such as herpesvirus, circovirus, polyomavirus, bornavirus and chlamydia". Disease could be transmitted across species by the parrot's sociable nature, through direct contact with perches or by airborne transmissions (Collar et al., 2015). All species can play a role in the spread of diseases or parasites to other animals (native species and on livestock and other domestic animals) or to humans (zoonotic). For further information on the impacts of zoonotic diseases, the following links are available: Department of Agriculture, Fisheries and Forestry - Animal Import Risk Analysis Department of Agriculture, Fisheries and Forestry - Exotic Environmental Pest List Wildlife Health Australia - Fact Sheets
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 damage 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, 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.* Low risk of harm to people. Although lories are medium sized birds their small beaks and lack of claws or talons make them unable to inflict much harm. The *Eos* species are gregarious parrots so many become a nuisance to communities when in large flocks.
C. PEST RISK SCORE **SUM C 1 TO C 11 (1–37)**	13 13 13 13 13	**All species score a 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	**All species are 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	***Eos cyanogenia*** **(Black-winged lory) – LOW establishment risk**
	2	***Eos histrio*** **(Red-and-blue lory) – LOW establishment risk**
	4	***Eos reticulata*** **(Blue-streaked lory) – LOW establishment risk**
	2	***Eos semilarvata*** **(Blue eared lory) – LOW establishment risk**
	2	***Eos squamata*** **(Violet-necked lory) – LOW establishment risk** **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	***Eos cyanogenia*** **(Black-winged lory) – LOW establishment risk**
	5	***Eos histrio*** **(Red-and-blue lory) – LOW establishment risk**
	6	***Eos reticulata*** **(Blue-streaked lory) – LOW establishment risk**
	4	***Eos semilarvata*** **(Blue eared lory) – LOW establishment risk**
	4	***Eos squamata*** **(Violet-necked lory) – LOW establishment risk** **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*	13	**All species a MODERATE pest risk**

ENVIRONMENT AND INVASIVES COMMITTEE THREAT CATEGORY	**MODERATE**

1a. World distribution map (IUCN Red List) and Climatch world distribution map for *Eos cyanogenia* indicating where meteorological data was sourced for the climate analysis (see B1):

Figure 1 - IUCN Red List World Distribution Map

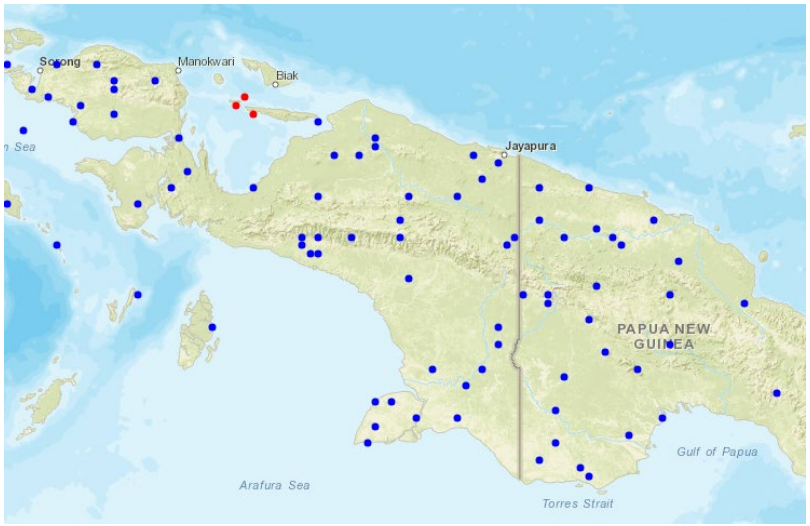
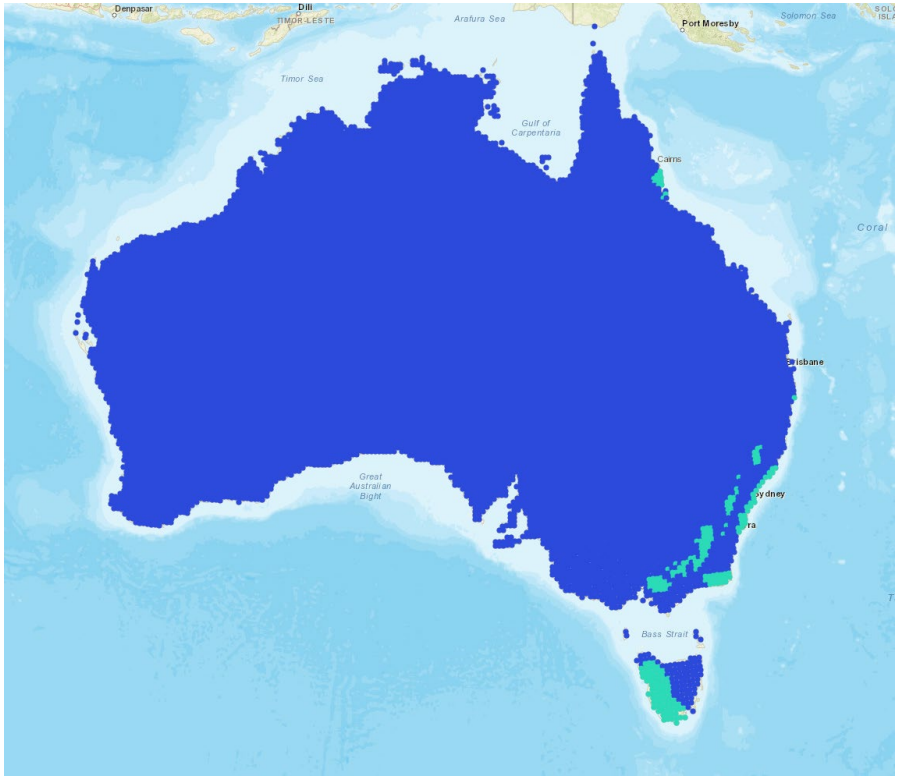


Figure 2 - Climatch World Distribution Map

1b. Climate match between world distribution of species and Australia:
Areas of Australia where the climate appears suitable for *Eos cyanogenia*
Only 3 matching points on Climatch.

Value X = 0 (1)



Score	Color	Count
0		19012
1		224
2		0
3		0
4		0
5		0
6		0
7		0
8		0
9		0
10		0

Species: Eos cyanogenia (Black Winged Lory)
Algorithm: Closest Standard Score
3 source features selected
19236 target features selected
Approximate selected area: 5,000 km^2

2a. World distribution map (IUCN Red List) and Climatch world distribution map for *Eos histrio* indicating where meteorological data was sourced for the climate analysis (see B1):

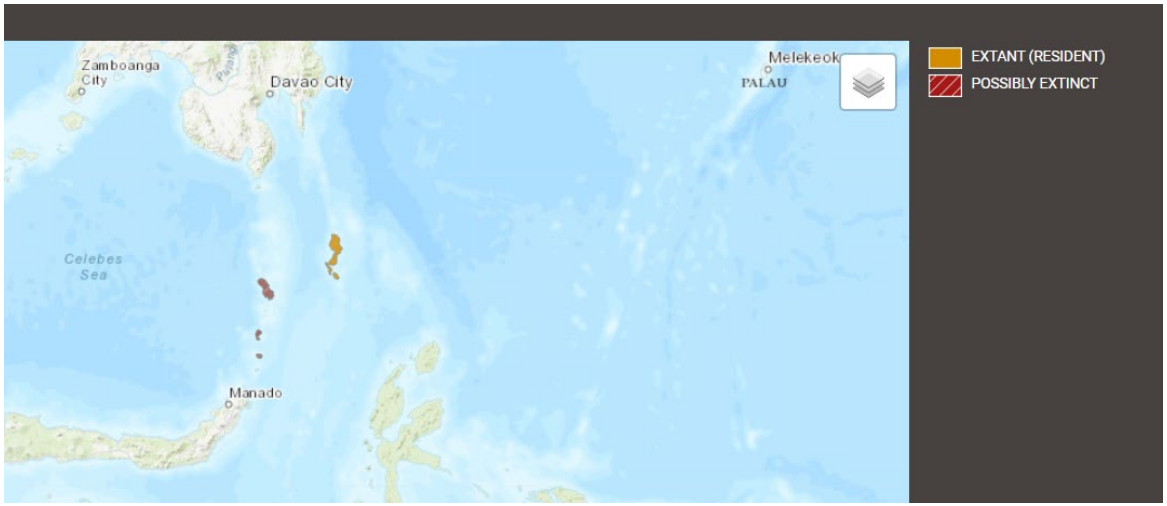
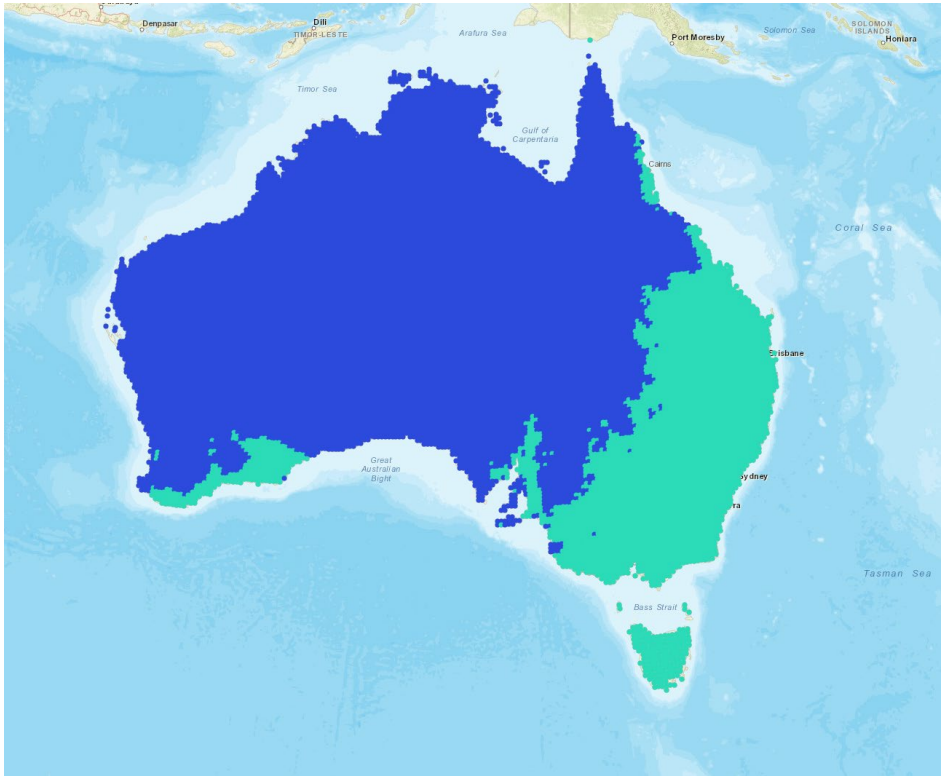


Figure 1 - IUCN Red List World Distribution Map

Figure 2 - Climatch World Distribution Map

2b. Climate match between world distribution of species and Australia:
Areas of Australia where the climate appears suitable for *Eos histrio*
Only 1 matching point on Climatch.

Value X = 0 (1)



Score	Color	Count
0		15113
1		4123
2		0
3		0
4		0
5		0
6		0
7		0
8		0
9		0
10		0

Species: Eos histrio (Red and Blue Lory)
Algorithm: Closest Standard Score
1 source features selected
19236 target features selected
Approximate selected area: 679 km^2

3a. World distribution map (IUCN Red List) and Climatch world distribution map for *Eos reticulata* indicating where meteorological data was sourced for the climate analysis (see B1):

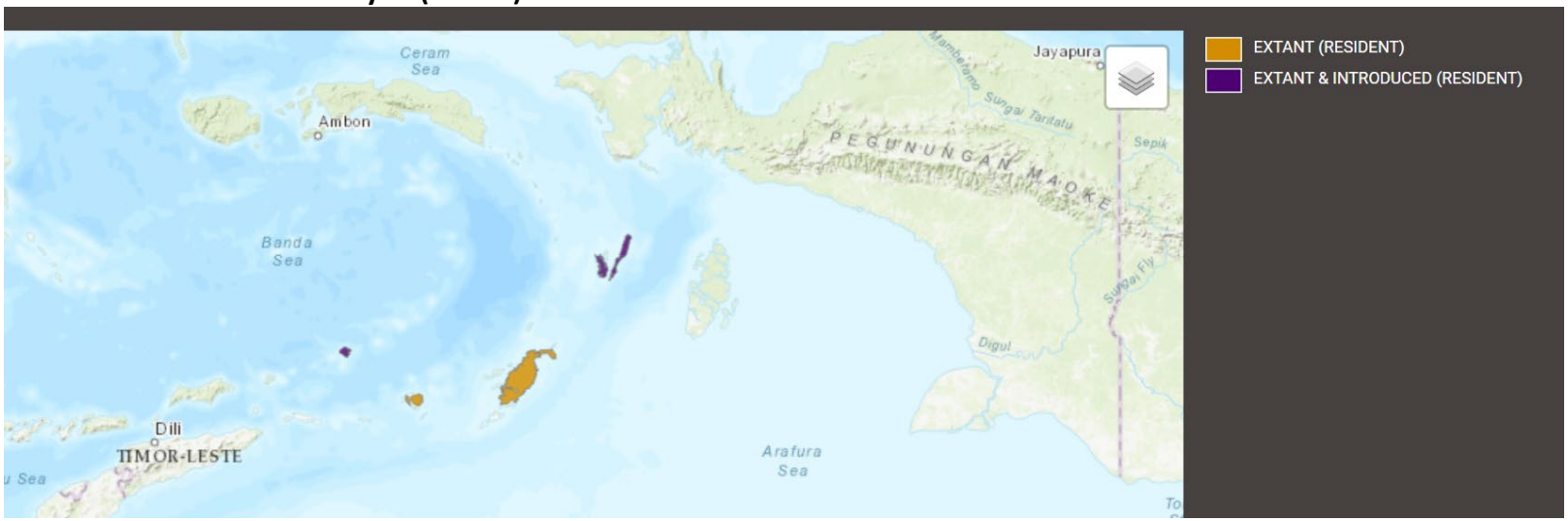


Figure 1 - IUCN Red List World Distribution Map

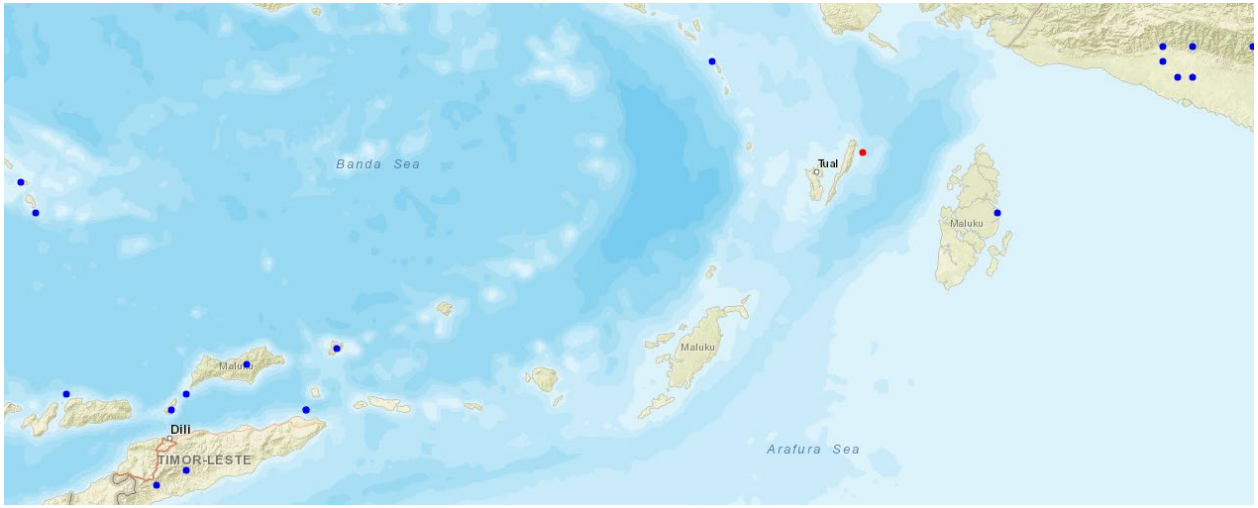


Figure 1 - Climatch World Distribution Map

3b. Climate match between world distribution of species and Australia:

Areas of Australia where the climate appears suitable for *Eos reticulata*

Only 1 matching point on Climatch.

Value X = 0 (1)

Score	Color	Count
0		0
1		19184
2		40
3		11
4		1
5		0
6		0
7		0
8		0
9		0
10		0

Species: Eos reticulata (Blue Streaked Lory)
Algorithm: Closest Standard Score
1 source features selected
19236 target features selected
Approximate selected area: 1,701 km^2

4a. World distribution map (IUCN Red List) and Climatch world distribution map for *Eos semilarvata* indicating where meteorological data was sourced for the climate analysis (see B1):

Figure 1 - IUCN RedList World Distribution Map

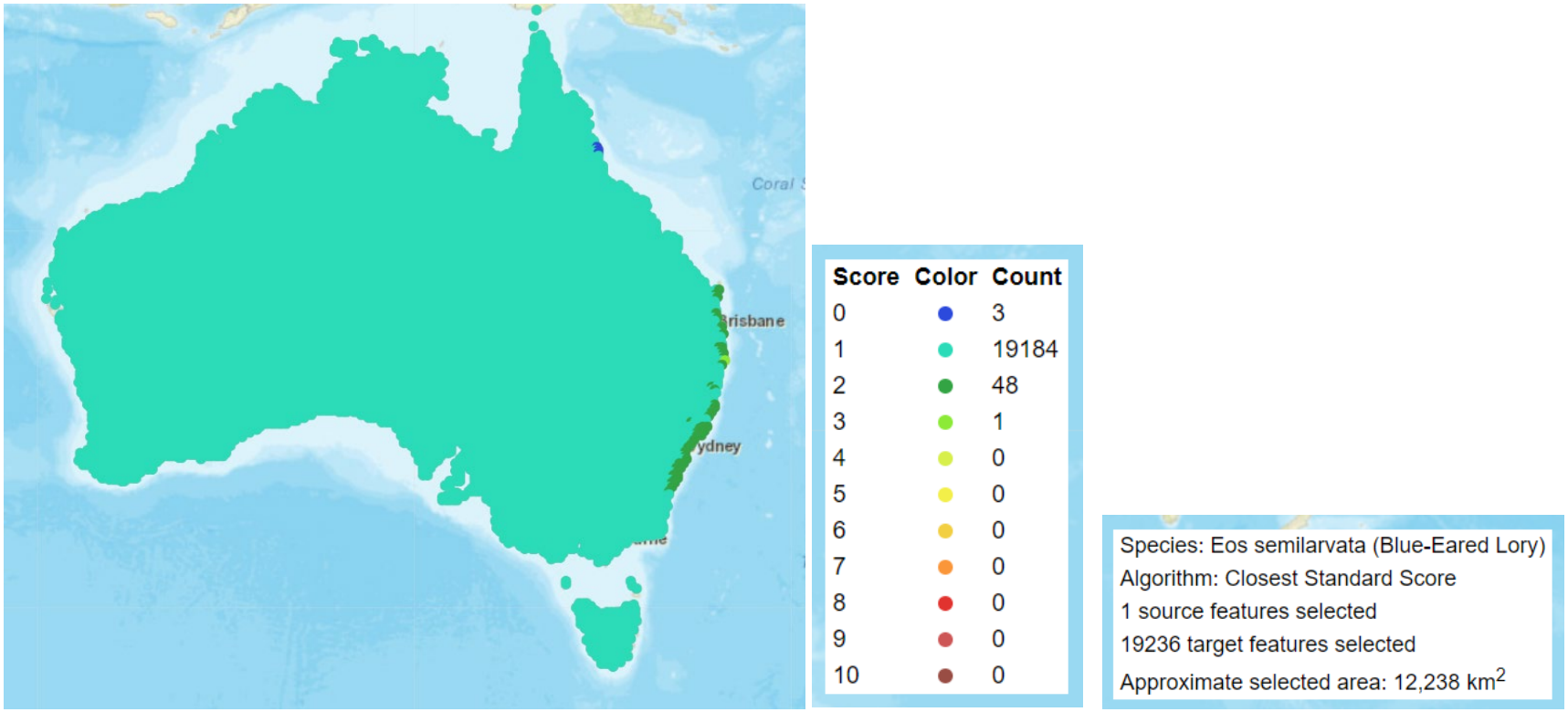
Figure 2 - Climatch World Distribution Map

4b. Climate match between world distribution of species and Australia:

Areas of Australia where the climate appears suitable for *Eos semilarvata*

1 matching point on Climatch (*occurs mainly in **montane forest > 1350 metres above sea level** so a lower coastal points on the island have not been selected)

Value X = 0 (1)



5a. World distribution map (IUCN Red List) and Climatch world distribution map for *Eos squamata* indicating where meteorological data was sourced for the climate analysis (see B1):

Figure 1 - IUCN Red List World Distribution Map

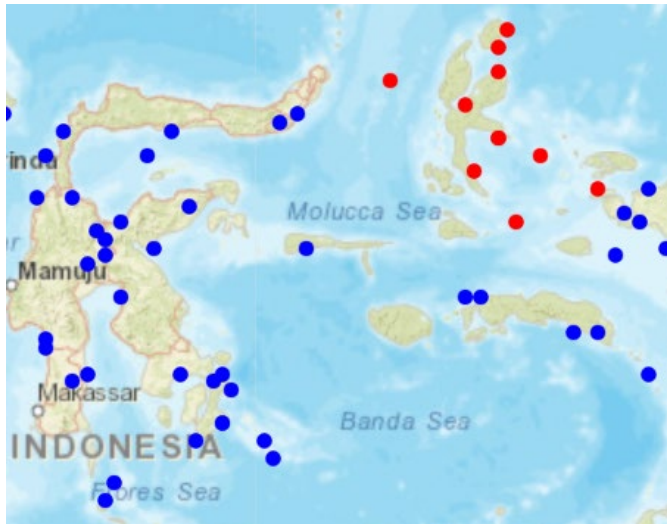


Figure 2 - Climatch World Distribution Map

5b. Climate match between world distribution of species and Australia:

Areas of Australia where the climate appears suitable for *Eos squamata*

*Only 10 matching points on Climatch

Value X = 0 (1)

Score	Color	Count
0		0
1		18772
2		385
3		76
4		3
5		0
6		0
7		0
8		0
9		0
10		0

Species: Eos squamata (Violet Necked Lory)
Algorithm: Closest Standard Score
11 source features selected
19236 target features selected
Approximate selected area: 35,847 km^2

Table 1: ABARES recalibration thresholds

Climate Match Score (CMS)	Climatch (50 km) Closest Standard Match Sum Level 6 (Value X)	2021 Recalibrated Climatch v2.0 (20 km) Closest Standard Match Sum Level 6 (Value X)
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 2020 – 2021 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 products and beef)	13			
Forestry (includes hardwood and softwood)	2	1	2	2
Cereal grain (includes wheat, barley, sorghum, corn, oats etc)	10	1	2	20
Sheep (includes wool and sheep meat)	5			
Fruit and nuts (includes wine grapes)	5	1	2	10
Vegetables	3			
Poultry and eggs	3			
Fisheries products	2			
Oilseeds (includes canola, soybeans and sunflower etc)	2	1	2	4
Grain legumes and pulses	1	1	2	2
Sugarcane	1			
Cotton	1			
Other crops and horticulture (includes nurseries and flowers)	3	1	2	6
Pigs	1			
Other livestock (includes goats, deer, camels, rabbits)	0.1			
Bees (includes honey and beeswax)	0.1	1	2	0.2
Total Commodity Damage Score (TCDS)				44.20

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 (i.e. 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 (i.e. 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 (i.e. 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**		

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National Risk Assessment: EXTREME

RISK ASSESSMENT FOR AUSTRALIA: Giraffe (*Giraffa camelopardalis*)

Class - Mammalia**, Order -** Artiodactyla**, Family -** Giraffidae**, Genus -** *Giraffa*.

