Round 8 and 9 Risk Assessments

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DRAFT National Risk Assessment: SERIOUS

RISK ASSESSMENT FOR AUSTRALIA: Snow leopard (*Panthera uncia*)

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

SPECIES: *Panthera uncia* (Schreber, 1775) **Synonyms:** *Felis uncia* (Schreber, 1775) *Uncia uncia* (Schreber, 1775) *Panthera uncia* (Schreber, 1775) **Sub Species:** Research by Janecka et al (2017) supports the creation of three subspecies. However, the snow leopard is currently classified as a monotypic species. **Common Names:** Snow Leopard Ounce	**Species description:** The snow leopard, also known as the 'Ghost of the Mountains' is an apex predator and a large carnivorous feline native to the mountainous regions of Central and South Asia. The snow leopard weighs between 30 to 50 kilograms and has a body length between 90 to 120 centimetres. Snow leopards possess a long and dense smoky grey or white-grey coat which is covered in a pattern of dark open rosettes and spots. The open rosettes are primarily located on the sides and tail whereas the spots are located on the head, neck and lower limbs (Kitchener et al., 2016). In comparison, the snow leopard's underparts are white (Kitchener et al., 2016). Snow leopards are specially adapted to cold, harsh environments. They have thick fur across their whole body (their abdomen fur ranges up to 12 centimetres in length), broad paws, and a long, muscular tail (approximately 1 metre long) that provides warmth when wrapped around the body and aids in their balance (National Geographic, 2020). Their fur not only offers protection from the cold but also serves as a visual adaptation for blending into the rocky and snowy landscapes of their environment. Snow leopards have enlarged nasal cavities and a well-developed chest, with short forelimbs, sizeable paws and strong hind limbs. The snow leopard is adapted to traversing steep terrain and capable of leaping as far as 15 metres (National Geographic, 2020; WWF Australia, 2025). Snow leopards are typically shy and elusive in nature and will keep away from humans where possible (WWFa, 2016). Snow leopards are crepuscular (Jackson and Ahlborn, 1989), meaning they are most active during dawn and dusk. They have light green or pale grey eyes. Snow leopards are unable to roar due to the physiology of their throat. Their larynx lacks the folds required to make a roar so instead the snow leopard makes a non-aggressive puff sound called a 'chuff'. Snow leopards are considered solitary animals and generally avoid interactions with other individuals, except during the mating season or when a mother is raising her cubs (GSLEP, 2025; IUCN Cat Specialist Group, 2025; Snow Leopard Trust, 2025; Snow Leopard Conservancy, 2025).

	General information: Distribution: The snow leopard is a resident of 12 countries including Afghanistan, Bhutan, China (Yunnan, Qinghai, Tibet [or Xizang], Sichuan, Gansu, Xinjiang, Nei Mongol), India (Himachal Pradesh, Sikkim, Jammu-Kashmir, Uttaranchal, Arunachal Pradesh), Kazakhstan, Kyrgyzstan, Mongolia, Nepal, Pakistan, the Russian Federation, Tajikistan and Uzbekistan (McCarthy et al., 2017). Myanmar was previously reported to have a small population of snow leopards, but their presence has not been confirmed in recent years (Snow Leopard Network, 2014). The snow leopards' current range is estimated to be 2.8 million km^2 (McCarthy et al., 2016). Habitat: They primarily inhabit alpine and subalpine zones and can be found on steep rugged terrains such as cliffs, ridges and rocky outcrops. The snow leopard is found at elevations ranging from 500 to 5,800 metres; however, they are predominantly found between 3,000 to 5,000 meters above sea level (McCarthy et al., 2017; McDougall, 2025; Snow Leopard Network, 2014). During the winter, the snow leopard will descend to lower elevations but will return to higher elevations during the summer (GSLEP, 2025). Snow leopards have extensive home ranges often covering hundreds of square kilometres. The Snow Leopard Trust (2025) estimates that the average home range is 230 km^2 for a male and 130 km^2 for a female. Home ranges will often overlap with other snow leopards (GSLEP, 2025; Jackson and Ahlborn, 1989). Snow leopards will mark their territory in multiple ways including through scent markings (faecal deposition or spraying urine) or by body rubbing (rubbing cheek against a rock surface) (Zaman, 2024). Diet: Snow leopards are primarily carnivorous and are opportunistic hunters who stalk and ambush their prey from vantage points above. They primarily hunt wild ungulates (blue sheep (bharal), argali and mountain ibex), however, they will prey on domestic animals (sheep, horses and goat etc.) if the opportunity arises. A single snow leopard requires around 1.5 kilograms of meat per a day (Schaller et al., 1988; Shrestha et al., 2018). The snow leopard will eat its prey slowly, often consuming it over a period of several days and will stay with the carcass to defend against scavengers (Snow Leopard Trust, 2025). Seasonal variation of diet was noted during the winter months (Koju et al., 2023; Shrestha et al., 2018). The snow leopard can kill prey up to three times its own body weight (IUCN Cat Specialist Group, 2025). Through scat analysis, the snow leopard has been shown to eat twigs and other vegetation (Schaller et al., 1988; Snow Leopard Trust, 2025). Reproduction: The species' reproductive behaviour requires further research due to their elusive nature. Snow leopards reach sexual maturity at around 2 to 3 years of age, and mating occurs from January to March. After a gestation period of approximately 90-100 days, females give birth to 2-3 cubs in a secluded den. The female snow