SPECIES: *Giraffa camelopardalis* (Linnaeus, 1758) **Synonyms:** *Cervus camelopardalis* (Linnaeus, 1758) **Subspecies:** *Giraffa giraffa angolensis* (Lydekker, 1903) *Giraffa camelopardalis thornicrofti* (Lydekker, 1911) *Giraffa camelopardalis antiquorum* (Jardine, 1835) *Giraffa tippelskirchi* (Matschie, 1898) *Giraffa camelopardalis camelopardalis* (Linnaeus, 1758) *Giraffa reticulata* (de Winton, 1899) *Giraffa rothschildi* (Lydekker, 1903) *Giraffa camelopardalis giraffa* (von Schreber, 1784) *Giraffa camelopardalis peralta* (Thomas, 1898) (Petzold et al. 2020) & (Fennessy et al. 2016) **Common Names:** Giraffe	**Species description:** The giraffe is the world's tallest mammal, with male giraffes standing between 5.3 and 5.7 metres from the ground to their horns: approximately 3.3 metres at the shoulders with a long neck of 2.4 metres. Female giraffes are 0.7 to 1.0 metre shorter than males. (Masiano, 2024). Males can weigh up to 1,930 kilograms and females up to 1,180 kilograms (Herbison et al., 2018). The giraffes neck contains 7 elongated vertebrates. The giraffe's coat consists of patches (ranging from light tan to different shades of brown, and almost black) across its body surrounded by a lighter/paler creamy colour lines. The pattern extends across the whole of the giraffe's body, covering its face and legs. Each pattern is unique with each subspecies having a slight variation (GCF, 2024). The patches camouflage the giraffe within its habit and assist with regulation of body temperature. The patches can also be used to identify each individual giraffe as a unique "fingerprint" as well as provide the age of the giraffe (Funnell, 2016; Muller et al., 2024)). Giraffes spend the majority of the day standing up. They will eat, sleep, and give birth all whilst standing. Their tail can be between 76 to 110 centimetres long and is used to defend against insects and the tsetse fly (MacDonald, 1984). The tongue is extensile, tends to be black (to protect against sunburn) and can grasp foliage (Long, 2003). **General information:** The giraffe's main habitat includes forest and shrubland (subtropical and Tropical Dry) as well as the savanna (dry and moist). The species is endemic in Botswana, Cameroon, Central African Republic, Chad, Democratic Republic of the Congo, Eswatini, Ethiopia, Kenya, Mozambique, Namibia, Niger, Rwanda, Somalia, South Africa, South Sudan, Uganda, United Republic of Tanzania, Zambia and Zimbabwe. (CITES, 2024; Muller et al., 2024).

	A group of giraffes are called a herd, a tower and a journey that consist of a dynamic social group that consistently changes herd members. A herd contains an average of 3 to 5 individuals with only 20-25 percent of herds being larger than 6 individuals. Most herds consist of one dominant male, and multiple adult females and their calves. Females exercise social preferences in their herds and form "cliques" to other female giraffes they have a bond with. Remaining adult males tend to be dispersed and live solitary or in bachelor herds consisting of unrelated individuals. (Crandall, 1964; Long, 2003; VandeerWaal et al., 2014). Giraffes are not territorial and are capable of long-distance movements between 50 to 300 kilometres a day (Pendu, 1999). Giraffes pace, meaning that both legs on the same side move together and they can either walk, run or gallop. (Mitchell, 2021). Speeds of around 50 kilometres can be maintained for several kilometres however speeds of around 60 kilometres can be maintained over shorter distances (Herbison et al., 2018). Both males and females have ossicones. Ossicones are formed from ossified cartilage and are fused to the skull of the giraffe. Ossicones have many functions including being used during male combat as well as used to identify the age and sex of the giraffe (Nasoori, 2020). Giraffes are polygynous. Sexual maturity for a female giraffe is attained around the fourth year, with conceiving from the fifth year. For males, sexual maturity is attained at three and a half years, but they do not successfully mate until they are fully grown, which isn't achieved until at least eight years of age (Crandall, 1964; Muller, 2022). The gestation period for a giraffe is 15 months. Calves are walking within hours of being born (Hertzberg, 2018). A giraffe gives birth to a single calf however there have been occurrences of twins being born (New Zealand Herald, 2024). Other female giraffes will often assist in the rearing of young giraffes forming creches to allow the mother the opportunity to feed (Lenberg, 2021; Saito et al, 2021). From an early age male giraffes will spar with one another using their heads to take swinging blows at their opponents' bodies. This is called necking. Necking can be playful in young males or used by adult males to fight for dominance and access to females, resulting in serious injury or death (Williams, 2016). Giraffes are herbivorous and have a variable diet that includes leaves, stems, flowers, and fruits including wild apricots. *Faidherbia, Boscia, Grewia*, and *Kigelia* have all been identified as the most common plant species in the diet of giraffes in the dry season in multiple locations (Muller et al., 2024).

	Giraffes also gnaw on animal bones, antlers, horns and ivory to maintain certain nutritional requirements (phosphorus and calcium) not obtained from a vegetarian diet (Hutson et al., 2013). When giraffes are not eating, they chew curd; this is a ball of leaves that regurgitates from the giraffe's throat for more grinding. Giraffes do not need to drink daily and can get water through the leaves that they chew. However, when they do drink at watering holes, they are at their most vulnerable to predators because of their "splayed leg" stance (Nowak, 1991). **Longevity:** The maximum recorded longevity for this species is 39.5 years in captivity (AnAge, 2023). In the wild, the average life span for a giraffe is 25 years (National Geographic, 2011). **Conservation status:** **IUCN:** Vulnerable **CITES:** Appendix II
DATE OF ORIGINAL ASSESSMENT: Dec 2024 (Aimee Carter, Penny Fisher (DEECA), DCCEEW) **EIC ENDORSEMENT:** Aug 2025 **Risk assessment model used for the assessment:** Bomford 2008, Bird and Mammal Model	**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, 2006, 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.*	2	*Animal that sometimes attacks when unprovoked and/or is capable of causing serious injury (requiring hospitalisation) or fatality.* Whilst uncommon, the giraffe sometimes attacks unprovoked or whilst protecting its young and is capable of causing serious harm and death due to its strength and size. Giraffes can use their neck, ossicones or kick to cause injury. There are several incidents on public record of giraffes injuring and killing members of the public: - An unprovoked incident resulted in a filmmaker being headbutted to death (Stubley, 2018). - A toddler was killed, and mother injured in October 2022 (Fihlani, 2022).
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: RISK OF ESTABLISHMENT **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, Value X = sum of classes 6 – 10, see Table 1.*	4	*High climate match to Australia* Value X = 8,767 Climate Match Score = 4
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.* However, the giraffe has been reintroduced to several countries where it had previously gone extinct. For example, the Giraffe was reintroduced to Malawi, Rwanda, Senegal and Swaziland (ICUN, 2024; Masion, 2006). Pre-2000s giraffes were released in South Africa, Tanzania and Zimbabwe (Long, 2003). Giraffe populations can also be moved within a country to establish new colonies. The BBC Natural World documentary, "Giraffes: Africa's Gentle Giants" details the movement of 20 Rothschild's giraffe across the Victoria Nile to Uganda's Murchison Falls National Park (Furnell, 2017).
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 square kilometres.* Overseas range approximately 9,400,000 km^2. The species is endemic in Botswana, Cameroon, Central African Republic, Chad, Democratic Republic of the Congo, Eswatini, Ethiopia, Kenya, Mozambique, Namibia, Niger, Rwanda, Somalia, South Africa, South Sudan, Uganda, United Republic of Tanzania, Zambia and Zimbabwe. (CITES, 2024; Muller et al., 2024). The giraffe was previously a resident but is now extinct from Eritrea, Guinea, Mauritania, Nigeria and Senegal. The giraffe is possible extinct from Mali. The giraffe is extant and

		introduced from Eswatini and Rwanda, and extinct and vagrant from Burkina Faso and Malwai (Mueller et al., 2024).
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* The giraffe has a variable diet that includes leaves, stems, flowers, and fruits. *Faidherbia, Boscia, Grewia,* and *Kigelia* have all been identified as the most common plant species in the diet of giraffes in the dry season in different locations (Muller et al., 2024).
B6. Habitat score (0–1) *Undisturbed or disturbed habitat*	1	*Disturbed habitat.* There are reports, blogs and posts of giraffes occupying community lands and co-existing with humans for available resources; for example, giraffes moving through crop lands to access water (Posts from Stewaht, 2024a; 2024b).
B7. Migratory score (0–1) *Always migratory = 0; non-migratory = 1*	1	*Facultative migrant in its native range.* Giraffes have small home ranges but have been observed to travel transboundary in multiple countries, most likely driven by resource availability and conflict (Convention on Migratory Species, 2017; Pellew 1984; Deacon, 2024).
B. ESTABLISHMENT RISK SCORE **SUM OF B1- B7 (1–16)**	9	**MODERATE establishment risk**
STAGE C: RISK OF BECOMING A PEST **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)	0	*Overseas geographic range less than 10 million square kilometres.*

Estimate the species overseas range size (including current and past 1000 years, natural and introduced range) in millions of square kilometres		Approximately 9,400,000 km^2
C3. Diet and feeding (0–3)	3	*Mammal that is a primarily a grazer or browser.* Giraffes are considered herbivorous and have a variable diet that includes leaves, stems, flowers, and fruits including wild apricots. *Faidherbia, Boscia, Grewia*, and *Kigelia* have all been identified as the most common plant species in the diet of giraffes in the dry season across multiple locations (Fennessy et al., 2016).
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.* Populations of *Acacia* species have been noted as having high levels of mortality where accessible to giraffes (Bond & Loffell, 2001).
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 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 critically endangered native species or ecological communities include (DAWE Protected Matters Search Tool): Brigalow (*Acacia harpophylla dominant and co-dominat*) – Endangered Curlew Sandpiper (*Calidris ferruginea*) – Critically endangered Plains-wanderer (*Pedionomus torquatus*) – Critically endangered Northern Hairy-nosed Wombat, Yaminon (*Lasiorhinus krefftii*) – Critically endangered Central Rock-rat, Antina (*Zyzomys pedunculatus*) – Critically endangered Capella Potato Bush (*Solanum orgadophilum*) – Critically endangered Lyon's Grassland Striped Skink, Lyon's Snake-eyed Skink (*Austroablepharus barrylyoni*) – Critically endangered

		Southern Snapping Turtle, Whitethroated Snapping Turtle (*Elseya albagual*) – 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.* There is evidence to suggest that this species will damage crops to access food and water holes when required. The Food and Agriculture Organisation of the United Nations provided statistics that from 2006 to 2008, giraffes resulted in 3.8% of crop damage in Naitolia, Lolkisale and Loborsoit A villages (Pittiglio, 2010). Giraffes were destructive and detrimental to the trees *Acacia nigrescens* according to a study by Fleming (Fleming et al., 2006). Giraffes can increase plant susceptibility to fire and reduce wood cover that may cause cascades (Muller et al., 2020).
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*	5	Total Commodity Damage Score = 253 (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 birds and mammals (likely or unknown effect on native species and on livestock and other domestic animals).* Giraffe ear disease and giraffe skin disease are prevalent in wild populations (Hans, 2022). Foot and Mouth disease, anthrax and anaplasma infections have also been noted in the giraffe (Williams et al., 2001). All species can play a role in the spread of diseases or parasites to other animals (native species and on livestock and other domestic animals) or to humans (zoonotic). For further information on the impacts of zoonotic diseases, the following links are available: Department of Agriculture, Fisheries and Forestry - Animal Import Risk Analysis Department of Agriculture, Fisheries and Forestry - Exotic Environmental Pest List

		Wildlife Health Australia - Fact Sheets
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	*$1.00 - $10 million dollar.* There are reports of giraffes damaging fences (Highlands Wilderness, 2024) and of escaped giraffes damaging vehicles (BBC, 2012).
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 moderate, severe or fatal and many people at risk: Extreme risk = 5.* Whilst uncommon, the giraffe sometimes attacks unprovoked and whilst protecting its young and is capable of causing serious harm and death due to its strength and size. There are several incidents on public record of giraffe's injuring and killing members of the public: - An unprovoked incident resulted in a filmmaker being headbutted to death (Stubley, 2018) - A toddler was killed, and mother injured in October 2022 (Fihlani, 2022). - The family of a British Scientist were trampled by a female giraffe who was with her calf (BBC, 2018).
C. PEST RISK SCORE SUM C 1 TO C 11 (1–37)	24	**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)**	6	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*	9	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*	24	EXTREME pest risk

ENVIRONMENT AND INVASIVES COMMITTEE THREAT CATEGORY	**EXTREME**

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

Figure 1 - World Distribution map - IUCN Red List

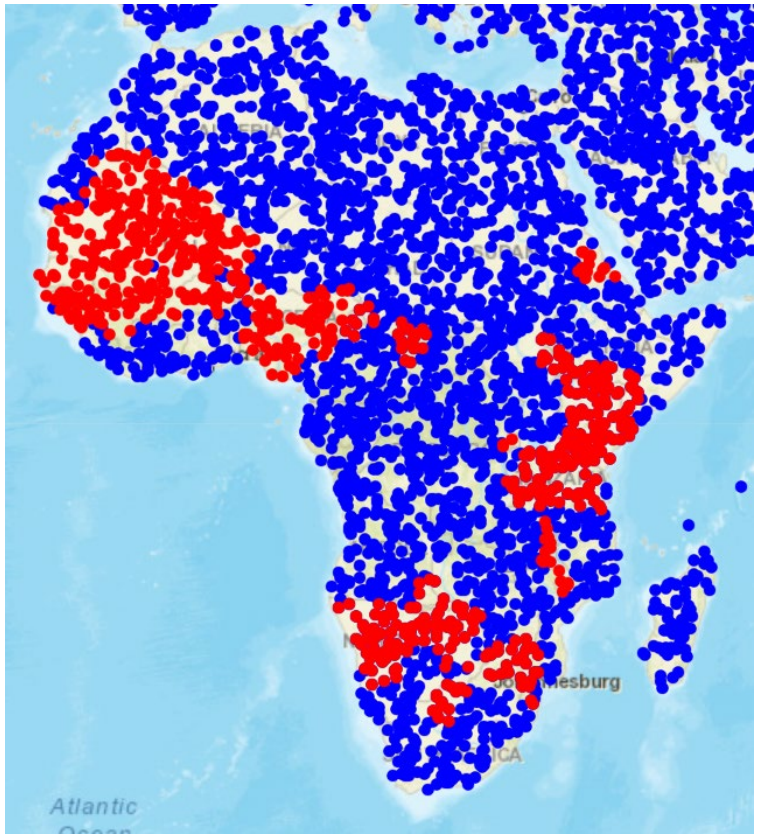
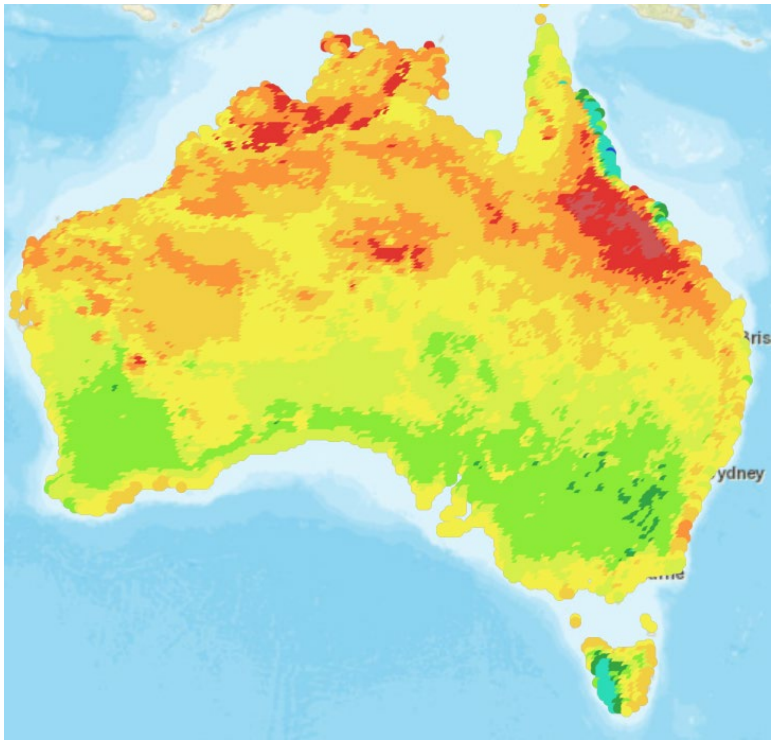


Figure 2 – World Distribution Map - Climatch

Climate match between world distribution of species and Australia:

Areas of Australia where the climate appears suitable for *Giraffa camelopardalis.*

Value X = 8,767



Score	Color	Count
0		1
1		80
2		112
3		2795
4		2943
5		4538
6		5307
7		2578
8		725
9		157
10		0

Species: Giraffa camelopardalis (Giraffe)
Algorithm: Closest Standard Score
760 source features selected
19236 target features selected
Approximate selected area: 9,318,848 km^2

Table 1: ABARES recalibration thresholds

Climate Match Score (CMS)	Climatch (50 km) Closest Standard Match Sum Level 6 (Value X)	2021 Recalibrated Climatch v2.0 (20 km) Closest Standard Match Sum Level 6 (Value X)
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 2020 – 2021 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 products and beef)	13	2	4	104
Forestry (includes hardwood and softwood)	2	1	5	10
Cereal grain (includes wheat, barley, sorghum, corn, oats etc)	10	2	2	40
Sheep (includes wool and sheep meat)	5	2	2	20
Fruit and nuts (includes wine grapes)	5	2	2	20
Vegetables	3	2	2	12
Poultry and eggs	3	1	3	9
Fisheries products	2			
Oilseeds (includes canola, soybeans and sunflower etc)	2	2	2	8
Grain legumes and pulses	1	2	2	4
Sugarcane	1	2	5	10
Cotton	1			
Other crops and horticulture (includes nurseries and flowers)	3	2	2	12
Pigs	1	2	2	4
Other livestock (includes goats, deer, camels, rabbits)	0.1			
Bees (includes honey and beeswax)	0.1			
Total Commodity Damage Score (TCDS)				253

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 (i.e. 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 (i.e. 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 (i.e. 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**		

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National Risk Assessment: EXTREME

RISK ASSESSMENT FOR AUSTRALIA: Hippopotamus (*Hippopotamus amphibius*)

Class - Mammalia**, Order -** Artiodactyla**, Family -** Hippopotamidae, **Genus -** *Hippopotamus*.

SPECIES: *Hippopotamus amphibius* (Linnaeus, 1758) **Synonyms:** Nil **Subspecies:** *Hippopotamus amphibius amphibius* (Linnaeus. 1758) *Hippopotamus amphibius capensis* (Desmoulins, 1825) *Hippopotamus amphibius kiboko* (Heller, 1914) **Common Names:** Hippopotamus Common Hippopotamus Large Hippo	**Species description:** The hippopotamus is the third largest living land mammal (African Wildlife Foundation, 2018). They have a large barrel shaped body ranging in weight from 1,400 to 3,200 kilograms, a height at the withers of 1.4 metres and a head to body length of between 3.3 to 3.5 metres (Dibloni et al., 2010; MacDonald, 1984). They have short stout legs and large canine tusks. The hippopotamuses' mouth is 50 centimetres wide and can open between 150 to 180 degrees (Eltringham, 2010; Haddara, 2020); it is equipped with very sharp triangular lower canines each measuring 30–50 centimetres. Its bite force measures 12,600 kilopascals (Haddara, 2020). The lower canines and incisors are used for biting and tearing when hippopotamuses fight, and their molars are used for chewing (National Geographic, 2024). The hippopotamus has two-inch thick skin which is usually a brownish to slate grey colour with the underside usually lighter. Their eyes, ears and nostrils are all positioned on the top of their head allowing the rest of the body to be submerged when they enter any body of water (Grzimek, 1964). Hippopotamuses have four hoofed webbed toes that help them move through the water. They do not swim instead they walk or run along the bottom of the riverbed. With the ability to shut their ears and nostrils, this allows the hippopotamus to be submerged for up to 6 minutes (Eltringham, 2010; National Geographic, 2024). Hippopotamuses are naturally aggressive animals. They can become aggressive when they sense danger, if mothers are protecting their young or if they know there is an obstruction between them and the water where they live (Kushner, 2021). When threatened, the male hippopotamus will display aggressive techniques including "yawning". This is where the hippopotamus will show how threatening its jaws and canines are (Mason, 2013). When defecating the hippopotamus uses its tail to scatter its droppings up to 10 metres away. Multiple theories surround why they do this including, using the faeces to mark their territory (Kesteven et al., 2022; Technology Org., 2018), reducing the risk of disease transmission by spreading the faeces further, a display of dominance (Land of Animalia, 2024) and ensuring that any leeches that were excreted out do not return (Schwarcz, 2017). **General information:**

	This species is a resident in Angola, Benin, Botswana, Burkina Faso, Burundi, Cameroon, Central African Republic, Chad, Congo, The Democratic Republic of the Congo, Côte d'Ivoire, Equatorial Guinea, Eswatini, Ethiopia, Gabon, Gambia, Ghana, Guinea, Guinea-Bissau, Kenya, Malawi, Mali, Mozambique, Namibia, Niger, Nigeria, Rwanda, Senegal, Sierra Leonie, Somalia, South Africa, South Sudan, Sudan, United Republic of Tanzania, Togo, Uganda, Zambia, and Zimbabwe (Lewison et al., 2017). The hippopotamus is commonly found in sub-Saharan Africa countries; in forest, savanna, shrubland, grassland, and always associated with a water source such as a river (GBIF, 2024; Lewison et al., 2017). Hippopotamuses spend most of the day within a water or mud source to keep cool and to avoid sunburn, therefore the water must be deep enough to allow full body coverage (it is estimated about 2 meters of water is preferred (Mason, 2011)). They secrete a red fluid from their skin which acts like a suncream to protect the animal's skin and may also be used to prevent against infection. If a hippopotamus is out of the water for too long, its skin will crack (African Wildlife Foundation, 2018; MacDonald, 1984). Hippopotamuses are generally found wallowing or submerged in the water during the day and are active at night, grazing for food on land up to 10km from their 'home' water resource (Herbison & Frame, 2024). The hippopotamus is a megaherbivore (Kendall, 2011). Their diet consists of terrestrial vegetation (MacDonald, 1984) but they also stray and eat farmers crops (for example eating maize, sweet potatoes and sorghum (Langat, 2022)). However, there have also been reports of hippopotamuses showing carnivorous behaviour when food has been scarce (Arnold, 2015; Dudley et al, 2016). It is estimated that hippopotamuses require 40 kilograms of food daily. This is a low figure compared to their body ratio (roughly equal to 1 to 1.5% percent) and is due to their mainly sedentary lifestyle (Grzimek, 1964). The hippopotamus exhibit's strong social bonds by living in a herd of anywhere between 40 to 200 animals with one male hippopotamus as the dominant male. Males defend territories only in the water including shoreline and a narrow strip of bank. Other male hippopotamuses are allowed in the territory only if they behave submissively (International Fund for Animal Welfare, 2024). Hippopotamuses are polygynous. In the wild, females become sexually mature between 7 and 15 and the males between 6 and 13. This will differ in captivity where both members become sexually mature as early as 3 and 4 years (Herbison & Frame, 2024). Mating tends to happen in the dry season and birth occurs in the water. A hippopotamuses gestation period is 234 days and results in the birth of one calf (AnAge, 2024). **Longevity:** The maximum recorded longevity for this species is 61.2 years (AnAge, 2024).

	Conservation status: **IUCN:** Vulnerable **CITES:** Appendix II
DATE OF ORIGINAL ASSESSMENT: Dec 2024 (Aimee Carter, Penny Fisher (DEECA), DCCEEW, Win Kirkpatrick (DPIRD)) **EIC ENDORSEMENT:** Aug 2025 **Risk assessment model used for the assessment:** Bomford 2008, Bird and Mammal Model	**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, 2006, 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)	2	*Animal that sometimes attacks when unprovoked and/or is capable of causing serious injury (requiring hospitalisation) or fatality.*

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.*		There are several incidents on public record of hippopotamus' injuring and killing members of the public: - One man lost his arm following an attack from a hippopotamus (Brown, 2023). - A man was hospitalised after a hippopotamus attacked his canoe (Gail & Cummins, 2024). - An unprovoked attacked by a hippopotamus resulted in the hospitalisation of the victim (Daily Query, 2024). - 7 people died after a hippo capsized their boat in 2023 (ABC News, 2023). - A park ranger died from crush and bite wounds in 2023 (Singh, 2023). In an article by the BBC 2016, it estimates that around 500 people are killed by hippopotamus's every year (BBC, 2016; Statista, 2022).
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: RISK OF ESTABLISHMENT **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.*	4	*High climate match to Australia* Value X = 8,869 Climate Match Score = 4

Use CLIMATCH v2.0, Value X = 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 (>50,000km^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).* In 1981, Pablo Escobar introduced 3 female and 1 male hippopotamus into his own private zoo (Hácienda Napoles). On his death in 1993, the zoo was left unattended as it was considered too expensive and challenging to move the hippopotamuses to an alternative location. This allowed the hippopotamuses to reproduce and spread along the Magdalena River basin. The population is now growing at a rate of 9.6% per year, with an expected total of 230 hippopotamuses by 2032 (Subalusky et al., 2023). The river basin is a suitable location for the hippopotamus with sightings of the hippopotamus being seen around 250 kilometres away from the Hácienda (Kremer, 2014).
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 square kiloemtres.* With a home range of approximately 7.3 million km^2, the hippopotamus is resident in Angola, Benin, Botswana, Burkina Faso, Burundi, Cameroon, Central African Republic, Chad, Congo, The Democratic Republic of the Congo, Côte d'Ivoire, Equatorial Guinea, Eswatini, Ethiopia, Gabon, Gambia, Ghana, Guinea, Guinea-Bissau, Kenya, Malawi, Mali, Mozambique, Namibia, Niger, Nigeria, Rwanda, Senegal, Sierra Leonie, Somalia, South Africa, South Sudan, Sudan, United Republic of Tanzania, Togo, Uganda, Zambia, and Zimbabwe (Lewison et al., 2017). The hippopotamus previously inhabited Algeria, Egypt, Eritrea, Liberia and Mauritania (Lewison et al., 2017). The hippopotamus has also been introduced into Columbia (Subalusky et al., 2023).
B4. Taxonomic Class (0–1) *Bird = 0; mammal = 1*	1	*Mammal*
B. ESTABLISHMENT RISK SCORE	10	**SERIOUS establishment risk**

SUM OF B1- B4 (1–13)		
Model 2: SEVEN-FACTOR MODEL FOR BIRDS AND MAMMALS (Bomford 2008)		
B5. Diet score (0–1) *Specialist = 0; generalist = 1*	1	*Generalist.* The hippopotamus is a megaherbivore (Kendall, 2011). Their diet consists of terrestrial vegetation (Field, 1970; MacDonald, 1984), including farmer's crops sometimes eating maize, sweet potatoes and sorghum (Langat, 2022).
B6. Habitat score (0–1) *Undisturbed or disturbed habitat*	1	*Disturbed habitat.*
B7. Migratory score (0–1) *Always migratory = 0; non-migratory = 1*	1	*Facultative migrant in its native range.* Hippopotami can be facultative migrants, moving locations based on the water levels available in their home ranges or reserves. In times of drought, overland movements may take place for hippopotami to find alternative water sources and more food (Herbison & Frame, 2024). Likewise, flooding is also a cause of movement amongst hippopotami. They move to shallower bodies of water to wait out the rainy season, before returning to their preferred resting pool (Dibloni et al., 2010; Post, 2017). Post's (2017) dissertation provides several maps on hippopotamus movements during the months of January to June in Lake Victoria, Kenya (Figure 4). One example is from the Nyando Division. Post writes that "during the long rains, hippos tend to move from the lakeshore and travel upstream River Nyando, towards Magina and Kochogo South Sublocations facilitated by the higher water level and availability of food". Post estimates that "during the long rains, hippos follow River Aguko upstream for three to four kilometres" (Post, 2017).
B. ESTABLISHMENT RISK SCORE SUM OF B1- B7 (1–16)	13	**SERIOUS establishment risk**
STAGE C: RISK OF BECOMING A PEST **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 kilometres*	0	*Overseas geographic range less than 10 million square kilometres.* Approximately 7.3 million km^2.
C3. Diet and feeding (0–3)	3	*Mammal that is primarily a grazer or browser.* The hippopotamus is an herbivorous grazer, mostly feeding on land near rivers and other water bodies. They will also browse on some aquatic plants (Kendall, 2011; Langat, 2022; MacDonald, 1984).
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?*	2	*Moderate environmental pest in any country or region.* Hippopotami dung has been shown to alter the chemical composition of water (GBIF, 2024). This can result in aquatic fish die-offs. Subalusky et al., (2014) calculated that in the Mara River, Kenya, an "average hippopotamus (1,500 kilograms) defecates 17.4 kilograms of wet mass faeces every day" estimating that "8.7 kilograms of that goes into the Mara River" where the hippopotami spend most of their day. Subalusky et al., also stated that "using population estimates from 2006 (estimated at 1,924 hippos), we estimated total loading for the hippopotamus population in the Mara River is 36,200 kilograms of faeces (wet mass) every day" (Subalusky et al., 2014). Within the river water, the excrement is broken down by oxygen consuming bacteria, resulting in bodies of water that are oxygen deficient. When a mass rainfall occurs, the water is flushed downstream resulting in a fish kill event from the lack of oxygenated water (Zeldovich, 2018). The deoxygenated water also encourages fish to rise to the surface of the water and become easy targets for predators (Stears et al., 2018). Hippopotami play a crucial role in shaping river ecosystems due to their daily movements between land and water. Their paths break through dense vegetation and create trunk

		trails or channels that can redirect water and sediment. The new channels often lead to lagoons, where hippopotami rest, and over time, will fill with sediment when they become reconnected to the main river. These in turn can alter the composition of the river, with the new channels becoming major waterways as the old ones fill and shift. Although, the constantly changing network of hippo-made channels provides vital habitats for fish, they also effect the geomorphology (through erosion), hydrology (through the diversion and water flow of newly created channels) and ecosystem connectivity of the areas they live (McCarthy, Ellery & Bloem, 1998; Mosepele et al., 2009). An adult hippopotamus will eat on average around 18 kilograms of grass (dry weight) per a day (Lock, 1962 cited in McCarthy, Ellery & Bloem, 1998). This megaherbivore diet results in the creation and maintenance of "hippo lawns" (regularly attended areas of short grass, primarily located near water that hippopotami will graze on during the night). Hippopotami can also over graze in areas, leaving the area destroyed of vegetation before moving on. Due to their extensive diet, hippopotami will change the abundance and composition of grass species (prioritising one species over another resulting in the decline of regrowth) as well as affecting the overall plant community structure in grazed areas (Field, 1970; McCarthy, Ellery & Bloem, 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 that overlap the distribution of any susceptible native species or ecological communities = 5* Examples of susceptible native species or ecological communities include (DCCEEW Protected Matters Search Tool): <u>Animal Communities:</u> *Calidris ferruginea (*Curlew Sandpiper*)* – Critically Endangered *Lasiorhinus krefftii* (Northern Hairy-nosed Wombat, Yaminon) – Critically Endangered *Solanum orgadophilum* (Capella Potato Bush) – Critically Endangered *Elseya albagula* (Southern Snapping Turtle, White-throated Snapping Turtle)) – Critically Endangered

		If the hippopotamus was to become established within Australia, their presence would cause both diet and habitat disturbance for native turtles and fish. Hippopotami would alter the oxygen and chemical profiles of the water that they inhabit (through their faecal deposits) leading to hypoxic events. These effects would be seen in both the pools that they would inhabit but also downstream, when the pools are "flushed" due to high water flows. The movement of this oxygen depleted and chemically altered water, would have lasting effects on the community composition, by increasing stress on native species unused to the conditions (Dutton et al., 2018). <u>Plant Communities:</u> *Solanum orgadophilum* (Capella Potato Bush) – Critically Endagered *Sporobolus pamelae* (Grass) – Endangered *Phaius australis* (Lesser Swamp-orchid) - 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* Crop raiding, trampling and soil erosion are the leading causes of damage to crops by hippopotamuses. Crop raiding occurs mostly at night. The closer the crops are to the water's edge, the higher the likelihood of raids (Kendall, 2011). It is not only eating that causes crop losses. Due to their broad footprints, hippopotamus trample and crush crops whilst walking through the fields (Kifle, 2023). A study by Kifle (2023) in Ethiopia, reported 91.2% of respondents claimed that the extent of crop damage from hippopotamuses was severe. Similarly, in a study by Lumbonyi et al., (2023), in Adamawa State, Nigeria, 79.1% of hippopotamus activity resulted in crop damage, followed by livestock predation at an average of 9.6%. The economic consequences of human-hippopotamus conflicts to small scale (1-5 hectares, 294 farms), medium scale (6-10 hectares, 72 farms) and large-scale farms (>10 hectares, 5 farms) (totalling 371 crop farmers), was substantial for farmers. Across all 3 farm types, the economic loss due to crop damage totalled ₦366,030 for sweet potato, ₦64,350 for maize and ₦75,239.50 for rice, to name a few. The figure was calculated through the average size of farmland destroyed and the average market price of the affected commodity (Lumbonyi et al., 2023 – note $1 USD was worth 360 Naira at

		the time of reporting – exchange rate in 2018 for $1 AUD was estimated to be 270 Naira (Exchange Rates, 2025; XE, 2025)). The Community Conservation Namibia provides a graph showing the hippopotamus as the fourth reported human-animal conflict in the Zambezi region. The main form of conflict with the hippopotamus is damage to seasonally grown crops (Community Conservation Namibia, 2024). This conflict often leads to retaliatory killings of local hippopotamus populations (Dibloni et al., 2010; Post 2017). Botswana's government includes compensation payments for livestock (35% of the value of livestock killed) and agricultural products (incurred for the destruction) due to a hippopotamus (Thobega, 2022). In 2008 in the Lake Victoria region of Kenya, crop damage to 326 small farms totalled ~52,000 USD, which when averaged per farm was greater than the monthly household income (Post, 2017) (exchange rate in 2008, approximately 1.195135 from 1 USD to 1 AUD, equals $62,147.02 (OFX, 2025)). In Namibia in 2009, crop damage by hippos was estimated at 2,193 USD per hectare which was calculated using prices from Namibia's Human-Wildlife Self Reliance Scheme (Kahler & Gore, 2015; MET, 2009) (exchange rate in 2009, approximately 1.280976 from 1 USD to 1 AUD, equals $2,809.18 (OFX, 2025)).
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*	5	Total Commodity Damage Score = 178 (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 birds and mammals (likely or unknown effect on native species and on livestock and other domestic animals).* Two hippopotamuses at Zoo Antwerp tested positive for SARS-CoV-2 in 2021. Humans infected the hippos according to the study by Vercammen et al 2023. The World Health Organisation reported an anthrax outbreak in 2023 reportedly from consuming meat from three wild hippopotamus carcasses (WHO, 2023).

		The leech *Placobdelloides jaegerskioeldi* is unique to the hippopotamus and lives primarily within the rectum (Oosthuizen and Davies, 1994; Rietmann and Walzer, 2014; Schwarcz, 2017). All species can play a role in the spread of diseases or parasites to other animals (native species and on livestock and other domestic animals) or to humans (zoonotic). For further information on the impacts of zoonotic diseases, the following links are available: Department of Agriculture, Fisheries and Forestry - Animal Import Risk Analysis Department of Agriculture, Fisheries and Forestry - Exotic Environmental Pest List Wildlife Health Australia - Fact Sheets
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	*$1.00 - $10 million* In 2018, the Namibian government updated their Human-Wildlife Conflict policy 2009. The policy provides information on payments from crop and livestock losses due to damages by hippopotamuses as well as payments for funeral expenses for accidentals death or injuries due to a wildlife attack (MET, 2018). The Food and Agriculture Organisation of the United Nations advises that hippopotamuses can destroy boats and fishing equipment (FAO, 2023; Marowa, 2021).
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.* There are several incidents on public record of hippopotamus' injuring and killing members of the public: - One man lost his arm following an attack from a hippopotamus (Brown, 2023). - A man was hospitalised after a hippopotamus attacked his canoe (Gail and Cummins, 2024). - An unprovoked attacked by a hippopotamus resulted in the hospitalisation of the victim (Daily Query, 2024). - 7 people died after a hippo capsized their boat in 2023 (ABC News, 2023). - A park ranger died from crush and bite wounds in 2023 (Singh, 2023).

		In an article by the BBC 2016, it estimates that around 500 people are killed by hippopotamus's every year (BBC, 2016; Statista, 2022). In 2018, the Namibian government updated their Human-Wildlife Conflict policy 2009. The policy provides information on payments from crop and livestock losses due to damages by hippopotamuses as well as payments for funeral expenses for accidentals death or injuries due to a wildlife attack (MET, 2018).
C. PEST RISK SCORE SUM C 1 TO C 11 (1–37)	29	**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*	10	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	29	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 Climatch world distribution map indicating where meteorological data was sourced for the climate analysis (see B1):

Figure 1 - World Distribution map - IUCN Red List

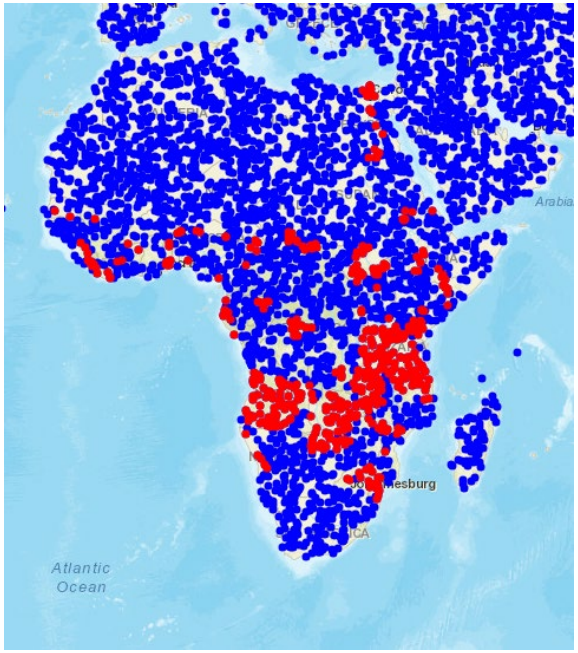


Figure 2 – World Distribution map – Climatch

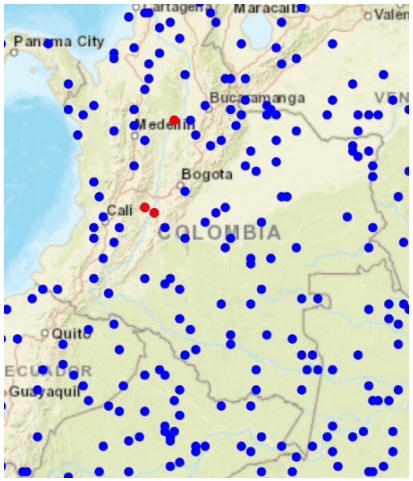
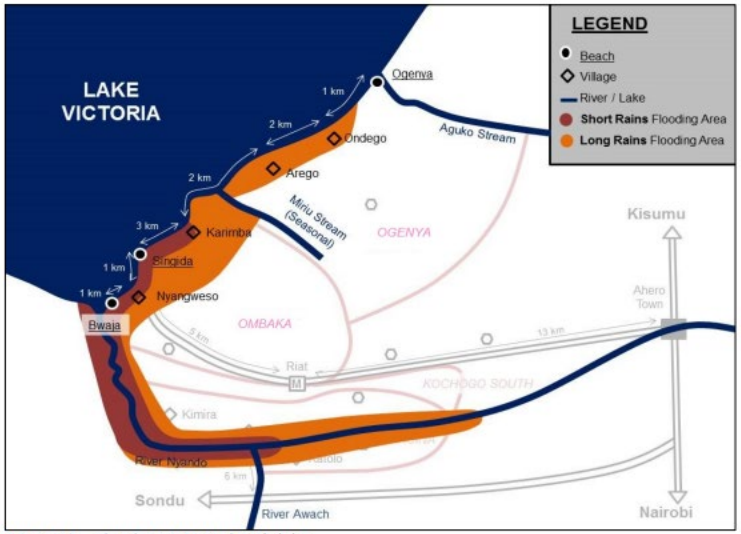
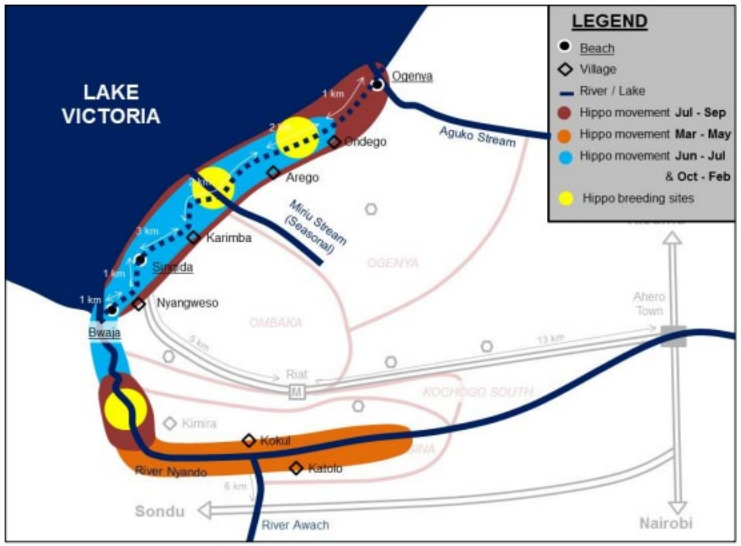


Figure 3 – World Distribution map Columbia



Map 4.4 – Flood map Nyando Division



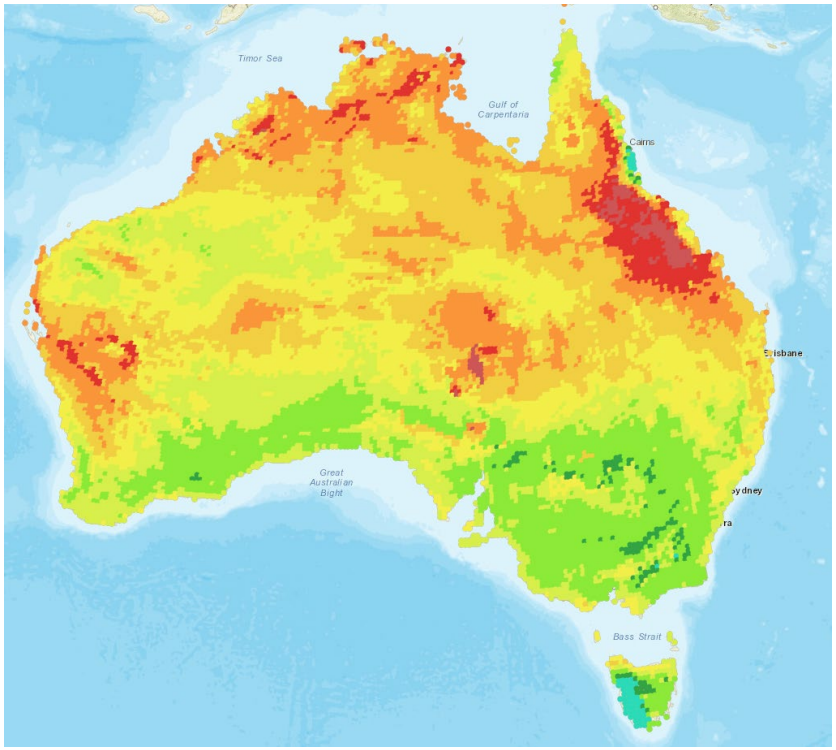
Map 4.5 – Hippo migration map Nyando Division

Figure 4 - Post (2017), pg. 62. Migration map for the hippopotamus in the Nyando Division.