	leopard will raise her cubs on her own. The cubs stay with their mother for up to 18 months to 2 years before setting out on their own (IUCN Cat Specialist Group, 2025; Snow Leopard Trust, 2025). **Longevity:** The maximum recorded longevity for this species in captivity is 21.2 years (AnAge, 2023). The life span for the snow leopard in the wild is between 10 to 20 years (IUCN Cat Specialist Group, 2025). **Conservation status:** **IUCN:** Vulnerable **CITES:** Appendix I - the species is threatened with extinction, where international trade is generally prohibited unless the purpose is non-commercial, such as scientific research.
DATE OF ORIGINAL ASSESSMENT: March 2025 (Aimee Carter PIRSA; Vic Greentree DPINSW; Penny Fisher; DEECA; Kristen Petrov, Jess Lyons, Veronica Blazely, DCCEEW) **EIC ENDORSEMENT:** 17 July 2026 **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.*	1	*Animal that is unlikely to make an unprovoked attack but which can cause serious injury (requiring hospitalisation) or fatality if cornered or handled.* The Snow Leopard Trust has stated that there has never been a "verified snow leopard attack on a human being" and they are more than likely to run away if they are disturbed (Snow Leopard Trust, 2025). However, the ABC News (2016), has reported two cases where a snow leopard has attacked people, leaving one seriously injured. Firsthand encounters have shown that interactions with humans are generally avoided by snow leopards (ABC News, 2016; Xiaoyun, 2024). However, the snow leopard's sharp claws, canines and powerful bite force can seriously injure and even kill a human.
A2. Risk to public safety from individual captive animals (0–2) *Assess the risk that irresponsible use of products obtained from captive individuals of the species (such as toxins) pose a public safety risk (excluding the safety of anyone entering the animals' cage/enclosure or otherwise coming within reach of the captive animals)*	0	*Nil or low risk (highly unlikely or not possible).*
STAGE A PUBLIC SAFETY RISK SCORE **SUM A1 - A2 (0-4)**	1	**MODERATELY dangerous**
STAGE B: 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 = 0 Climate Match Score = 1
B2. Exotic population established overseas (0–4) *An established exotic population means the introduced species must have bred outside of captivity and must currently maintain a viable free-living population where the animals are not being intentionally fed or sheltered, even though they may be living in a highly disturbed environment with access to non-natural food supplies or shelter.*	0	*No exotic populations have been established.* No reports found advising that the snow leopard has established exotic populations.
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 – 70 million square kilometres.* Approximately 2.8 million km^2 (McCarthy et al., 2016).
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 with a broad diet of many food types* (Shrestha et al., 2018). Snow leopards are primarily carnivorous and are opportunistic hunters who stalk and ambush their prey from above on the rocky terrain. They primarily hunt wild ungulates (blue sheep (bharal), argali and mountain ibex), however, the snow leopard will prey on domestic animals

		(sheep, horses and goat etc.) if the opportunity and circumstances call for it (GSLEP, 2025; IUCN Cat Specialist Group, 2025; Snow Leopard Trust, 2025; Snow Leopard Conservancy, 2025).
B6. Habitat score (0–1) *Undisturbed or disturbed habitat*	0	*Undisturbed.* Snow leopards occupy Asia's high mountains and predominantly live in isolated and remote landscapes. Their landscape is largely considered undisturbed by humans (Snow Leopard Network, 2014) with less than 23% of the snow leopards' range having been researched (WWFb, 2021).
B7. Migratory score (0–1) *Always migratory = 0; non-migratory = 1*	1	*Altitude migrant.* Snow leopards have extensive home ranges. The Snow Leopard Trust (2025) estimates that the average home range for a male is 230 km^2 and is 130 km^2 for a female. The snow leopard may migrate to lower elevations during the winter to avoid the deep snow of the mountainous regions and to follow the movements of their primary prey species (Snow Leopard Network, 2014).
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*	0	*Overseas geographic range less than 10 million square kilometres.* Approximately 2.8 million km^2 (McCarthy et al., 2016). In the past 1,000 years the snow leopard was much more widely distributed having an estimated distribution range of 10.47 million km^2 (Mahmood et al., 2019). The map of distribution has been provided as Figure 4.

C3. Diet and feeding (0–3)	2	*Mammal that is a strict carnivore (eats only animal matter) and is also strictly ground living.* Snow leopards are primarily carnivorous and are opportunistic hunters who stalk and ambush their prey from above. They primarily hunt wild ungulates (blue sheep (bharal), argali and mountain ibex), however, the snow leopard will prey on domestic animals (sheep, horses and goat etc.) if the opportunity and circumstances arise (GSLEP, 2025; IUCN Cat Specialist Group, 2025; Snow Leopard Trust, 2025; Snow Leopard Conservancy, 2025).
C4. Competition with native fauna for tree hollows (0–2)	0	*Does not use tree hollows.*
C5. Overseas environmental pest status (0–3) *Has the species been reported to cause declines in abundance of any native species of plant or animal or cause degradation to any natural communities in any country or region of the world?*	0	*Never reported as an environmental pest in any country or region.*
C6. Climate match to areas with susceptible native species or communities (0–5) *Identify any native Australian animal or plant species or communities that could be susceptible to harm by the exotic species if it were to establish a wild population here.*	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 1–346 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 (DCCEWW Protected Matters Search Tool) include: *Phascolarctos cinereus* (Koala) – Endangered *Lathamus discolor* (Swift Parrot) – Critically Endangered *Elseya albagula* (Southern Snapping Turtle) – Critically Endangered
C7. Overseas primary production pest status (0–3) *Has the species been reported to damage crops or other primary production in any country or region of the world?*	2	*Moderate pest of primary production in any country or region.* Although the snow leopard is found primarily away from human habitation, climate change and human activities (including effects on the snow leopards prey base and habitat) have seen the snow leopard increasingly attack domestic livestock (WWFa, 2016).

		Reports from snow leopard attacks on domestic animals show that the snow leopards may not only take 1 animal but can take multiple; 30 livestock were killed in Northeastern Afghanistan by a pack of snow leopards in February 2024 (Rahmati, 2024), in India another farmer lost 40 sheep in one night (Butler, 2024) and Poudel (2014) reports that one farmer lost 60 mountain goats over a 3-year period as a result of snow leopard attacks. The cost of a snow leopard attack on primary production is substantial to the producers (Bagchi and Mishra, 2006; Oli et al., 1997). • Khanal et al., (2020) looked at the effects of snow leopard predation on livestock in Nepal. They found that in the Upper Dolpa (located within the district of Dolpa) each household, lost on average, four domestic animals to snow leopards in one year. The resulting financial loss, of around 120,000-140,000 Nepali rupees (GBP £690-£870/USD $900-$1,050), is roughly equivalent to the average person's annual income in western Nepal (Khanal et al., 2020; McDougal, 2025). Approximately AUD $1,3907.97 to $1,525.97 at an average 2020 exchange rate of AUD $1.4533 to USD $1 (Exchange Rates, 2025a). • Hanson (2022) conducted 2 surveys with local populations at Sagarmatha National Park and the Annapurna Conservation Area, both in Nepal, to understand the household conflicts with snow leopards. The results from the surveys, (completed February to March and March to May in 2014 in Sagarmatha National Park and the Annapurna Conservation Area respectively) showed that in the previous 12 months, livestock lost by households represented 3.4% of total livestock owned and had a figure of USD $ 132,450 in financial value (approximately AUD $147,059.24 (Exchange Rates, 2025b)). However, the loss of livestock by snow leopards is relatively small compared to other animals (therefor assessed as MODERATE rather than MAJOR). • In research by Schaller et al., (1988), he reports that of 5 households with a total domestic animal count of 2350, only 12 animals were lost due to wolf and snow