Climate match between world distribution of species and Australia:

Areas of Australia where the climate appears suitable for *Hippopotamus amphibius.*

Value X = 8,869



Score	Color	Count
0		0
1		57
2		144
3		2724
4		3141
5		4301
6		5248
7		2765
8		652
9		204
10		0

Species: Hippopotamus amphibius (Hippopotamus)
Algorithm: Closest Standard Score
476 source features selected
19236 target features selected
Approximate selected area: 7,287,978 km^2

Table 1: ABARES recalibration thresholds

Climate Match Score (CMS)	Climatch (50 km) Closest Standard Match Sum Level 6 (Value X)	2021 Recalibrated Climatch v2.0 (20 km) Closest Standard Match Sum Level 6 (Value X)
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 2020 – 2021 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 products and beef)	13			
Forestry (includes hardwood and softwood)	2			
Cereal grain (includes wheat, barley, sorghum, corn, oats etc)	10	2	3	60
Sheep (includes wool and sheep meat)	5			
Fruit and nuts (includes wine grapes)	5	2	5	50
Vegetables	3	2	3	18
Poultry and eggs	3			
Fisheries products	2	2	5	20
Oilseeds (includes canola, soybeans and sunflower etc)	2	2	3	12
Grain legumes and pulses	1	2	3	6
Sugarcane	1			
Cotton	1			
Other crops and horticulture (includes nurseries and flowers)	3	2	3	12
Pigs	1			
Other livestock (includes goats, deer, camels, rabbits)	0.1			
Bees (includes honey and beeswax)	0.1			
Total Commodity Damage Score (TCDS)				178

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 (i.e. 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 (i.e. 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 (i.e. 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**		

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National Risk Assessment: EXTREME

RISK ASSESSMENT FOR AUSTRALIA: Chimpanzee (*Pan troglodytes*)

Class - Mammalia**, Order -** Primates**, Family -** Hominidae**, Genus -** *Pan*.

SPECIES: *Pan troglodytes* (Blumenbach, 1799) **Synonyms:** *Simia troglodytes* (Blumenbach, 1799) **Subspecies:** *Pan troglodytes verus* (Western Chimpanzee – Schwarz, 1934) *Pan troglodytes ellioti* (Nigeria-Cameroon Chimpanzee – Gray, 1862) *Pan troglodytes troglodytes* (Central Chimpanzee – Blumenbach, 1799) *Pan troglodytes schweinfurthii* (Eastern Chimpanzee – Giglioli, 1872) **Common Names:** Chimpanzee Common Chimpanzee Robust Chimpanzee	**Species description:** The chimpanzee stands between 1.0 and 1.7 metres tall and weighs between 25 and 70 kilograms (African Wildlife Foundation, 2018; Shefferley, 2005). The chimpanzee has arms that extend beyond the knees, opposable thumbs, and a prominent mouth. The skin on the face, ears, palms, and soles of the feet is bare, and the rest of the body is covered with long, coarse black or brown hairs (Born Free, 2024a, 2024b; IFAW, 2024). As chimpanzee's age, their forehead often becomes bald, and the back of their heads becomes grey (Nishida, 2018). Chimpanzees are quadrupedal and walk on all fours using their knuckles and feet. However, they can also walk up to a kilometre on just their legs (Pester, 2021; WWF, 2021). The chimpanzee's arm span can measure up to 1.5 times their height and they use this leverage to swing from branches (Ivory, 20007; Shefferly, 2005). Chimpanzees do not have a tail (African Wildlife Foundation, 2018; Nishida, 2018). They climb trees, constructing their arboreal nests near the canopy to provide them shelter from the elements and protection when they sleep (Hernandez-Aguila and Reitan, 2020; Koops et al., 2012; National Geographic, 2011). Chimpanzees communicate through loud vocalisations, facial expressions, and body postures (IFAW, 2024; Max Planck Institute, 2011). The chimpanzee is the closest living relative to the *Homo sapiens* sharing around 98.7% of their DNA (Goodall Institute, 2022, Prüfer et al., 2012; Southafrica.net, 2023). **General information:** The Chimpanzee has the widest geographic distribution of any great ape and can be found in savanna woodlands, grassland-forest mosaics, and tropical moist forests (GBIF, 2024). This species is endemic in Angola; Burundi; Cameroon; Central African Republic; Congo; The Democratic Republic of the Congo; Côte d'Ivoire; Equatorial Guinea (mainland); Gabon; Ghana; Guinea; Guinea-Bissau; Liberia; Mali; Nigeria; Rwanda; Senegal; Sierra Leone; South Sudan; United Republic of Tanzania and Uganda (Plumptre et al., 2016).

	Chimpanzees are omnivores (Hockings et al., 2009). The chimpanzee's diet consists of fruit, blossoms and young leaves and is supplemented by a variety of insects, small vertebrates and eggs (Shefferly, 2005). Chimpanzees can spend up to six to eight hours a day foraging for food (WWF, 2021). Due to deforestation, chimpanzees have resorted to feeding from local crops planted by villagers, such as mangoes, maize, and legumes (Dotras et al., 2024, McGuinness and Taylor, 2014; Wallace and Hill, 2012). Chimpanzees are frequent predators on small to medium bodied mammals with roughly 2% of their diet containing meat such as tortoises (Anderson, 2018; ABC News, 2019; Pika et al., 2019). The chimpanzee lives in a multi-male/multi-female group of 5 to as many as 180 individuals (Born Free, 2024a; Pester, 2021;). These groups are governed by an alpha male and alpha female (Jane Goodall Institute, 2022). The chimpanzee lives in a fission-fusion social organisation in which they will break off into smaller groups before periodically coming back together (Project R&R, 2019). Social behaviour includes grooming each other, which rids the chimpanzee of pests and encourages strong bonds to be formed amongst the troop (Jane Goodall Institute Australia, 2024). Male chimpanzee's reach sexual maturity between 12 to 15 years and female chimpanzees between 10 to 13 years (Shefferly, 2005). Upon reaching sexual maturity, female chimpanzees emigrate from their communities to find a mate, whereas the males stay within the community they are born too (Arcadi, 2018; Goldsborough et al., 2021; Wilson et al., 2014). The gestation period for a female chimpanzee is around 230 days with most female chimpanzees giving birth to a single infant, though twins have been reported (GBIF, 2024; Kelly, 2014). Chimpanzees are aggressive and territorial primates, often patrolling the borders of their colony's territories both in captivity and in the wild (BBC, 2014; Chimp Haven, 2024; David Shepherd Wildlife Foundation, 2024). Chimpanzees will attack and kill infants and adults from neighbouring communities (Born Free, 2024b; Mitani et al., 2010). Internal group aggression is rare. Most lethal aggression involves adult males as both the victim and the attacker (Anderson, 2018, Kaburu et al., 2013; Pruetz, 2017; Wilson et al., 2014). The chimpanzee will also use its aggression to compete for dominance within its troop and to obtain a mate (Pruefer et al., 2012). Chimpanzees can construct and use tools for the hunting of insects and to access the underground storage organs of plants (Pruetz & Bertolani, 2007; Hernandez-Aguilar et al., 2007). **Longevity:** The maximum recorded longevity for this species is 68 years in captivity (AnAge, 2023). In the wild, the life span of a chimpanzee can be between 40 to 45 years (WNPC, 2024). **Conservation status:**

	IUCN: Endangered with a decreasing population trend. **CITES:** Appendix I
DATE OF ORIGINAL ASSESSMENT: Dec 2024 (Aimee Carter, Penny Fisher (DEECA), DCCEEW) **EIC ENDORSEMENT:** Aug 2025 **Risk assessment model used for the assessment:** Bomford 2008, Bird and Mammal Model	**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, 2006, 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*	2	*Animal that sometimes attacks when unprovoked and/or is capable of causing serious injury (requiring hospitalisation) or fatality.*

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.*		There are several incidents on public record of chimpanzee's injuring and killing members of the public: - Chimpanzees have attacked and killed children in Kyamjaka, Uganda (Quammen, 2019). - Chimpanzees have mauled, bitten and severed limbs of people when unprovoked (ABC News, 2005; Pilkington, 2009). - Chimpanzees have 1.35 times the strength of a human and therefore could drag or pull people (O'Neill et al., 2017; Staff, 2012).
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: RISK OF ESTABLISHMENT **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, Value X = sum of classes 6 – 10, see Table 1.*	2	*Low climate match to Australia* Value X = 2,335 Climate Match Score = 2
B2. Exotic population established overseas (0–4)	0	*No exotic population ever established.*

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.		No reference found. Not listed on the Global Invasive Species Database.
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 square kilometres.* Overseas range approximately 3,900,000 km^2. This species is a resident in Angola; Burundi; Cameroon; Central African Republic; Congo; The Democratic Republic of the Congo; Côte d'Ivoire; Equatorial Guinea (mainland); Gabon; Ghana; Guinea; Guinea-Bissau; Liberia; Mali; Nigeria; Rwanda; Senegal; Sierra Leone; South Sudan; United Republic of Tanzania and Uganda. This species has been reported as extinct in Benin, Burkina Faso and Togo (Plumptre et al, 2016).
B4. Taxonomic Class (0–1) *Bird = 0; mammal = 1*	1	*Mammal*
B. ESTABLISHMENT RISK SCORE **SUM OF B1- B4 (1–13)**	4	**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* Researchers have advised that chimpanzees are considered ripe-fruit specialists (Conklin-Brittain et al., 1998; Hockings and McLennan, 2016; Watts et al., 2012), however as they are moving to crops and eat meat and insects, they have been classified as generalist.
B6. Habitat score (0–1) *Undisturbed or disturbed habitat*	1	*Disturbed Habitat.* Whalley (2019) documents chimpanzees walking across agricultural lands, encountering people, and crossing roads with large volumes of traffic (also see Hockings et al., 2006).

		Chimpanzees have also been noted to drink from the same stream where villagers collect water resulting in human-chimpanzee conflict (Pacheco et al., 2012; Quammen, 2019).
B7. Migratory score (0–1) *Always migratory = 0; non-migratory = 1*	1	*Facultative Migrant.* Upon reaching sexual maturity, female chimpanzees migrate to new social groups where they bring new skills and technology. Male chimpanzees stay with the troop they were born in. (Arcadi, 2018; Nuwer, 2024; Wilson et al., 2014). McLennan reported that villagers have seen chimpanzees travel to and from the direction of more than one 'resident area'. McLennan suggests that this movement shows the possibility of range overlap and the potential for migration. (McLennan, 2008). However, due to deforestation, chimpanzees are unable to migrate between sites that they previously had access to (Small, 1994).
B. ESTABLISHMENT RISK SCORE SUM OF B1- B7 (1–16)	7	**MODERATE establishment risk**
STAGE C: RISK OF BECOMING A PEST **Probability an established species will become a pest**		
C1. Taxonomic group (0–4)	0	*Other taxonomic group.* Family – Hominidae.
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 is less than 10 million square kilometres.* Approximately 3,900,000 km^2 This species has been reported as extinct in Benin, Burkina Faso and Togo (Plumptre et al., 2016).
C3. Diet and feeding (0–3)	3	*Mammal that is primarily a grazer or browser.* Chimpanzees are omnivores (Hockings et al., 2009). The chimpanzee's diet consists of fruit, blossoms and young leaves as well as supplemented by a variety of insects, small

		vertebrates and eggs (Shefferly, 2005). Chimpanzees can spend up to six to eight hours a day foraging for food (WWF, 2021). Due to deforestation, chimpanzees have resorted to feeding from local crops planted by villagers, such as mangoes, maize and legumes (Dotras et al., 2024; McGuinness & Taylor, 2014; Wallace & Hill, 2012). For example, McLennan noted cultivated jackfruit became a "staple" in the chimpanzee's diet following deforestation (McLennan et al., 2020). Chimpanzees are frequent predators on small to medium bodied mammals with roughly 2% of their diet containing meat such as tortoises (ABC News, 2019; Anderson, 2018; Pika et al., 2019)
C4. Competition with native fauna for tree hollows (0–2)	0	*Does not use tree hollows.* Chimpanzees construct arboreal nests in trees (Hernandez-Aguila and Reitan, 2020; Koops et al., 2012).
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.* Chimpanzees play a role in seed dispersal by defecation throughout their habitats (Lambert, 1999; Pacheco et al., 2012). A sample of chimpanzee dung found that 98.5% of it contained seeds, with fig seeds being the most common. The research also noted that gut passage increased the speed and germination of seeds with an estimated 369 large seeds dispersed per kilometre per day (Wrangham et al., 1994).
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 between 63 – 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 (DCCEEW Protected Matters Search Tool): *Calidris ferruginea* (Curlew Sandpiper) – Critically Endangered *Numenius madagascariensis* (Eastern Curlew, Far Eastern Curlew) – Critically Endangered *Tiliqua scincoides intermedia* (Northern Blue Tongued Skink) – Critically Endangered
C7. Overseas primary production pest status (0–3)	2	*Moderate pest of primary production in any country or region.*

Has the species been reported to damage crops or other primary production in any country or region of the world?		Chimpanzees will raid crops and cash crops to get food resources (Gill, 2014; McLennan, 2012 & 2014). At Bossou in Guinea, crops accounted for an average 8.8% of chimpanzee feeding time in 2010 (Hockings et al., 2010) and 14% in 2014 (McLennan & Hockings, 2014). Through the raiding of crops, farmers need to replace the shoots which is costly (Tweheyo et al., 2005). Chimpanzees have also raided domestic animal shelters and taken animals such as chickens (McLennan, 2008). McGuinness and Taylor (2014) report that in Rwanda, replacement costs for crop losses possibly reached between 10% to 20% of a total households' income.
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*	4	Total Commodity Damage Score = 126 (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).* Primates amplify pathogens which pose a risk to humans and animals (Lonsdorf et al, 2021; Ortolani, 219). All species can play a role in the spread of diseases or parasites to other animals (native species and on livestock and other domestic animals) or to humans (zoonotic). For further information on the impacts of zoonotic diseases, the following links are available: Department of Agriculture, Fisheries and Forestry - Animal Import Risk Analysis Department of Agriculture, Fisheries and Forestry - Exotic Environmental Pest List Wildlife Health Australia - Fact Sheets
C10. Harm to property (0–3)	1	*$1.00 - $10 million*

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.		Chimpanzees are tolerated by farmers as they consider the primates prevent the presence of other more destructive primates (Dotras et al., 2024). Compensation and insurance schemes are established in different countries to assist with the financial costs of crop raiding and damage to property from wildlife (McGuinness & Taylor, 2014). For example, Rwanda will provide compensation for loss or damage to property from wildlife (Rwandalii.org, 2011). The amount of compensation received depends on a case-by-case basis (Bowen-Jones, 2012). However, according to Hockings and McLennan (2016), damage to property by chimpanzees is rare with minor damage being inflicted on fences as the chimpanzee's cross terrain to access crops.
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.* There are several incidents on public record of chimpanzee's injuring and killing members of the public: - Chimpanzees have attacked and killed children in Kyamjaka, Uganda (Quammen, 2019). - Chimpanzees have mauled, bitten and severed limbs of people when unprovoked (ABC News, 2005; Pilkington, 2009). - Chimpanzees have 1.35 times the strength of a human and therefore can drag or pull people (O'Neill et al., 2017; Staff, 2012).
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	4	LOW establishment risk

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*		
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*	7	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*	21	EXTREME pest risk

ENVIRONMENT AND INVASIVES COMMITTEE THREAT CATEGORY	**EXTREME**

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

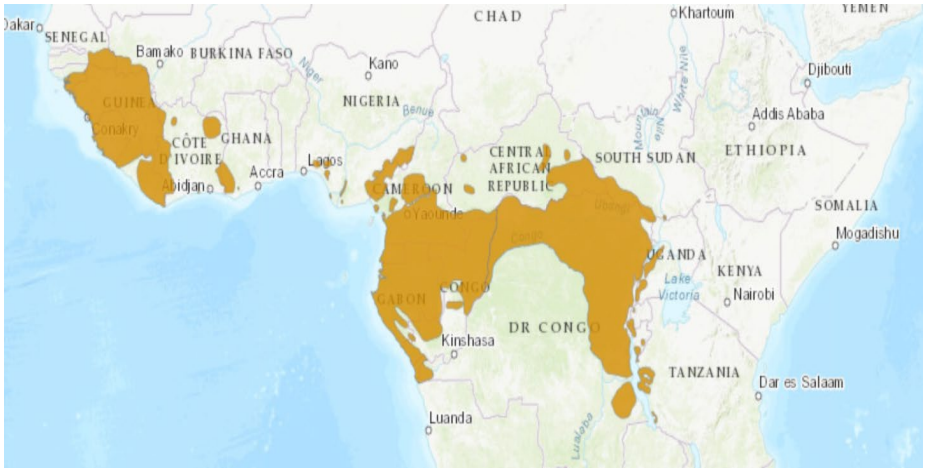


Figure 1 - World Distribution map - IUCN Red List

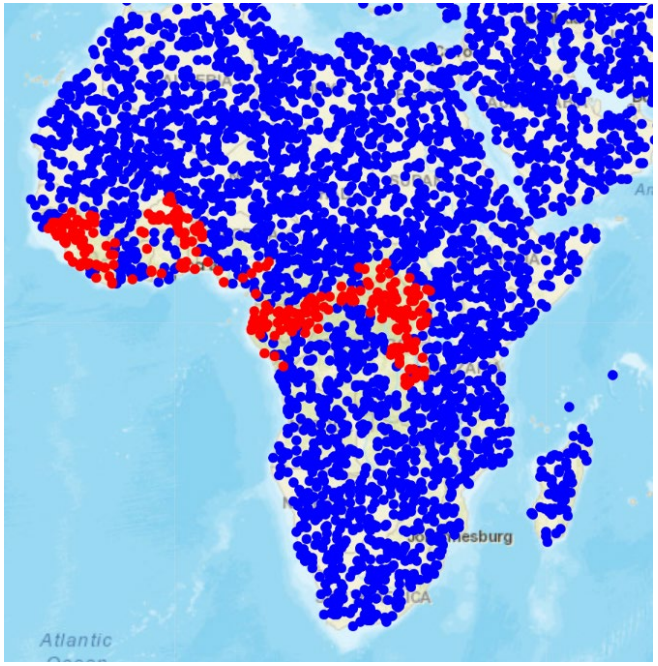
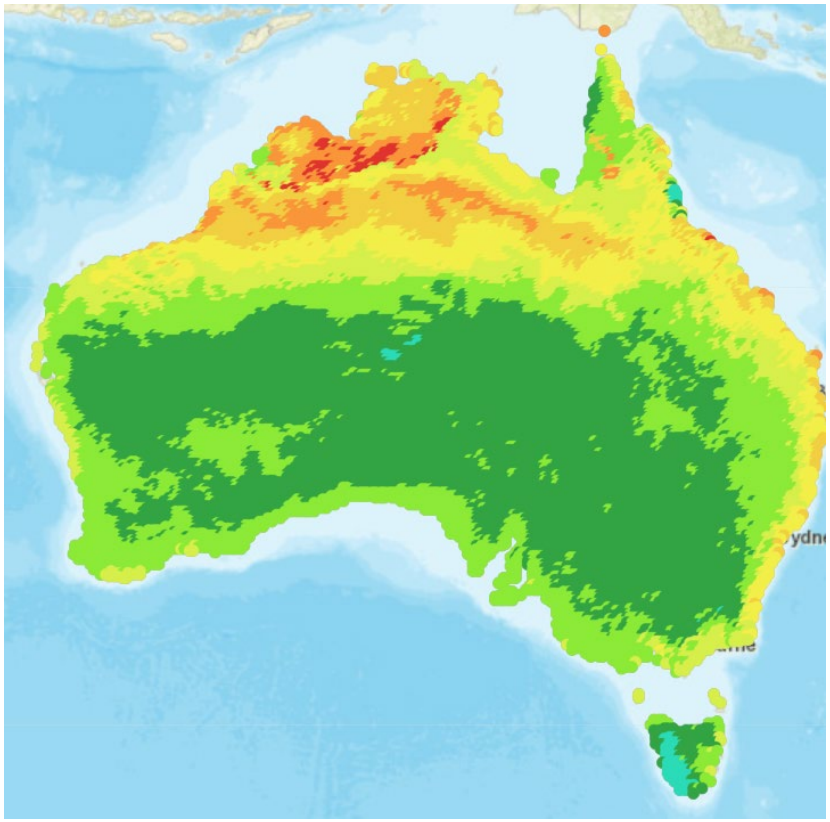


Figure 2 - World Distribution map - Climatch

Climate match between world distribution of species and Australia:

Areas of Australia where the climate appears suitable for *Pan troglodytes*

Value X = 2,335



Score	Color	Count
0		0
1		76
2		8143
3		4372
4		2148
5		2162
6		1507
7		719
8		109
9		0
10		0

Species: Pan troglodytes (Chimpanzee)
Algorithm: Closest Standard Score
278 source features selected
19236 target features selected
Approximate selected area: 3,808,681 km^2

Table 1: ABARES recalibration thresholds

Climate Match Score (CMS)	Climatch (50 km) Closest Standard Match Sum Level 6 (Value X)	2021 Recalibrated Climatch v2.0 (20 km) Closest Standard Match Sum Level 6 (Value X)
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 2020 – 2021 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 products and beef)	13	1	2	26
Forestry (includes hardwood and softwood)	2	2	2	8
Cereal grain (includes wheat, barley, sorghum, corn, oats etc)	10	2	2	40
Sheep (includes wool and sheep meat)	5	1	0	0
Fruit and nuts (includes wine grapes)	5	2	2	20
Vegetables	3	2	2	12
Poultry and eggs	3	3	0	0
Fisheries products	2			
Oilseeds (includes canola, soybeans and sunflower etc)	2	2	0	0
Grain legumes and pulses	1	2	2	4
Sugarcane	1	3	5	15
Cotton	1			
Other crops and horticulture (includes nurseries and flowers)	3	2	0	0
Pigs	1	1	0	0
Other livestock (includes goats, deer, camels, rabbits)	0.1	2	5	1
Bees (includes honey and beeswax)	0.1			
Total Commodity Damage Score (TCDS)				126

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 (i.e. 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 (i.e. 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 (i.e. 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**		

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National Risk Assessment: EXTREME

RISK ASSESSMENT FOR AUSTRALIA: African Buffalo (*Syncerus caffer*)

Class - Mammalia**, Order -** Artiodactyla**, Family -** Bovidae**, Genus -** *Syncerus*.