		leopard attacks in the previous 12 months in east Anyemaqen, China (the visit took place in 1985). • In the Sanjiangyuan Region of the Tibetan Plateau, snow leopards consisted of only 10.6% of livestock losses in the previous 12 months with an estimated total USD loss of $92,957 or $646 per a household (Li et al., 2013), approximately AUD $96,396.41 or $669.90 respectively (Exchange Rates, 2025c). Compensation schemes have been implemented to support producers with livestock losses (Joshi, 2023; Li et al., 2013; Mishra, 1997; WWF Nepal, 2021).
C8. Climate match to susceptible primary production (0–5) *Assess Potential Commodity Impact Scores for each primary production commodity listed in Table 9, based on species' attributes (diet, behaviour, ecology), excluding risk of spreading disease which is addressed in Question C9.* *0 = 0; 1-19 = 1; 20-49 = 2; 50-99 = 3; 100-149 = 4; ≥150 = 5*	3	Total Commodity Damage Score = 88.60 (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).* Like all animals, snow leopards are also susceptible to diseases and pathogens that can be transmitted to humans and other species. Essen et al (2019) health screened 20 snow leopards from 2008 to 2015 in the South Gobi Desert of Mongolia. Although the snow leopards did not show clinical signs of any diseases, the following zoonotic pathogens were detected through antibodies developed in the snow leopards: *Coxiella burnetii*, *Leptospira species* and *Toxoplasma gondii*. Both *Coxiella burnetii* and *Toxoplasma gondii* will infect livestock (Essen et al., 2019; Snow Leopard Trust, 2019). 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 - $10 million.* Some leopards break into corrals and pens and cause damage to the facilities used to keep livestock (WWF India, 2016). The corrals and pens often need to be repaired or replaced (Fietcher and Thinley, 2019) and can cost between $500 to $2,000 US dollars (Jackson et al., n.d) (as no date provided, using the 2010 average exchange rate of AUD $1.09, the cost is between AUD $545 to $2,180 (Exchange Rates, 2025d)). However, the impact is felt more upon the loss of the livestock rather than the damage to the pen/corrals (Mishra et al., 2016).
C11. Harm to people (0–5) *Assess the risk that, if a wild population established, the species could cause harm to or annoy people. Aggressive behaviour, plus the possession of organs capable of inflicting harm, such as sharp teeth, tusks, claws, spines, a sharp bill, horns, antlers or toxin delivering organs may enable animals to harm people. Any known history of the species attacking, injuring or killing people should also be taken into account (see Stage A, Score A1).*	3	*Annoyance moderate or severe but few people exposed = 3.* The Snow Leopard Trust has stated that there has never been a 'verified snow leopard attack on a human being' and they are more than likely to run away if they are disturbed (Snow Leopard Trust, 2025). However, the ABC News (2016), has reported 2 cases where a snow leopard has attacked people, 1 leaving serious injuries. Firsthand encounters have shown that interactions with humans are generally avoided by snow leopards (ABC News, 2016; Xiaoyun, 2024). However, the snow leopard's sharp claws, canines and powerful bite force can make it possible that it can seriously injure and even kill a human.
C. PEST RISK SCORE SUM C 1 TO C 11 (1–37)	16	**SERIOUS pest risk**
STAGE A. PUBLIC SAFETY RISK RANK – RISK TO PUBLIC SAFETY POSED BY CAPTIVE OR RELEASED INDIVIDUALS *0 = Not dangerous; 1 = Moderately dangerous; ≥ 2 = Highly dangerous*	1	MODERATELY dangerous

STAGE B. ESTABLISHMENT RISK RANK – RISK OF ESTABLISHING A WILD POPULATION **MODEL 1: FOUR-FACTOR MODEL FOR BIRDS AND MAMMALS (BOMFORD 2008)** *≤ 5 = low establishment risk; 6-8 = moderate establishment risk; 9-10 = serious establishment risk; ≥ 11-13 = extreme establishment risk*	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 *< 9 = low pest risk; 9-14 = moderate pest risk; 15-19 = serious pest risk; > 19 = extreme pest risk*	16	SERIOUS pest risk

ENVIRONMENT AND INVASIVES COMMITTEE THREAT CATEGORY	**SERIOUS**

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

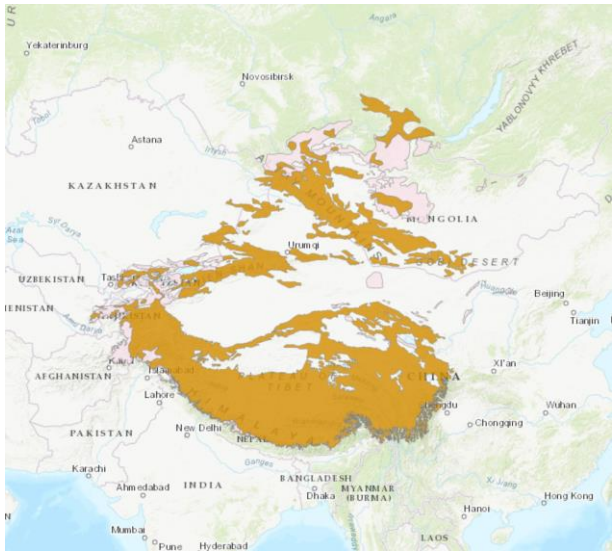


Figure 1- World Distribution Map - IUCN Red List

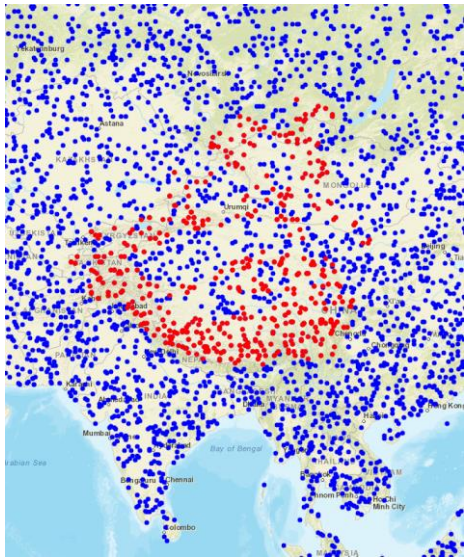


Figure 2 - Climatch World Distribution Map



Figure 3 – World Georeferenced records (GBIF)