SPECIES: *Syncerus caffer* (Sparrman, 1779) **Subspecies:** *Syncerus caffer aequinoctialis* (Blyth, 1866) - Central African Buffalo *Syncerus caffer brachyceros* (Gray, 1837) - West Africa Savannah Buffalo *Syncerus caffer caffer* (Sparrman, 1779) - Cape Buffalo /Southern Savana Buffalo *Syncerus caffer nanus* (Boddaert, 1785) - Forest Buffalo **Common Names:** African Buffalo Cape Buffalo Forest Buffalo West African savannah buffalo Central African buffalo Congo Buffalo Lake Chad Buffalo Southern Savana Buffalo	**Species description:** The African buffalo is a large bodied ungulate and is considered one of the "Big Five" in Africa. The African buffalo ranges in colour from dark brown or black to bright red (*Syncerus caffer nanus*) (Groucho, 2025; Huffman, 2024). When a juvenile is born, they are often born a reddish-brown with their coat changing as they mature (AWF, 2019). The African buffalo's body is heavy set, with a large head, a short neck and stocky legs. The front hooves are larger to support the weight of the head and torso. African buffalos have a long tail ending in a tuft of long hair (between 55 to 120 centimetres depending on sub-species) and drooped ears (Cornelis et al., 2014; Furstenburg, 2020). They can reach heights of up to 1.5 metres and can weigh between 300 to 900 kilograms (Kruger Park, 2024; Huffman, 2024). Sexual dimorphism exists in this species. For example, both male and female African buffalo have horns however, the males are larger than the females. In males, the horns are fused to the base of the head, forming a bone shield across the top of the buffalo's head called a boss (Groucho, 2025). The different subspecies also have a variance in horn shape and size with the *Syncerus caffer nanus* having shorter horns with no boss and the *Syncerus caffer caffer* having hooked shaped horns and the males having a large prominent boss (Cornelis et al., 2014; Huffman, 2024). African buffalo have great eyesight, hearing and smell which assists them in navigating their environment and spotting predators (Ng, 2015). They are also good swimmers and cross rivers regularly. They will take to water to find better grazing areas or to escape from predators (BBC News, 2018; Furstenburg, 2020). **General information:** This species is endemic to Angola; Benin; Botswana; Burkina Faso; Burundi; Cameroon; Central African Republic; Chad; Congo; The Democratic Republic of the Congo; Côte d'Ivoire; Equatorial Guinea; Ethiopia; Gabon; Ghana; Guinea; Guinea-Bissau; Kenya; Liberia; Malawi; Mali; Mozambique; Namibia; Niger; Nigeria;

	Rwanda; Senegal; Sierra Leone; Somalia; South Africa; South Sudan; Sudan; United Republic of Tanzania; Togo; Uganda; Zambia and Zimbabwe (Cornelis et al., 2023; IUCN SSC Antelope Specialist Group, 2018). It was extant and reintroduced to Eswatini (Cornelis et al., 2016; IUCN SSC Antelope Specialist Group, 2018; Tambling, 2022). The African buffalo inhabits savannas, dry shrubland and grassy clearings in dense tropical rainforests (Cornelis et al., 2023). The African buffalo is water dependent (preferring a proximity of less than a kilometre to water) and can be found at altitudes exceeding 4,000 metres (Kaszta et al., 2016; Ng, 2015). The African buffalo is active both at day and night, with most of the feeding taking place after sunset. They avoid peak temperatures due to thermoregulatory considerations (Taylor et al., 2023). African Buffalo require large amounts of vegetation to sustain themselves often having extensive periods of feeding followed by resting and ruminating periods (AWF, 2019; Kaszta et al., 2016; Ng, 2015). African buffalo are herbivores (Bennitt, 2024), mainly eating grass, leaves and other plants and will chew on cud to extract further nutrients (African Wildlife Foundation, 2019; Groucho, 2025; Ng, 2015). African buffalo are bulk grazers depending on large areas of herbaceous forage and can be a selective feeder when the opportunity for higher quality foraging sites is available (Bar-David et al., 2009; Cornelis et al., 2014; Kaszta, 2016). Strongly gregarious, African buffalo can range in herds from a dozen up to 1,000 individuals (GBIF, 2025; Winnie et al., 2008). The herds are made up of related females and their offsprings with males forming bachelor herds and only returning to the main herd during mating seasons. Herds are dynamic and African buffalo will often split into smaller herds during the dry season and reconvene during the rainy season (Dixon, 2023; Ng, 2015). Female African buffalo have their first calf at age 4 or 5 and have a gestation period of 330 days with a singular calf born usually every 2 years. The calf is dependent on its mother for up to a year. Around four years old, the male African buffalo will leave the herd whereas the females display a sense of loyalty to their birth herd and remain with them throughout her life (AWF, 2019; Kruger Park, 2024). Males establish dominance through a variety of displays and threatening behaviour; from demonstrating the size of their horns (and thrashing these up and down) through to head-on combat (noting that this behaviour between mature males is relatively rare) (GBIF, 2025). African buffalo regularly bathe in mud to help remove insects, ticks and parasites that may latch onto their skin (Mohr, 2019). **Longevity:**

	The maximum recorded longevity for this species is 32.8 years in captivity and on average 18 years in the wild (AnAge, 2025). **Conservation status:** **IUCN:** Near Threatened **CITES:** Not listed (Huffman, 2024; Jirik, 2024)
DATE OF ORIGINAL ASSESSMENT: Jan 2025 (Aimee Carter, Penny Fisher (DEECA), DCCEEW) **EIC ENDORSEMENT:** Aug 2025 **Risk assessment model used for the assessment:** Bomford 2008, Bird and Mammal Model	**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, 2006, 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.*	2	*Animal that sometimes attacks when unprovoked and/or is capable of causing serious injury (requiring hospitalisation) or fatality.* There are several incidents on public record of African buffalo injuring and killing members of the public: - An unprovoked attack resulted in the medical evacuation and hospitalisation of a women in Tanzania (Global Rescue, 2011). - A student was attacked whilst trekking through Serengeti (Currin, 2005). - Multiple deaths have been reported because of African buffalo attacks (Malm, 2018; Wilson, 2004; Wray, 2024). It is estimated that they may kill as many as 200 people per year (Mukamuri et al., 2023).
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: RISK OF ESTABLISHMENT **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 = 9,639 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, Value X = 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 population ever established.* No exotic population has been established as reported on the Global Invasive Species Database (GISD, 2024).
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 square kilometres.* Overseas range for the African buffalo is approximately 10,707,000 km^2. The African buffalo is extinct in Eritrea, Gambia and Lesotho (IUCN SSC Antelope Specialist Group, 2018).
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* The African buffalo is a bulk grazer and selective feeder when the opportunity for higher quality foraging sites is available (Bar-David et al., 2009; Kaszta, 2016).
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 African buffalo lives in a disturbed habitat that is fragmented through the development of human society (AWF, 2019; Mukamuri et al., 2023).
B7. Migratory score (0–1) *Always migratory = 0; non-migratory = 1*	1	*Facultative migrant in its native range.* African buffalo are facultative migrants and require a constant and large water source. Their home ranges will follow this water source (Bennit, 2024; GBIF, 2025). Some African buffalo will stay stationary if the resources are sufficient (Naidoo et al., 2012). The African buffalo's home ranges vary in distance depending on whether it is the wet or dry season (Roug, 2020). In the wet season, they move away from permanent water sources and prefer the use of ephemeral water sources due to the abundance of forage that is available to them. However, in the dry season, African buffalo occupy habitats that are closer to a permanent water source (Bennitt et al., 2014; Naidoo et al., 2012).
B. ESTABLISHMENT RISK SCORE SUM OF B1- B7 (1–16)	9	**MODERATE establishment risk**
STAGE C: RISK OF BECOMING A PEST **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 kilometres*	1	*Overseas geographic range 10 – 30 million square kilometres* Approximately 10,707,000 km^2 The African buffalo is extinct in Eritrea, Gambia and Lesotho (IUCN SSC Antelope Specialist Group, 2018).
C3. Diet and feeding (0–3)	3	*Mammal that is primarily a grazer or browser.*

		African buffalo are herbivores (Bennitt, 2024). They mainly eat grass, leaves and other plants and will chew on cud to extract further nutrients (African Wildlife Foundation, 2019; Groucho, 2025; Ng, 2015).
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?*	2	*Moderate environmental pest in any country or region.* African buffalo can change plant communities and the dynamics of other herbivore populations through their grazing patterns (Bar-David et al., 2009; McNaughton, 1985; Thompson, 2015; Winnie et al., 2008). They trample and turn up soil resulting in the regrowth of vegetation but with the potential for soil erosion. They also disperse seeds through the vegetation they have eaten (IFAW, 2024).
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 that overlap the distribution of any susceptible native species or ecological communities = 5* Examples of susceptible native species or ecological communities include (DCCEEW Protected Matters Search Tool): *Botaurus poiciloptilus* (Australasian Bittern) – Endangered *Pedionomus torquatus* (Plains-wanderer) – Critically Endangered *Litoria nyakalensis* (Mountain Mist Frog, Nyakala Frog) – Critically Endangered *Pseudomys shortridgei* (Heath Mouse, Dayang, Heath Rat) – 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 environmental pest in any country or region.* Africa buffalo will damage and raid crops through feeding and trampling (Geleta et al., 2019). Common crops that were noted to be destroyed by African buffalo include cereal grains (wheat, maize), corn, pea, and broad bean (Geleta et al.,2019; Hariohay et al., 2024: Long, 19) with most crop damage reported in the wet season than in the dry (Hariohay et al., 2024). African buffalo have also been recorded as killing livestock such as cattle (Long, 2019; Mukeka et al., 2019).

		Insurance schemes and mitigation strategies have been implemented to cover the cost to local farmers of livestock killed by African buffalo or undertaking capture operations (Hendry, 2021; Leslie et al., 2019) Anderson & Pariela (2005) suggest that the human-buffalo conflict could be the 'most economically harmful' to the cattle industry in Mozambique and could affect agricultural development. African buffalo are a vector for spreading foot and mouth disease (FMD) to cattle with few infected buffalo developing clinical signs of the disease (Sutmoller et al., 2000). This could cause economic losses to the livestock industry by both the deaths of the cattle and through the losses sustained through FMD free certification. Between 2010 and 2021, it was estimated that an average outbreak of FMD in Ethiopia resulted in a national average annual cost of USD 0.9 million (Rasmussen et al., 2024).
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*	5	Total Commodity Damage Score = 477.30 (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).* The African buffalo can carry and spread infectious diseases to their environment (Bengis et al, 2023; Maree et al, 2016). African buffalo can be asymptomatic to diseases and are vectors for the transmission of diseases such as FMD, *Theileria parva* and Bovine tuberculosis (Michel & Bengis, 2011; Morrison et al., 2015 & 2020). All species can play a role in the spread of diseases or parasites to other animals (native species and on livestock and other domestic animals) or to humans (zoonotic).

		For further information on the impacts of zoonotic diseases, the following links are available: Department of Agriculture, Fisheries and Forestry - Animal Import Risk Analysis Department of Agriculture, Fisheries and Forestry - Exotic Environmental Pest List Wildlife Health Australia - Fact Sheets
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	*$1.00 - $10 million* Africa buffalo are known to damage property and break fences (AWF, 2019). In Kenya from 2005 to 2016, 5% of property damage was caused by buffalo which included damage to water structures, fences, and houses (Long, 2019).
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.* There are several incidents on public record of African buffalo injuring and killing members of the public: - An unprovoked attack resulted in the medical evacuation and hospitalisation of a women in Tanzania (Global Rescue, 2011). - A student was attacked whilst trekking through Serengeti (Currin, 2005). - Multiple deaths have been reported because of African Buffalo attacks (Malm, 2018; Wilson, 2004; Wray, 2024). It is estimated that they may kill as many as 200 people per year (Mukamuri et al., 2023).
C. PEST RISK SCORE SUM C 1 TO C 11 (1–37)	28	**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)**	6	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*	9	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*	28	EXTREME pest risk

ENVIRONMENT AND INVASIVES COMMITTEE THREAT CATEGORY	**EXTREME**

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

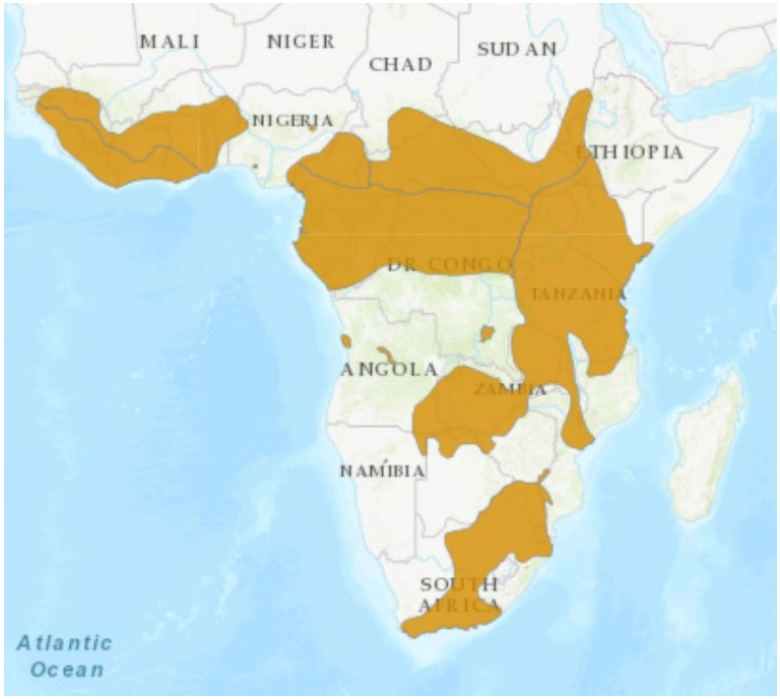


Figure 1 - World Distribution Map - IUCN Red List

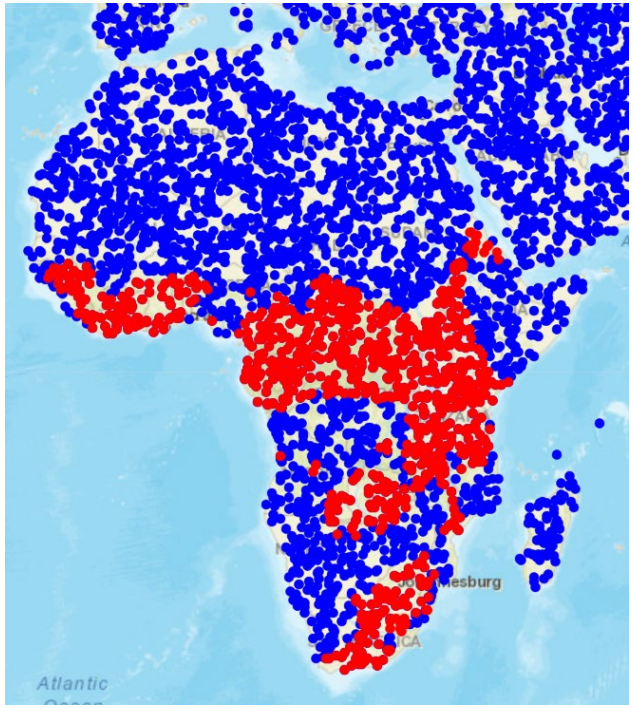
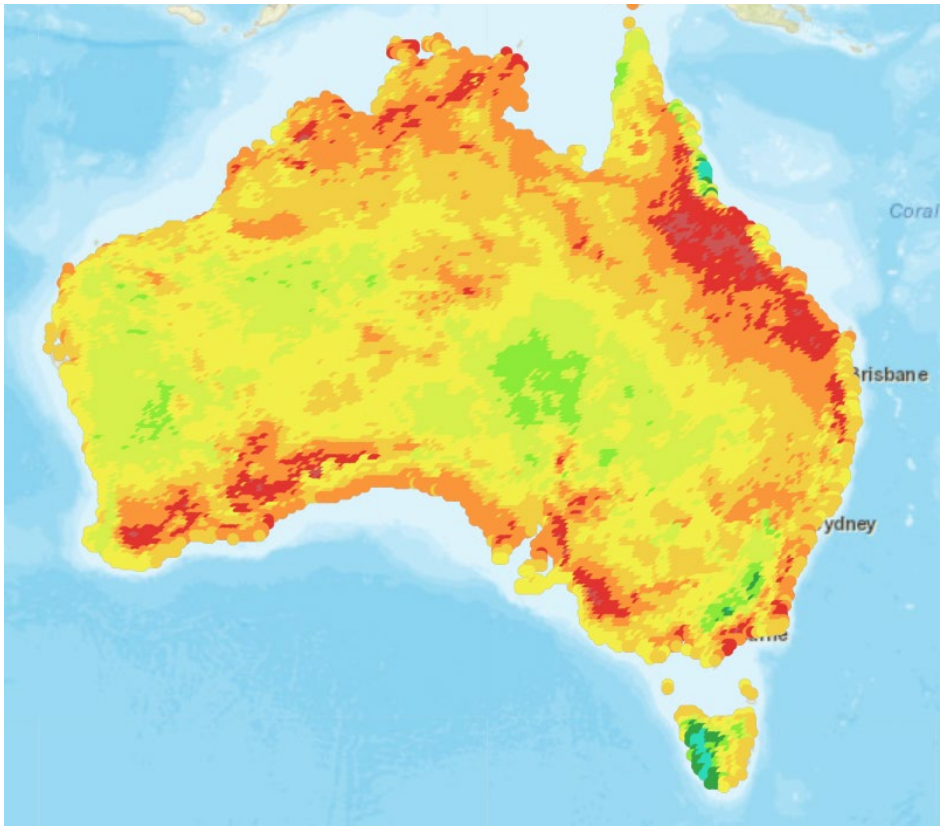


Figure 2 - World Distribution Map - Climatch

Climate match between world distribution of species and Australia:

Areas of Australia where the climate appears suitable for *Syncerus caffer*

Value X = 9,639



Score	Color	Count
0		0
1		30
2		47
3		529
4		3480
5		5511
6		5097
7		3324
8		1069
9		149
10		0

Species: Syncerus caffer (African Buffalo)
Algorithm: Closest Standard Score
941 source features selected
19236 target features selected
Approximate selected area: 10,706,490 km^2

Table 1: ABARES recalibration thresholds

Climate Match Score (CMS)	Climatch (50 km) Closest Standard Match Sum Level 6 (Value X)	2021 Recalibrated Climatch v2.0 (20 km) Closest Standard Match Sum Level 6 (Value X)
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 2020 – 2021 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 products and beef)	13	3	5	195
Forestry (includes hardwood and softwood)	2	1	4	8
Cereal grain (includes wheat, barley, sorghum, corn, oats etc)	10	2	5	100
Sheep (includes wool and sheep meat)	5	3	5	75
Fruit and nuts (includes wine grapes)	5	2	3	30
Vegetables	3	2	4	24
Poultry and eggs	3			
Fisheries products	2			
Oilseeds (includes canola, soybeans and sunflower etc)	2	1	4	8
Grain legumes and pulses	1	1	4	4
Sugarcane	1			
Cotton	1			
Other crops and horticulture (includes nurseries and flowers)	3	2	4	24
Pigs	1	3	3	9
Other livestock (includes goats, deer, camels, rabbits)	0.1	1	3	0.3
Bees (includes honey and beeswax)	0.1			
Total Commodity Damage Score (TCDS)				477.30

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 (i.e. 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 (i.e. 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 (i.e. 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**		

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National Risk Assessment: EXTREME

RISK ASSESSMENT FOR AUSTRALIA: **Cantil (*Agkistrodon bilineatus*)**

Class - Reptilia**, Order -** Squamata**, Family -** Viperidae**, Genus –** *Agkistrodon.*

SPECIES: *Agkistrodon bilineatus* (Günther, 1863) **Sub Species:** *Agkistrodon bilineatus bilineatus* (Günther, 1863) *Agkistrodon bilineatus howardgloydi* (Conant, 1984) *Agkistrodon bilineatus russeolus* (Gloyd, 1972) **Synonyms:** *Agkistrodon bilineatus bilineatus* (Günther, 1863) *Trigonocephalus specialis* (Recinos, 1954) *Arkistrodon bilineatus* (Martin del Campo, 1953) *Ankistrodon bilineatum* (F. Müller, 1877) *Ancistrodonus bilineatus* (A.L. Herrera, 1899) *Ancistrodon bilinaetus (Villa, 1962)* **Common Names:** Cantil	**Species description:** The cantil is a venomous pit viper named due to the "indented, heat-sensing pits located between the nostrils and eyes" (Gwaltney-Brant et al., 2012; Tangella, 2022). There are three recognised subspecies: *A. b. bilineatus, A. b. russeolus, and A. b. howardgloydi*. The cantil has a stout body shape and can range in length from 0.6 to 1.3 metres (Lomonte et al., 2013). The cantil has a triangular head with two thin light lines on the side of their head. For *A. b. bilineatus,* the upper line is narrow and travels along the canthus continuing behind the eye. The second lower line is wider travelling along the upper part of the supralabials to the corner of the mouth (Gloyd, 1972; U.S. Office of Naval Intelligence; 1968). For *A. b. russeolus,* the upper line is narrow and may be intermittent behind the eye while the lower line is wider and continuous down the body. These lines are separated by a broad dark reddish brown cheek stripe (Gloyd, 1972; Gloyd and Conant, 1990). *A. b. howardgloydi* has an upper line which is narrow, and the posterior part is often broken or absent. The lower line is wider and splits into two parts, which may often meet at the suture of the second or third supralabial scale (Conant, 1984; Gloyd and Conant, 1990). The cantil has small eyes with vertically oval pupils (Porras et al., 2013). The colouration of the cantil differs between the three subspecies: ***A. b. bilineatus:*** As adults the dorsal coloration of *A. b. bilineatus* is very dark brown to black and crossbands are usually absent or if present they are difficult to detect. Sexual colour dimorphism has not been reported in *A. b. bilineatus.* Along the dorsal area *A. b. bilineatus* juveniles are shades of brown with crossbands, which are flecked white on their lateral edges, and separated by a paler ground cover. As neonates they also have a bright yellow tail tip (Porras et al., 2013). ***A. b. russeolus:*** The dorsal ground colour of the adult *A. b. russeolus* is typically pale reddish brown. Their crossbands are broad and range from a deep reddish brown to brown. Unlike *A. b. bilineatus*, *A. b. russeolus* crossbands remain apparent even as an older adult. The centres of the crossband often have one or two darks spots and are often "separated dorsally by areas of paler colouration and edged irregularly with white" (Porras

Mexican Cantil Mexican Ground Pit Viper Mexican Moccasin Mexican Pit Viper Black Moccasin	et al., 2013). As neonates they have a grey tail tip that darkens as they mature. Sexual colour dimorphism has not been reported in *A. b. russeolus* (Gloyd, 1972; Gloyd and Conant, 1990; Porras et al., 2013). ***A. b. howardgloydi:*** The dorsal ground colour of the adult *A. b. howardgloydi* is reddish brown or brown. In Nicaragua, *A. b. howardgloydi* has been reported to have black pigmentation with darker crossbands (Porras et al., 2013). The chin and throat are either orange yellow, bright orange, or brownish orange and have several small white spots. However, this colouring stops at the ventral scales with the venter becoming darker. Juveniles have a dorsal colour that is typically tan to reddish orange with distinguishable reddish brown crossbands. These crossbands are edged intermittently with white and/or black as they approach the venter. The juvenile's tail tip is banded with a sequential pattern. The colours range from a dark grey to pale grey and are interspaced with a white or pale grey pattern. Sexual colour dimorphism has been reported in *A. b. howardgloydi* with females often distinctly banded and paler in overall colouration (Conant, 1984; Gloyd and Conant, 1990; Porras et al., 2013). The cantil is generally shy in nature either fleeing or camouflaging into the scrub if disturbed. If this does not deter the predator or they are unable to flee they will strike (Wildlife North America, 2025). In its native habitat, the cantil is feared among the local populace (due to the toxicity of its venom) and is often killed when spotted (Hardy et al., 1969). The cantil has hinged fangs between 4 to 6 millimetres long (Olivo, 2025; Smetsers, 1993). Antivenom is available to combat the effects of a cantil snake bite, however, severe swelling, motor impairment and even fatalities have occurred (Guadarrama-Martínez et al., 2024; Lonati et al., 2005; State Toxicology Services, 2025). **General information** Distribution: endemic in Belize, Costa Rica, El Salvador, Guatemala, Honduras, Mexico and Nicaragua (Chaves et al., 2021). Habitat: occupies lowland areas within tropical deciduous forests, dry or thorn forests and savannas (Monroy-Vilchis et al, 2024; Porras et al, 2012). It can be found at elevations from sea level to 1,500 metres above sea level (Wilson & Johnson, 2010). Diet: Juveniles prey primarily on reptiles and amphibians, such as lizards and frogs, and adults prey on rodents (Gloyd & Conant, 1990; Lomonte et al., 2013; McAlister et al., 2021). Reproduction: ovoviviparous, producing 5 to 20 live young per clutch (Britannica, 2025). **Longevity:**

	In captivity is 24.3 years (AnAge, 2024). The World Life Expectancy (2025) records longevity as 24 years in captivity. **Conservation status:** **IUCN:** Near Threatened **CITES:** Not Listed
DATE OF ASSESSMENT: Jan 2025 **EIC ENDORSEMENT:** Aug 2025 **Risk assessment model used for the assessment:** Bomford 2006, Risk assessment for the establishment of exotic vertebrates in Australia: recalibration and refinement of models **Australian Reptile and Amphibian Model (Bomford 2008)** Bird and Mammal Model for Reptiles and Amphibians (Bomford 2008)	**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, 2006, 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/.

Risk assessment for the establishment of exotic vertebrates in Australia: recalibration and refinement of models (Bomford 2006):

FACTOR	SCORE	DETAIL
STAGE A: RISKS POSED BY CAPTIVE OR RELEASED ANIMALS		

A. Climate match risk score *Map the selected reptile or amphibian species' overseas range, including its entire native and exotic (excluding Australia) ranges over the past 1000 years. Use CLIMATCH v2.0 to determine the climate match between this overseas range and Australia, selecting Euclidian Match and using all 16 climate variables for the analysis.* *CMS = sum of classes 7 – 10* *CMRS = 100 x (CMS/19236).*	31.47	CMRS = 100 x (6,053/19,236) = 31.46704096485756 CMRS = 31.47 Note: The species has two GBIF georeferenced occurrences from outside its natural range (Manitoba, Canada and Nex Mexico, United States of America) (Barrow and Giermakowski, 2025; Morris, 2025). These occurrences have been presumed to be waifs rather than an established population and have not been added to the statistics (see Figure 2 for reported location not included).
B. Exotic Elsewhere Risk score (0, 15 or 30) *Score B = A species' Exotic Elsewhere Risk Score, calculated as follows:* • *Species has established breeding self-sustaining exotic population in another country = 30* • *Species has been introduced into another country and records exist of it in the wild, but it is uncertain if a breeding self-sustaining population has established = 15* • *Species has not established an exotic population (including species not known to have been introduced anywhere) = 0*	0	*No evidence the species has ever established an exotic population.* Overseas natural range size is estimated at 0.9 million km^2 including current and past 1,000 years.
C. Taxonomic Family Risk Score	10	*Viperidae*
ESTABLISHMENT RISK RANK *A species' Establishment Risk Score = Score A + Score B + Score C.* *Establishment Risk Rank — Establishment Risk Score* *Low — ≤ 22* *Moderate — 23-60* *Serious — 61-115* *Extreme — ≥ 116*	41.47	**MODERATE establishment risk**

Bird and Mammal Model for Reptiles and Amphibians:

A. Degree of climate match between species overseas range and Australia (1–6) *Map the selected reptile or amphibian species' overseas range, including its entire native and exotic (excluding Australia) ranges over the past 1000 years.* *Use CLIMATCH v2.0, Value X = sum of classes 6 – 10, see Table 1.*	3	*Moderate match to Australia* Value X = 5,894 CMS = 3 Note: The species has two GBIF georeferenced occurrences from outside its natural range (Manitoba, Canada and Nex Mexico, United States of America) (Barrow and Giermakowski, 2025; Morris, 2025). These occurrences have been presumed to be waifs rather than an established population and have not been added to the statistics (see Figure 2 for reported location not included).
B. 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 evidence the species has ever established an exotic population.* The cantil is endemic in Belize, Costa Rica, El Salvador, Guatemala, Honduras, Mexico and Nicaragua (Chaves et al., 2021).
C. Overseas range size score (0–2) < 1 = 0; 2– 69 = 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 size is less than 1 million square kilometres.* Overseas natural range size is estimated at 0.9 million km^2 including current and past 1,000 years, natural and introduced range.
ESTABLISHMENT RISK RANK *A species' Establishment Risk Score = Score A + Score B + Score C.* *Establishment Risk Rank — Establishment Risk Score* *Low — ≤ 4* *Moderate — 5-7* *Serious — 8-9* *Extreme — 10-12*	3	**LOW establishment risk**

ENVIRONMENT AND INVASIVES COMMITTEE THREAT CATEGORY*	**EXTREME***
*For reptiles and amphibians, the assessed Establishment Risk Rank is combined with an allocated Extreme Pest Risk Rank (based on the precautionary approach), resulting in the Assignment of species into one of two EIC Threat Categories: Extreme or Serious.	*Score assigned based on the highest Establishment Risk Rank (based on the precautionary approach).

NOTE: Where multiple Bomford risks assessment models are applicable, all models have been assessed and the threat category has been assigned based on a precautionary approach, meaning the highest threat category has been assigned and used to calculate the Environment and Invasives Committee Threat Category.

World distribution map (IUCN Red List); world Georeferenced records (GBIF); and Climatch world distribution map indicating where meteorological data was sourced for the climate analysis:

Figure 1 - World Distribution Map - IUCN Red List

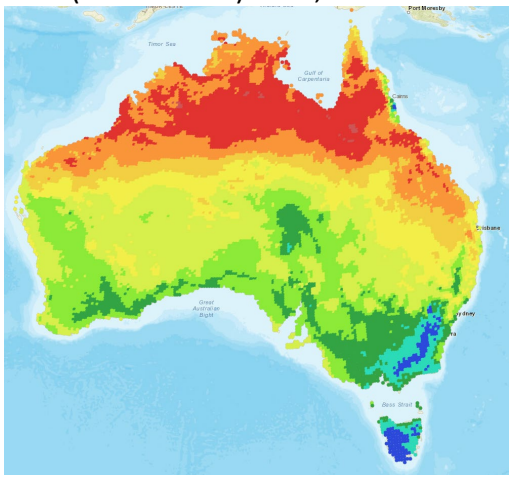
Figure 2 - World Georeferenced records (GBIF)

Figure 3 - World Distribution map – Climatch

Australian Reptile and Amphibian Model (Bomford 2006): Climate match between world distribution of species and Australia:

Areas of Australia where the climate appears suitable for *Agkistrodon bilineatus*

CMS (Sum Level 7) = = 6,053



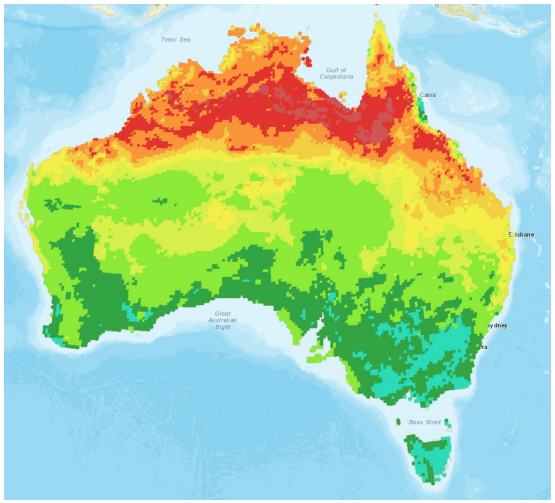
Score	Color	Count
0		185
1		367
2		1366
3		3145
4		4177
5		2201
6		1742
7		3095
8		2921
9		37
10		0

Species: Agkistrodon bilineatus (Mexican Cantil)
Algorithm: Euclidean
56 source features selected
19236 target features selected
Approximate selected area: 899,796 km^2

Bird and Mammal model for reptiles and amphibians (Bomford 2008): Climate match between world distribution of species and Australia:

Areas of Australia where the climate appears suitable for *Agkistrodon bilineatus*

Value X (Sum Level 6) = 5,894



Score	Color	Count
0		0
1		723
2		3071
3		5480
4		2509
5		1559
6		1371
7		2336
8		1804
9		383
10		0

Species: Agkistrodon bilineatus (Mexican Cantil)
Algorithm: Closest Standard Score
56 source features selected
19236 target features selected
Approximate selected area: 899,796 km^2

Table 1: ABARES recalibration thresholds

Climate Match Score (CMS)	Climatch (50 km) Closest Standard Match Sum Level 6 (Value X)	2021 Recalibrated Climatch v2.0 (20 km) Closest Standard Match Sum Level 6 (Value X)
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: 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**		

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National Risk Assessment: EXTREME

RISK ASSESSMENT FOR AUSTRALIA: # Dumeril's Boa (*Acrantophis dumerili*)

Class - Reptilia**, Order -** Squamata**, Family -** Boidae**, Genus –** *Acrantophis*

SPECIES: *Acrantophis dumerili* (Jan, 1860) **Subspecies:** Monotypic **Synonyms:** *Boa dumerili* (Jan, 1860) *Boa dumerili* (Boulenger, 1893) *Acrantophis madagascariensis dumerili* (Duméril and Bibron, 1844) *Acrantophis madagascariensis dumerili* (Stull, 1935) **Common names:** Dumeril's Boa Dumeril's Ground Boa Madagascar Ground Boa	**Species description:** The Dumeril's boa is a large, heavy bodied ground snake. It can grow up to 2 metres long and is typically grey-brown or reddish-brown with darker patches, allowing it to camouflage amongst the tree litter (Christy, 2016; Healey, 2016). They have elliptical pupils and a forked tongue which is used to detect odours in the air such as nearby prey or chemical communications from other Dumeril's boas (Oakland Zoo, 2025). The species is sexually dimorphic with the females being larger overall and the males having a longer thinner tail, and spurs used for courtship (Peoria Zoo, 2014). Adult Dumeril's boas are cathemeral (active either during the day or at night) whereas the juveniles tend to be nocturnal (Christy, 2016; Marwell Zoo, 2024). The Dumeril's boa survives in extremely hot and dry conditions by shielding itself underground in mammal burrows or under fallen debris piles (Exotic Keeper Magazine, 2024; Jungle Dragon, 2025). The Dumeril's boa is a solitary animal which will undergo a period of brumation (state or condition of sluggishness, inactivity, or torpor**)** in the cooler and drier winter months (Peoria Zoo, 2014). **General information:** Distribution: Dumeril's boa is endemic to the south and southwest of the island of Madagascar. The boa's current range is estimated at 242,716 km^2, from sea level to elevations of 1,300 metres (Raxwothy et al., 2011). Habitat: The Dumeril's boa lives in semiarid habitats with low rainfall and are often found in intact or disturbed dry forest, thorn bush at low and mid-elevations and savannas on the central highlands (Christy, 2016; Glaw and Vences, 2007). Predominantly ground dwelling, the Dumeril's boa is a terrestrial species and can live in disturbed habitats such as eucalyptus forests or villages (Raxworthy et al., 2011). Diet: The Dumeril's boa is a carnivore and often feeds on a variety of small animals including small mammals, birds and lizards. It has also been reported to eat domestic poultry (Oakland Zoo, 2025). The Dumeril's boa is an ambush predator and a constrictor with a slow metabolic rate. It will wait for its prey to come close before striking out. The Dumeril's boa will use its teeth to hold onto its prey before wrapping its body around the animal and constricting it until death. It will then swallow the animal whole (Boback et al., 2015; Nelson, 2022).

	Reproduction: The Dumeril's boa is ovoviviparous, meaning the eggs stay inside the mother's body until they're ready to hatch, after which she gives birth to live young. It reaches sexual maturity between 3 to 5 years with mating taking place between March and May. The Dumeril's boa has a gestation period of between 6 to 8 months and has litters consisting of between 6 to 28 neonates (Christy, 2016; Raxwothy et al., 2011; Uetz et al., 2025). **Longevity:** The record longevity in captivity is 26 years (AnAge, 2023). In captivity, they are estimated to live between 16 to 20 years (World Life Expectancy, 2025). **Conservation status:** **IUCN:** Least Concern **CITES:** Appendix I
DATE OF ASSESSMENT: Jan 2025 **EIC ENDORSEMENT:** Aug 2025 **Risk assessment model used for the assessment:** Bomford 2006, Risk assessment for the establishment of exotic vertebrates in Australia: recalibration and refinement of models **Australian Reptile and Amphibian Model (Bomford 2008)** Bird and Mammal Model for Reptiles and Amphibians (Bomford 2008)	**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, 2006, 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/.

Risk assessment for the establishment of exotic vertebrates in Australia: recalibration and refinement of models (Bomford 2006):

FACTOR	SCORE	DETAIL
STAGE A: RISKS POSED BY CAPTIVE OR RELEASED ANIMALS		
A. Climate match risk score *Map the selected reptile or amphibian species' overseas range, including its entire native and exotic (excluding Australia) ranges over the past 1000 years. Use CLIMATCH v2.0 to determine the climate match between this overseas range and Australia, selecting Euclidian Match and using all 16 climate variables for the analysis.* *CMS = sum of classes 7 – 10* *CMRS = 100 x (CMS/19236).*	14.16	CMRS = 100 x (2,724/19,236) = 14.16 Note: The species had five singular GBIF georeferenced occurrences from outside its natural range. These occurrences (all located in Florida, Untied States of America, Figure 5) have been presumed to be waifs rather than an established population and have not been added to the statistics (see Figure 4 for reported locations not included). Note: The Dumeril's boa has been reported as having an invasive population on Reunion Island, however these may have been reported in error (Bosch, 2020; Vences and Glaw, 2003; Wallach and Glaw, 2009). Although this location for the Dumeril's boa has been reported in the National Incursion Response Plan for Australia, this population has not been reported on the IUCN website (Christy, 2016). Climatch also does not have a weather station located on Reunion Island. Therefore, the location of Dumeril's boa on Reunion Island has not been included.
B. Exotic Elsewhere Risk score (0, 15 or 30) *Score B = A species' Exotic Elsewhere Risk Score, calculated as follows:* • *Species has established breeding self-sustaining exotic population in another country = 30* • *Species has been introduced into another country and records exist of it in the wild, but it is uncertain if a breeding self-sustaining population has established = 15* • *Species has not established an exotic population (including species not known to have been introduced anywhere) = 0*	15	*Species has been introduced into another country and records exist of it in the wild, but it is uncertain if a breeding self-sustaining exotic population has established.* Note: The Dumeril's boa has been reported as having an invasive population on Reunion Island, however these may have been reported in error (Bosch, 2020; Vences & Glaw, 2003; Wallach & Glaw, 2009). Although this location for the Dumeril boa has been reported in the National Incursion Response Plan for Australia, this population has not been reported on the IUCN website (Christy, 2016). Climatch also does not have a weather station located on Reunion Island. Therefore, the location of Dumeril's boa on Reunion Island has not been included.

C. Taxonomic Family Risk Score	5	*Boidae*
ESTABLISHMENT RISK RANK *A species' Establishment Risk Score = Score A + Score B + Score C.* *Establishment Risk Rank* *Establishment Risk Score* *Low* *≤ 22* *Moderate* *23-60* *Serious* *61-115* *Extreme* *≥ 116*	34.16	**MODERATE establishment risk**

Bird and Mammal Model for Reptiles and Amphibians (Bomford 2008):

A. Degree of climate match between species overseas range and Australia (1–6) *Map the selected reptile or amphibian species' overseas range, including its entire native and exotic (excluding Australia) ranges over the past 1000 years.* *Use CLIMATCH v2.0, Value X = sum of classes 6 – 10, see Table 1.*	2	*Low match to Australia* Value X = 3,876 CMS = 2 Note: The species had five singular GBIF georeferenced occurrences from outside its natural range. These occurrences (all located in Florida, Untied States of America, Figure 5) have been presumed to be waifs rather than an established population and have not been added to the statistics (see Figure 4 for reported locations not included).
B. 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 evidence the species has ever established an exotic population.* The Dumeril's boa is endemic to the south and southwest of the island of Madagascar. The boa's range is estimated to be 242,716 km^2, from sea level to elevations of 1,300 metres (Raxwothy et al., 2011).
C. Overseas range size score (0–2) < 1 = 0; 2–69 = 1; >70 = 2	0	*Overseas range size is between 0 - 1 million square kilometres.*

Estimate the species overseas range size including currently and the past 1000 years; natural and introduced range in millions of square kilometres		Overseas natural range size is estimated at 242,716 km^2 as provided on the IUCN website by Raxworthy et al. (2011).
ESTABLISHMENT RISK RANK *A species' Establishment Risk Score = Score A + Score B + Score C.* *Establishment Risk Rank — Establishment Risk Score* *Low — ≤ 4* *Moderate — 5-7* *Serious — 8-9* *Extreme — 10-12*	2	**LOW establishment risk**

ENVIRONMENT AND INVASIVES COMMITTEE THREAT CATEGORY*	**EXTREME***
*For reptiles and amphibians, the assessed Establishment Risk Rank is combined with an allocated Extreme Pest Risk Rank (based on the precautionary approach), resulting in the Assignment of species into one of two EIC Threat Categories: Extreme or Serious.	*Score assigned based on the highest Establishment Risk Rank (based on the precautionary approach).

NOTE: Where multiple Bomford risks assessment models are applicable, all models have been assessed and the threat category has been assigned based on a precautionary approach, meaning the highest threat category has been assigned and used to calculate the Environment and Invasives Committee Threat Category.

World distribution map (IUCN Red List); world Georeferenced records (GBIF); and Climatch world distribution map indicating where meteorological data was sourced for the climate analysis:

Figure 1 - World Distribution Map - IUCN Red List

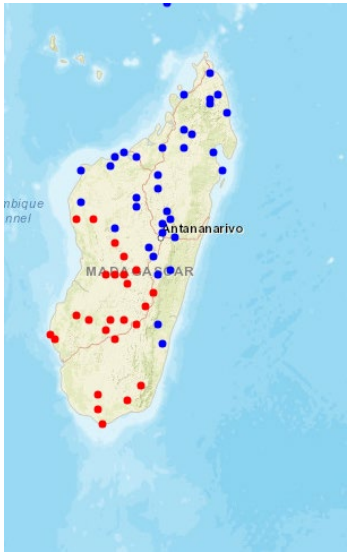


Figure 2 – World Distribution map – Climatch

Figure 3 – World Georeferenced records (GBIF) - Madagascar

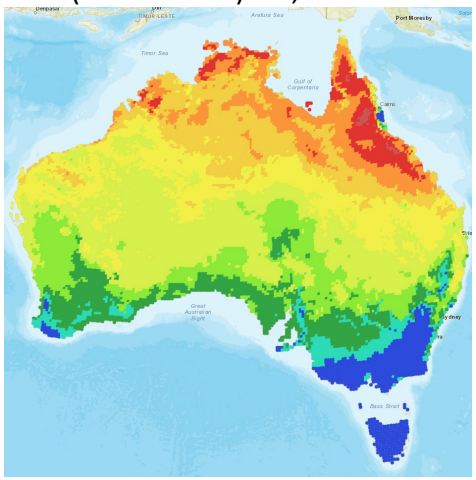
Figure 4 - World Georeferenced records (GBIF) – Reported Locations

Figure 5 – World Georeferenced records (GBIF) – Florida

Australian Reptile and Amphibian Model (Bomford 2006): Climate match between world distribution of species and Australia:

Areas of Australia where the climate appears suitable for *Acrantophis dumerili*

CMS (Sum Level 7) = 2,724



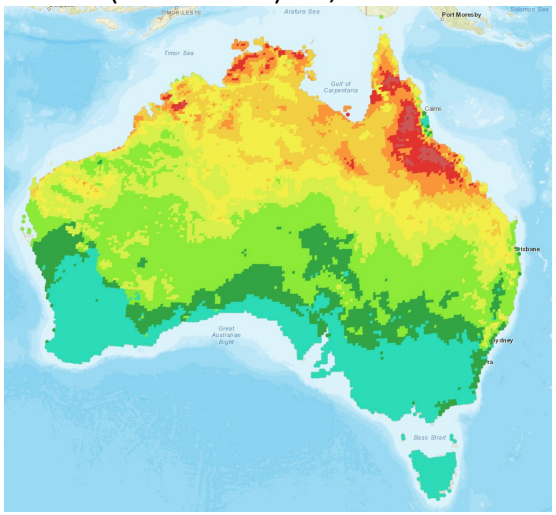
Score	Color	Count
0		861
1		622
2		1687
3		2251
4		4947
5		3278
6		2866
7		1871
8		801
9		52
10		0

Species: Acrantophis dumerili (Dumeril's Boa)
Algorithm: Euclidean
25 source features selected
19236 target features selected
Approximate selected area: 323,825 km^2

Bird and Mammal model for reptiles and amphibians (Bomford 2008): Climate match between world distribution of species and Australia:

Areas of Australia where the climate appears suitable for *Acrantophis dumerili*

Value X (Sum Level 6) = 3,876



Score	Color	Count
0		0
1		3008
2		2036
3		4746
4		2835
5		2735
6		2254
7		988
8		486
9		147
10		1

Species: Acrantophis dumerili (Dumeril's Boa)
Algorithm: Closest Standard Score
25 source features selected
19236 target features selected
Approximate selected area: 323,825 km^2

Table 1: ABARES recalibration thresholds

Climate Match Score (CMS)	Climatch (50 km) Closest Standard Match Sum Level 6 (Value X)	2021 Recalibrated Climatch v2.0 (20 km) Closest Standard Match Sum Level 6 (Value X)
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: 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**		

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National Risk Assessment: EXTREME

RISK ASSESSMENT FOR AUSTRALIA: **Ball python (*Python regius*)**

Class - Reptilia**, Order -** Squamata**, Family -** Pythonidae**, Genus –** *Python*

SPECIES: *Python regius* (Shaw, 1802) **Subspecies:** Monotypic **Synonyms:** *Boa regia* (Shaw, 1802) *Cenchris regia* (Shaw, 1802) *Enygrus regius* (Shaw, 1802) *Hortulia regia* (Shaw, 1802) *Python bellii* (Gray, 1842) *Shireenhoserus regia* (Hoser, 2004) *Shireenhoserus regius* (Hoser, 2004) *Cenchris regia* (Gray 1831) *Enygrus regius* (Wagler 1830) *Hortulia regia* (Gray 1849) **Common names:** Ball python Royal python	**Species description:** The ball python is among the world's most popular reptile pet species and is regularly exported with more than a million currently kept in captivity or in zoos (Cacioppa et al, 2021). They have a docile disposition which makes them suitable as pets (Cacioppa et al, 2021). Although regulated under CITES Appendix II, illegal trade is still believed to be occurring (Toudonou, 2025). The ball python can grow between 1.0 to 1.5 metres (with some reported to grow as large as 1.8 metres) and has an average weight of 8.8 kilograms (AnAge, 2023; Graf, 2011). The ball python is a heavy bodied snake, with a large wedge-shaped head compared to its relatively slender neck (Graf 2011). In the wild, their typical colour pattern is black / dark brown with light brown or golden sides and dorsal blotches to allow them to camouflage amongst the tree litter (Christy 2016; Grumbeck 2007). Their blotches also extend down their sides and can often have one or more smaller spots within them (Mattison 2005). Genetic adaptations within ball pythons have resulted in 'colour morphs' such as the albino python. The albino python has reduced melanin and has a bright yellow and white skin with red or pink eyes (Brown et al, 2021; Dao et al, 2023; Kokiattrakool et al, 2024). The ball python has five labial heat sensing pits which are used to detect heat radiation from prey. These heat sensing pits can be found on each side of the upper jaw (Mattison 2005; Rizzo 2014; Sutherland 2005). Sexual dimorphism is apparent in adult ball pythons with the female being larger and having longer jaws that her male counterpart (De Vosjoli, et al., 1995; Graf, 2011). *Python regius* has the common name "ball python" because of the defensive tactic it uses where it will curl itself into a "ball" and hides its head between the coils of its body (Grumbeck, 2007, Mehrtens, 1987). **General information:** Distribution: The ball python has a wide distribution and can be found in Central and Western Africa. It is extant to Benin, Burkina Faso, Cameroon, Central African Republic, Chad, Congo, The Democratic Republic of Congo, Côte

	d'Ivoire, Gambia, Ghana, Guinea, Guinea-Bissau, Mali, Niger, Nigeria, Senegal, Sierra Leone, South Sudan, Togo and Uganda. It can be found from sea level to elevations of 1,000 metres (D'Cruze et al., 2021). Habitat: The ball python is a solitary and primarily terrestrial species preferring grasslands, savannahs, and sparsely wooded areas, living in both undisturbed and disturbed habitats (Christy, 2016). However, they have also been documented as hunting frequently in trees (Healey, 2023). They are primarily crepuscular (active at dawn and dusk) but are also active during the night (Toudonou et al., 2022). The female ball python uses mammal burrows in the dry season to protect and incubate her clutch as well as to shelter from the heat during the day (Mehrtens, 1987). Diet: The ball python is a non-venomous snake and will constrict its prey. It is an opportunistic ambush predator, having a carnivorous diet consisting of small mammals and occasionally birds (Christy, 2016). Reproduction: Ball pythons reach reproductive maturity between 27 to 31 months for females and between 16 to 18 months for males (Toudonou, 2025). It is oviparous (produces eggs which hatch after being laid) and on average has 7 eggs per a clutch (between 3 to 11 eggs can be laid at one time) (AnAge, 2023; Christy, 2016). The female will raise her body temperature and incubate the eggs by wrapping her body around them for varying lengths of time, a process known as shivering thermogenesis (Mehrtens, 1987; O'Shea, 2023). It will take between 55 to 60 days for the eggs to hatch (Christy, 2016). **Longevity:** The record longevity in captivity is 47.5 years (AnAge, 2023). In the wild, its lifespan is around 10 years (D'Cruze et al, 2021). **Conservation status:** **IUCN:** Near Threatened **CITES:** Appendix II
DATE OF ASSESSMENT: Jan 2025 **EIC ENDORSEMENT:** Aug 2025	**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, 2006, 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 2006, Risk assessment for the establishment of exotic vertebrates in Australia: recalibration and refinement of models **Australian Reptile and Amphibian Model (Bomford 2008)** Bird and Mammal Model for Reptiles and Amphibians (Bomford 2008)	**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/.

Risk assessment for the establishment of exotic vertebrates in Australia: recalibration and refinement of models (Bomford 2006):

FACTOR	SCORE	DETAIL
STAGE A: RISKS POSED BY CAPTIVE OR RELEASED ANIMALS		
A. Climate match risk score *Map the selected reptile or amphibian species' overseas range, including its entire native and exotic (excluding Australia) ranges over the past 1000 years. Use CLIMATCH v2.0 to determine the climate match between this overseas range and Australia, selecting Euclidian Match and using all 16 climate variables for the analysis.* *CMS = sum of classes 7 – 10* *CMRS = 100 x (CMS/19236).*	10.06	CMRS = 100 x (1,936/19,236) = 10.06 Note: The species has had several GBIF georeferenced occurrences from outside its natural range (Figure 4). These occurrences have not been reported on the IUCN website and have been presumed to be released or escaped pets rather than an established population and have not been added to the statistics (Figure 3 shows Climatch data reported on).
B. Exotic Elsewhere Risk score (0, 15 or 30) *Score B = A species' Exotic Elsewhere Risk Score, calculated as follows:* • *Species has established breeding self-sustaining exotic population in another country = 30*	15	*Species has been introduced into another country and records exist of it in the wild, but it is uncertain if a breeding self-sustaining exotic population has established.* The CABI Compendium website reports that ball pythons have been reported as present in the Canary Islands (CABI Compendium, 2019; Seebens et al., 2017). The

• *Species has been introduced into another country and records exist of it in the wild, but it is uncertain if a breeding self-sustaining population has established = 15* • *Species has not established an exotic population (including species not known to have been introduced anywhere) = 0*		ball python has been reported on the *Boletín Oficial del Estado* as an invasive species of concern for the outermost region of the Canary Islands and volunteers upload sighting of the species to the Redexos site (Boletín Oficial del Estado, 2019; Hernández-López et al., 2024; Redexos, 2020). The Global Biodiversity Information Facility map shows high reporting of the ball python in Florida, Southeast United States of America. Scientific studies and newspapers have also reported sightings of the ball python within a Florida community (Hanslowe et al., 2018; Levesque, 2023). The United States of America is the biggest importer of ball pythons for commercial use in the pet trade (Harrington et al., 2020). The Early Detection and Distribution Mapping System (2025) notes that ball pythons have been spotted in the area, but it has not been confirmed if the exotic population has been established (Invasive.org, 2018).
C. Taxonomic Family Risk Score	5	*Pythonidae* (Appendix C, Bomford, 2008)
ESTABLISHMENT RISK RANK *A species' Establishment Risk Score = Score A + Score B + Score C.* *Establishment Risk Rank — Establishment Risk Score* *Low — ≤ 22* *Moderate — 23-60* *Serious — 61-115* *Extreme — ≥ 116*	30.06	**MODERATE establishment risk**

Bird and Mammal Model for Reptiles and Amphibians:

A. Degree of climate match between species overseas range and Australia (1–6) *Map the selected reptile or amphibian species' overseas range, including its entire native and exotic (excluding Australia) ranges over the past 1000 years.* *Use CLIMATCH v2.0, Value X = sum of classes 6 – 10, see Table 1.*	2	*Low match to Australia* Value X = 2,504 CMS = 3 Note: The species has had several GBIF georeferenced occurrences from outside its natural range (Figure 4). These occurrences have not been reported on the IUCN

		website and have been presumed to be released or escaped pets rather than an established population and have not been added to the statistics (Figure 2 shows Climatch data reported on).
B. 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 evidence the species has ever established an exotic population.* The ball python has a wide distribution and can be found in Central and Western Africa. It is extant to Benin, Burkina Faso, Cameroon, Central African Republic, Chad, Congo, The Democratic Republic of Congo, Côte d'Ivoire, Gambia, Ghana, Guinea, Guinea-Bissau, Mali, Niger, Nigeria, Senegal, Sierra Leone, South Sudan, Togo and Uganda. It can be found from sea level up to elevations of 1,000 metres (D'Cruze et al. 2021).
C. Overseas range size score (0–2) < 1 = 0; 2– 69 = 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 is between 2 – 69 million km^2.* Overseas natural range size is estimated at 5.4 million km^2 including current and past 1,000 years.
ESTABLISHMENT RISK RANK *A species' Establishment Risk Score = Score A + Score B + Score C.* *Establishment Risk Rank — Establishment Risk Score* *Low — ≤ 4* *Moderate — 5-7* *Serious — 8-9* *Extreme — 10-12*	3	**LOW establishment risk**

ENVIRONMENT AND INVASIVES COMMITTEE THREAT CATEGORY* *For reptiles and amphibians, the assessed Establishment Risk Rank is combined with an allocated Extreme Pest Risk Rank (based on the precautionary approach),	**EXTREME*** *Score assigned based on the highest Establishment Risk Rank (based on the precautionary approach).

resulting in the Assignment of species into one of two EIC Threat Categories: Extreme or Serious.	

NOTE: Where multiple Bomford risks assessment models are applicable, all models have been assessed and the threat category has been assigned based on a precautionary approach, meaning the highest threat category has been assigned and used to calculate the Environment and Invasives Committee Threat Category.

World distribution map (IUCN Red List); world Georeferenced records (GBIF); and Climatch world distribution map indicating where meteorological data was sourced for the climate analysis:

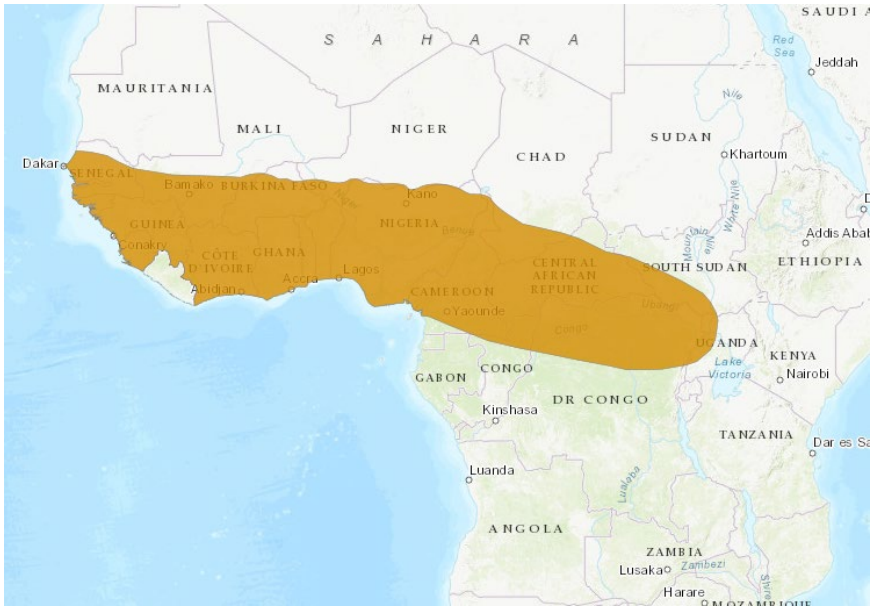


Figure 1 - IUCN Red List World Distribution Map

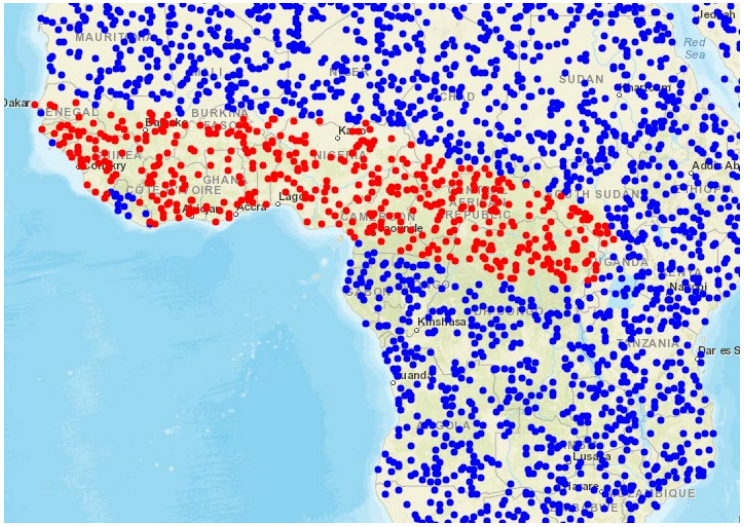


Figure 2 - Climatch World Distribution Map

Figure 3 - World Georeference Records (GBIF) Map

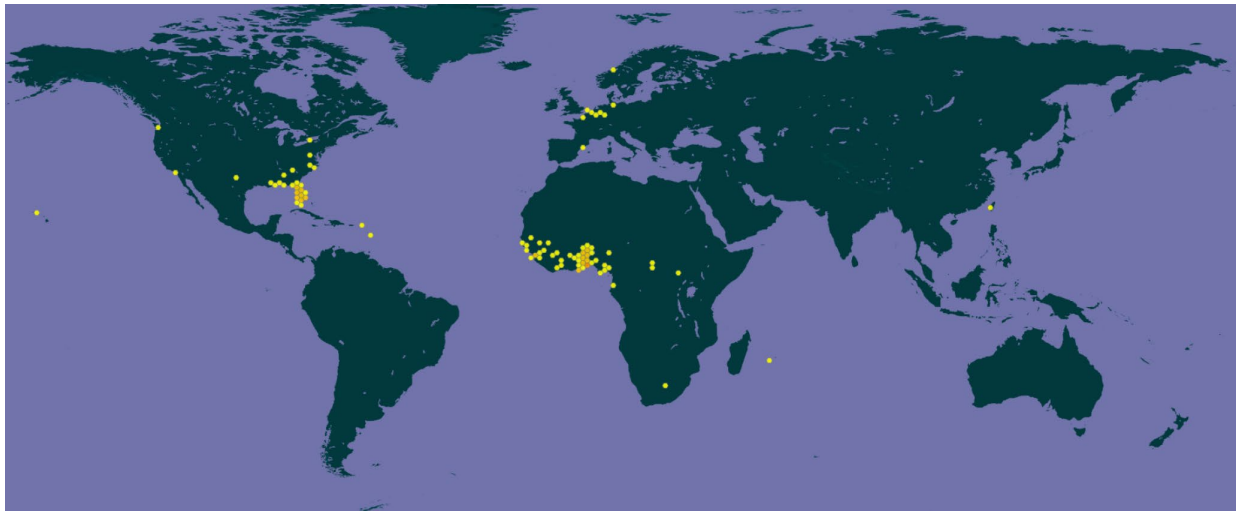
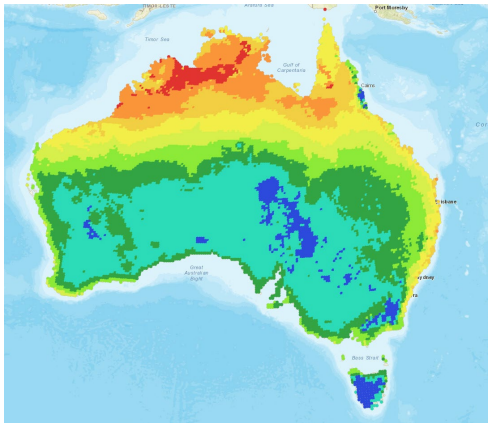


Figure 4 - World Georeference Records (GBIF) World Map - All referenced locations

Australian Reptile and Amphibian Model (Bomford 2006): Climate match between world distribution of species and Australia:

Areas of Australia where the climate appears suitable for *Python regius*

CMS (Sum Level 7) = 1,936



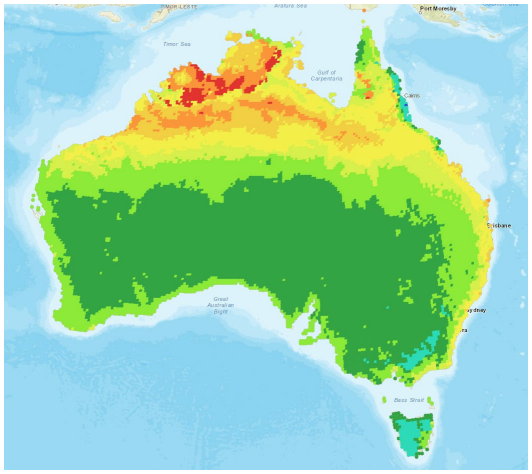
Score	Color	Count
0		675
1		5988
2		3501
3		2110
4		1596
5		1798
6		1632
7		1538
8		398
9		0
10		0

Species: Python regius (Ball Python)
Algorithm: Euclidean
473 source features selected
19236 target features selected
Approximate selected area: 5,419,252 km^2

Bird and Mammal model for reptiles and amphibians (Bomford 2008): Climate match between world distribution of species and Australia:

Areas of Australia where the climate appears suitable for *Python regius*

Value X (Sum Level 6) = 2,504



Score	Color	Count
0		1
1		225
2		8417
3		4023
4		1780
5		2286
6		1471
7		790
8		243
9		0
10		0

Species: Python regius (Ball Python)
Algorithm: Closest Standard Score
473 source features selected
19236 target features selected
Approximate selected area: 5,419,252 km^2

Table 1: ABARES recalibration thresholds

Climate Match Score (CMS)	Climatch (50 km) Closest Standard Match Sum Level 6 (Value X)	2021 Recalibrated Climatch v2.0 (20 km) Closest Standard Match Sum Level 6 (Value X)
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: 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**		

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National Risk Assessment: EXTREME

RISK ASSESSMENT FOR AUSTRALIA: Tokay gecko (*Gekko gecko*)

Class - Reptilia**, Order -** Squamata**, Family -** Gekkonidae**, Genus –** *Gekko*

SPECIES: *Gekko gecko* (Linnaeus, 1758) **Subspecies:** *Gekko gecko gecko* (Linnaeus, 1758) *Gekko gecko azhari* (Mertens, 1955) **Synonyms:** *Gekko aculeatus* (Houttuyn, 1782) *Gekko annulatus* (Kuhl, 1820) *Gekko guttatus* (Daudin, 1802) *Gekko indicus* (Girard, 1858) *Gekko verus* (Merrem, 1820) *Gekko perlatus* (Houttuyn, 1782) *Gekko tenuis* (Hallowell, 1857) *Gekko teres* (Laurenti, 1768) *Gekko verticillatus* (Laurenti, 1768 (fide Taylor 1963)) *Lacerta gecko* (Linnaeus, 1758) *Stellio maculatus* (Schneider, 1792) **Common Names:** Tokay Gecko	**Species description:** The tokay gecko is a large species of arboreal gecko native to Southeast Asia. Its name, tokay, is derived from the characteristic vocalization it produces, which sounds like "to-kay" (Flank, 1998; Mattison, 2004). Adult male tokay geckos typically measure around 35 centimetres in total length (Corl, 1999) although some individuals can grow even larger (measurements between 30 to 40 centimetres) (Bergman, 2012; Corl, 1999; SNZCBI, 2016). Females tend to smaller and measure between 20 to 30 centimetres (Bergman, 2012). Its body is robust and muscular, adapted to its arboreal lifestyle weighing between 100 to 150 grams with some larger males weighing as much as 300 grams (Bergman, 2012). The head is larger compared to the rest of its slender body. The tokay gecko's eyes are bright gold, large and round with vertically slit pupils. Their eyelids are fused together and transparent and they have the remains of a third eye which is believed to coordinate their activity to light conditions (Corl, 1999; SNZCBI, 2016). The tokay gecko has a variety of colouration patterns but typically has a blue-grey or greenish body with bright orange or red spots across the back and tail (Corl, 1999). These markings, along with its rough textured skin and ability to lighten or darken its skin, provides effective camouflage among the foliage of its natural habitat (SNZCBI, 2016). The tokay gecko has a protective outer layer made up of plate-like and granular osteoderm (Paluh et al., 2016; Van Hoose, 2017). The tokay gecko's fingers and toes are wide with small claw tips that curl back (Kurniati et al., 2023). The tokay gecko has adhesive toe pads consisting of thousands of tiny hair-like structures called setae. The setae branch off into even smaller bristles and these help the gecko to cling to various surfaces including smooth vertical surfaces like glass panes (Halliday, 1986; Meneses et al., 2022). The tokay gecko's tail is prehensile, allowing it to grasp surfaces and aiding its climbing abilities. The tokay gecko can dispose of its tail when it is attacked by a predator as a form of defence. The tail will then regenerate but with some anatomical differences (Crew, 2021; Nurhidayat et al., 2025). The tokay gecko can be recognised by the male's distinct loud vocalizations which is commonly heard at night or early morning (Meneses et al., 2022; Walls and Walls, 2001). Tokay geckos will communicate with each other when looking for potential mates. They will also bark and growl repeatedly and loudly when threatened or disturbed as tokay geckos are aggressive and territorial (Cogger et al., 2003; Kaiser et al., 2020). They will bark and growl to establish territorial boundaries and to deter predators (Mattison, 2004). When the tokay gecko feels

Tokay Gekko Tokeh Tokeh-tokeh Toko Narrow-disked Gecko Tuctoo	threatened, it will often display a gaping mouth before attacking and biting its potential aggressor (Wever et al., 1963). With its sharp teeth and strong jaw, the tokay gecko can cause injuries even death to conspecific species as well as humans (Kaiser and O'Shea, 2020; Walls and Walls, 2001). Tokay geckos are solitary animals, typically only interacting with others during mating seasons (Corl, 1999). **General information:** Distribution: *G.g. gecko* has an extensive range across Southeast Asia and is native to Bhutan, Cambodia, China, India, Indonesia, Lao People's Democratic Republic, Malaysia, Myanmar, Nepal, Philippines, Thailand, Timor-Leste and Vietnam. The tokay gecko has also been introduced and has a resident population in the following countries: Guadeloupe, Hong Kong, Madagascar, Martinique, Singapore and the United States of America (Florida and Hawaii), with a possible exotic population also established in Belize (Bergman, 2012; Capinha et al., 2017; Lwin et al., 2019). Lee et al., (2019) report that the tokay gecko has a successful colony in Taiwan (Republic of China), while Kaiser et al., (2011) report that the tokay gecko is established in Timor Leste. The tokay gecko has been reported in South Africa (Invasives South Africa, 2025), Mexico (Villalobos-Juárez et al., 2022) and Brazil (Rocha Junior et al, 2015) however, this is not reflected in the IUCN reporting and has not been included in the statistics below as no established population has been confirmed. *G. g. azhari* is only found in Bangladesh (Uetz et al., 2025). Habitat: The tokay gecko is a territorial species and lives in both disturbed and undisturbed habitats. It is often found in areas of lowland, primary and secondary tropical and subtropical forests and hill dipterocarp forests (Fauzan et al., 2022; Lwin et al., 2019). They are arboreal, living in trees and on cliff faces (Corl, 1999). The tokay gecko can be found at elevations from sea level to 1,100 metres (Lwin et al., 2019). Diet: The tokay gecko is a voracious feeder. It has a fast strike rate and strong bite enabling it to eat an array of vertebrates and invertebrates (Bauer, 2013). The tokay gecko is primarily nocturnal, foraging at night for food. The tokay gecko's diet consists of a variety of cockroaches, locusts, small mammals, birds and other small reptiles such as corn snakes (Krysko et al., 2016). Reproduction: Tokay geckos exhibit sexual dimorphism, with males typically being larger and more brightly coloured than females (Baldwin, 2011). Mating occurs during the wet season usually from October through to May. Females are oviparous, laying two eggs at a time, approximately one month after mating. Females can also hold sperm if the conditions for egg laying are not suitable. The eggs are usually placed in sheltered locations such as crevices or under tree bark and are "glued" to solid vertical surfaces such as bark or slate in the protected area (Bergman, 2012; Billewicz, 2014). The eggs are hard-shelled and are generally incubated for 65 days (depending on environmental conditions incubation can last between 3 to 6 months) (Das, 2016; Walls and Walls,

	2001). Both parents are involved in the parental care of the young through egg guarding and offspring protection (Bergman, 2012; Szabo & Ringler, 2025). The juvenile's grow rapidly and will stay with their parents for several months until reaching sexual maturity. Tokay geckos will reach full maturity between 1 to 2 years (Nijman et al., 2015; SNZCBI, 2016). **Longevity:** The record longevity in captivity is 23.5 years (AnAge, 2023). The World Life Expectancy (2025) states the expected life expectancy for a tokay gecko is between 10 to 15 years in captivity. Although the exact life span for a tokay gecko in the wild is unknown (SNZCBI, 2016), it is predicated to be between 7 to 10 years (Sacramento Zoo, 2025). **Conservation status:** **IUCN:** Least Concern **CITES:** Appendix II
DATE OF ASSESSMENT: Feb 2025 (Aimee Carter, Kristen Petrov, Veronica Blazely, DCCEEW) **EIC ENDORSEMENT:** Aug 2025 **Risk assessment model used for the assessment:** Bomford 2006, Risk assessment for the establishment of exotic vertebrates in Australia: recalibration and refinement of models **Australian Reptile and Amphibian Model (Bomford 2008)**	**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, 2006, 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),

Bird and Mammal Model for Reptiles and Amphibians (Bomford 2008)	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/.

Risk assessment for the establishment of exotic vertebrates in Australia: recalibration and refinement of models (Bomford 2006):

FACTOR	SCORE	DETAIL
STAGE A: RISKS POSED BY CAPTIVE OR RELEASED ANIMALS		
A. Climate match risk score *Map the selected reptile or amphibian species' overseas range, including its entire native and exotic (excluding Australia) ranges over the past 1000 years. Use CLIMATCH v2.0 to determine the climate match between this overseas range and Australia, selecting Euclidian Match and using all 16 climate variables for the analysis.* *CMS = sum of classes 7 – 10* *CMRS = 100 x (CMS/19236).*	20.34	CMRS = 100 x (3,912/19,236) = 20.43 According to the IUCN website, the tokay gecko has been reported as being invasive in the United States of America (Florida and Hawaii), Martinique, Guadeloupe, Hong Kong, Singapore and Madagascar (Lwin et al., 2019). Lee et al (2019) report that the tokay gecko has a successful colony in Taiwan (Republic of China) and Kaiser et al., (2011) report that the tokay gecko is established in Timor Leste. These have been included in the reporting for Climatch (Figure 3) and GBIF (Figure 5). Note: The reports of sightings in Brazil, Mexico and South Africa have not been included in the figures as established populations have not yet been confirmed.
B. Exotic Elsewhere Risk score (0, 15 or 30) *Score B = A species' Exotic Elsewhere Risk Score, calculated as follows:* • *Species has established breeding self-sustaining exotic population in another country = 30* • *Species has been introduced into another country and records exist of it in the wild, but it is uncertain if a breeding self-sustaining population has established = 15* • *Species has not established an exotic population (including species not known to have been introduced anywhere) = 0*	30	*Species has established breeding self-sustaining exotic population in another country.* It has been introduced to parts of the United States of America (including Florida and Hawaii) (Invasive.org, 2018; Pavia, 1999), offshore islands in Belize (Stafford & Meyer, 2000), Madagascar (Lever, 2003), Martinique, Guadeloupe, Hong Kong and Singapore (Lwin et al., 2019). Lee et al., (2019) report that the tokay gecko has a successful colony in Taiwan (Republic of China) while Kaiser et al., (2011) report that the tokay gecko is established in Timor Leste. The tokay gecko has been found in Mexico and South Africa, however established breeding populations are yet to be confirmed (Villalobos-Juárez et al., 2022; Invasives South Africa, 2025).

		The tokay gecko has also been reported as a stowaway in a cargo ship in Brazil though there have been no reports of an established invasive population (Rocha Junior et al., 2015).
C. Taxonomic Family Risk Score	30	*Gekkonidae*
ESTABLISHMENT RISK RANK *A species' Establishment Risk Score = Score A + Score B + Score C.* *Establishment Risk Rank — Establishment Risk Score* *Low — ≤ 22* *Moderate — 23-60* *Serious — 61-115* *Extreme — ≥ 116*	80.34	**SERIOUS establishment risk**

Australian Reptile and Amphibian Model (Bomford 2008):

FACTOR	SCORE	DETAIL
STAGE A: RISKS POSED BY CAPTIVE OR RELEASED ANIMALS		
A. Family Random Effect value *A family random effect assumed drawn from a Gaussian distribution with mean zero and variance that was estimated from Bomford et al's (2008) data.*	-0.41	
B. Prop.species value *The number of jurisdictions where a species successfully established divided by the total number of jurisdictions where species has been introduced.*	0.33	
C. S(Climate 6) value *Map the selected reptile or amphibian species' overseas range, including its entire native and exotic (excluding Australia) ranges over the past 1000 years.*	-0.302	Score as reported in Bomford Model 2008 Sum Euclidian match scores to Australia levels 6-10 = 1,034 Climate 6 score = 1,034/2,785 = 0.3712746858168761

Use CLIMATCH v2.0 to determine the climate match between this overseas range and Australia, selecting Euclidian Match and using all 16 climate variables for the analysis. Sum the five scores for classes 6-10. Express this as a proportion of the maximum possible score (19,236). *Use Fig 3.4 to calculate value.*		S(Climate 6) value from Figure 3.4 = 4.25(Climate 6 Score) – 1.88. S(Climate 6) value from Figure 3.4 = 4.25(0.3712746858168761) – 1.88. Figure 3.4= -0.302 <u>Score reflecting the version of Climatch 2.0</u> Sum Euclidian match scores to Australia levels 6-10 = 6,349 Climate 6 score = 6,349/19,236 = 0.3300582241630277 S(Climate 6) value from Figure 3.4 = 4.25(Climate 6 Score) – 1.88. S(Climate 6) value from Figure 3.4 = 4.25(0.3300582241630277) – 1.88. Figure 3.4= -0.477
ESTABLISHMENT RISK RANK *A species' Establishment Risk Score = 1/ (1 + exp(0.80 – 2.90(Prop.species) – S(Climate 6) – Family Random Effect))* *Establishment Risk Rank* *Establishment Risk Score* *Low* *≤ 0.16* *Moderate* *0.17-0.39* *Serious* *0.40-0.85* *Extreme* *≥ 0.86*	0.36	1/(1 + exp(0.80 – 2.90(0.33) – -0.302 – -0.41) 1/(1 + exp(0.80 – 0.957 + 0.302 + 0.41)) 1/(1+EXP(0.555)) **=0.364705** **MODERATE**

Bird and Mammal Model for Reptiles and Amphibians (Bomford 2008):

A. Degree of climate match between species overseas range and Australia (1–6)	3	*MODERATE match to Australia* Value X = 4,864 Climate Match Score = 3

Map the selected reptile or amphibian species' overseas range, including its entire native and exotic (excluding Australia) ranges over the past 1000 years. *Use CLIMATCH v2.0, Value X = sum of classes 6 – 10, see Table 1.*		According to the IUCN website, the tokay gecko has been reported as being invasive in the United States of America (Florida and Hawaii), Martinique, Guadeloupe, Hong Kong, Singapore and Madagascar (Lwin et al., 2019). Lee et al (2019) report that the tokay gecko has a successful colony in Taiwan (Republic of China) and Kaiser et al., (2011) report that the tokay gecko is established in Timor Leste. These have been included in the reporting for Climatch (Figure 3) and GBIF (Figure 5). Note: The reports in Mexico, Brazil and South Africa have not been included into the figures as established populations have not yet been confirmed.
B. 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 populations established on larger island (>50,000 km^2) or anywhere on a continent.* It has been introduced to parts of the United States of America (including Florida and Hawaii) (Invasive.org, 2018; Pavia, 1999), offshore islands in Belize (Stafford & Meyer, 2000), Madagascar (Lever, 2003), Martinique, Guadeloupe, Hong Kong and Singapore (Lwin et al., 2019). Lee et al., (2019) report that the tokay gecko has a successful colony in Taiwan (Republic of China) while Kaiser et al., (2011) report that the tokay gecko is established in Timor Leste.
C. Overseas range size score (0–2) < 1 = 0; 2– 69 = 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 (million km^2) is between 2 – 69 million km^2* Overseas natural range size is estimated at 5.85 million km^2 including current and past 1,000 years, natural and introduced range (Figure 3). Note: The reports in Mexico, Brazil and South Africa have not been included into the figure's as established populations have not yet been confirmed.
ESTABLISHMENT RISK RANK *A species' Establishment Risk Score = Score A + Score B + Score C.* *Establishment Risk Rank Establishment Risk Score* *Low ≤ 4*	8	**SERIOUS establishment risk**

Moderate *Serious* *Extreme*	*5-7* *8-9* *10-12*		

ENVIRONMENT AND INVASIVES COMMITTEE THREAT CATEGORY*	**EXTREME***
*For reptiles and amphibians, the assessed Establishment Risk Rank is combined with an allocated Extreme Pest Risk Rank (based on the precautionary approach), resulting in the Assignment of species into one of two EIC Threat Categories: Extreme or Serious.	*Score assigned based on the highest Establishment Risk Rank (based on the precautionary approach).

NOTE: Where multiple Bomford risks assessment models are applicable, all models have been assessed and the threat category has been assigned based on a precautionary approach, meaning the highest threat category has been assigned and used to calculate the Environment and Invasives Committee Threat Category.

World distribution map (IUCN Red List); world Georeferenced records (GBIF); and Climatch world distribution map indicating where meteorological data was sourced for the climate analysis:

Figure 1- World Distribution Map - IUCN Red List

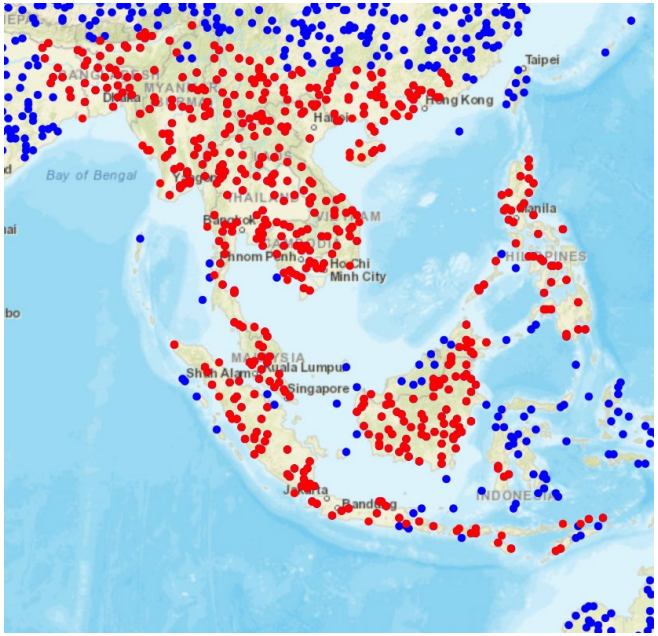


Figure 2 – World Distribution map – Climatch – current locations

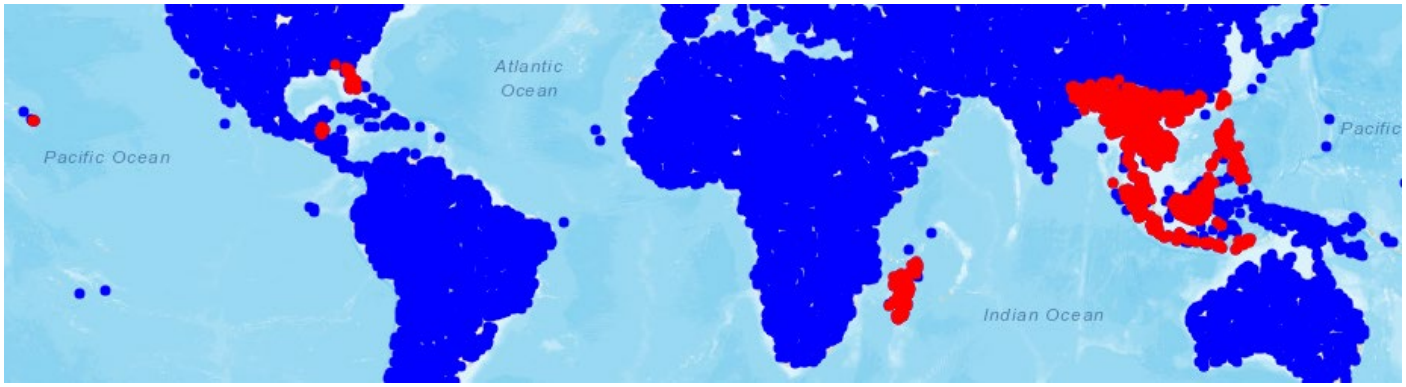


Figure 3 - Climatch – All referenced locations over past 1000 years

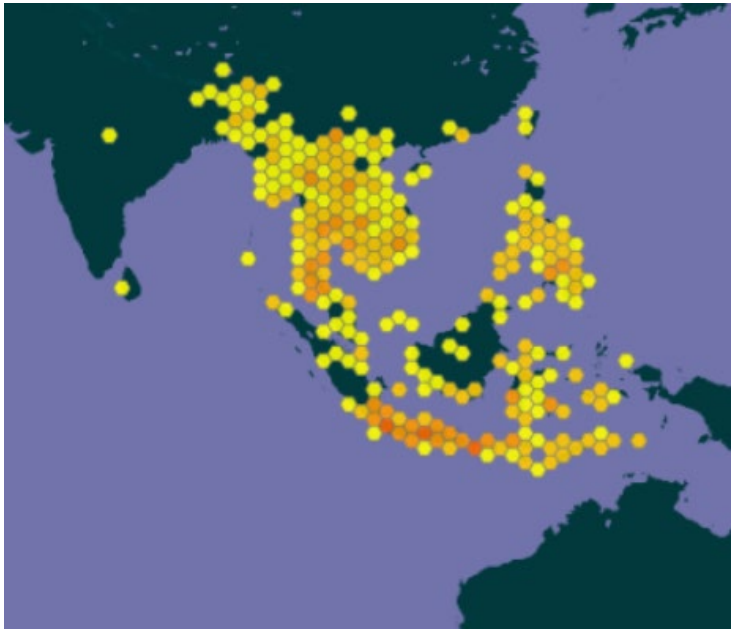


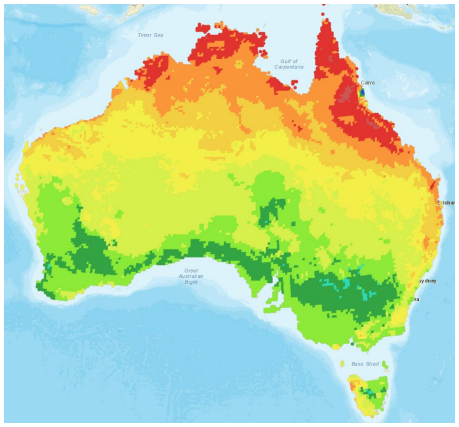
Figure 4 – World Georeferenced records (GBIF)

Figure 5 – World Georeferenced records (GBIF) – All referenced locations World Distribution map

Australian Reptile and Amphibian Model (Bomford 2006): Climate match between world distribution of species and Australia:

Areas of Australia where the climate appears suitable for *Gekko gecko*

CMS (Sum Level 7) = 3,912



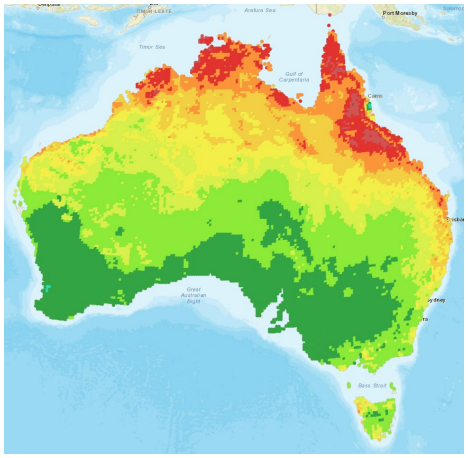
Score	Color	Count
0		2
1		51
2		1570
3		3141
4		4587
5		3536
6		2437
7		2502
8		1355
9		55
10		0

Species: Gekko gecko (Tokay Gecko)
Algorithm: Euclidean
652 source features selected
19236 target features selected
Approximate selected area: 5,842,008 km^2

Bird and Mammal model for reptiles and amphibians (Bomford 2008): Climate match between world distribution of species and Australia:

Areas of Australia where the climate appears suitable for *Gekko gecko*

Value X (Sum Level 6) = 4,864



Score	Color	Count
0		0
1		6
2		4191
3		4898
4		2913
5		2364
6		2006
7		1559
8		1109
9		189
10		1

Species: Gekko gecko (Tokay Gecko)
Algorithm: Closest Standard Score
652 source features selected
19236 target features selected
Approximate selected area: 5,842,008 km^2

Table 1: ABARES recalibration thresholds

Climate Match Score (CMS)	Climatch (50 km) Closest Standard Match Sum Level 6 (Value X)	2021 Recalibrated Climatch v2.0 (20 km) Closest Standard Match Sum Level 6 (Value X)
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: 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**		

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