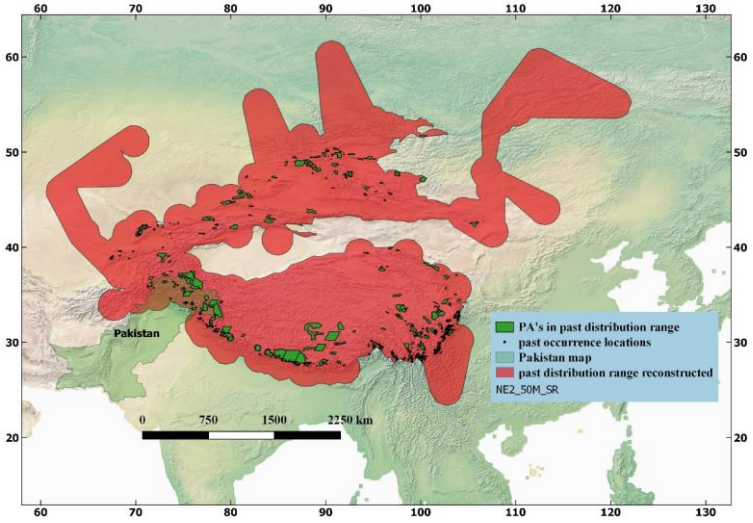
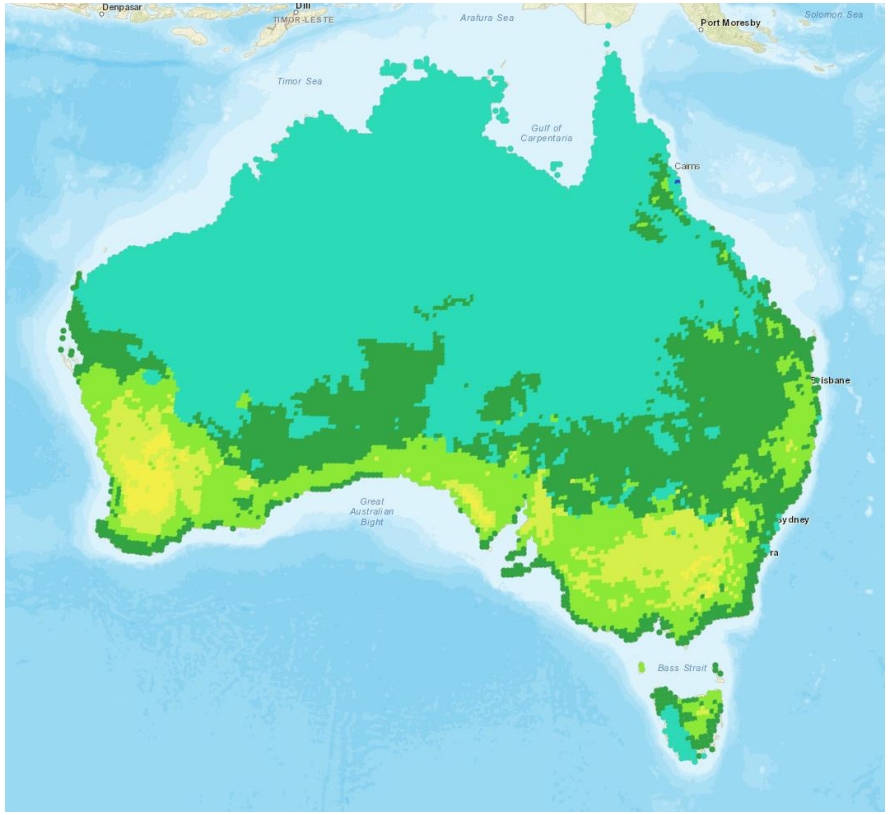


Figure 4 – Previous establishment of Panthera uncia (Mahmood et al, 2019)

Climate match between world distribution of species and Australia:

Areas of Australia where the climate appears suitable for *Panthera uncia*

Value X = 0



Score	Color	Count
0		1
1		11479
2		4167
3		2301
4		1076
5		212
6		0
7		0
8		0
9		0
10		0

Species: Panthera uncia (Snow Leopard)
Algorithm: Closest Standard Score
656 source features selected
19236 target features selected
Approximate selected area: 5,482,832 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	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			
Vegetables	3			
Poultry and eggs	3	2	2	12
Fisheries products	2			
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	3	0.6
Bees (includes honey and beeswax)	0.1			
Total Commodity Damage Score (TCDS)				88.60

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**		

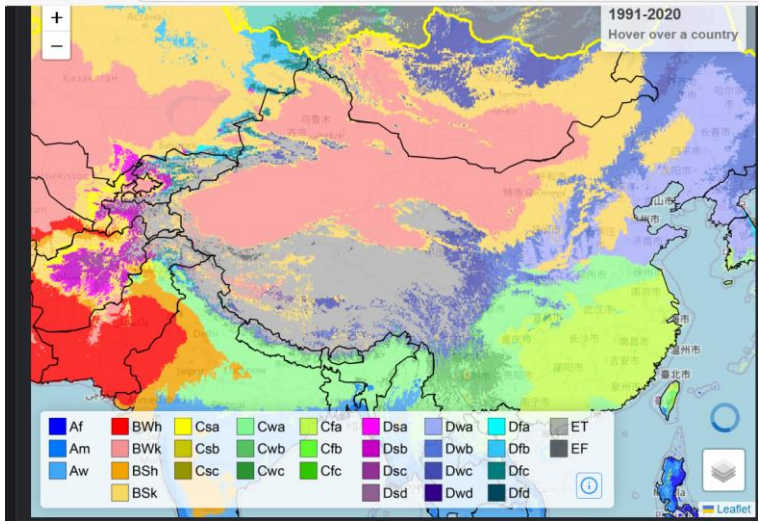
Koppen Gëiger Analysis

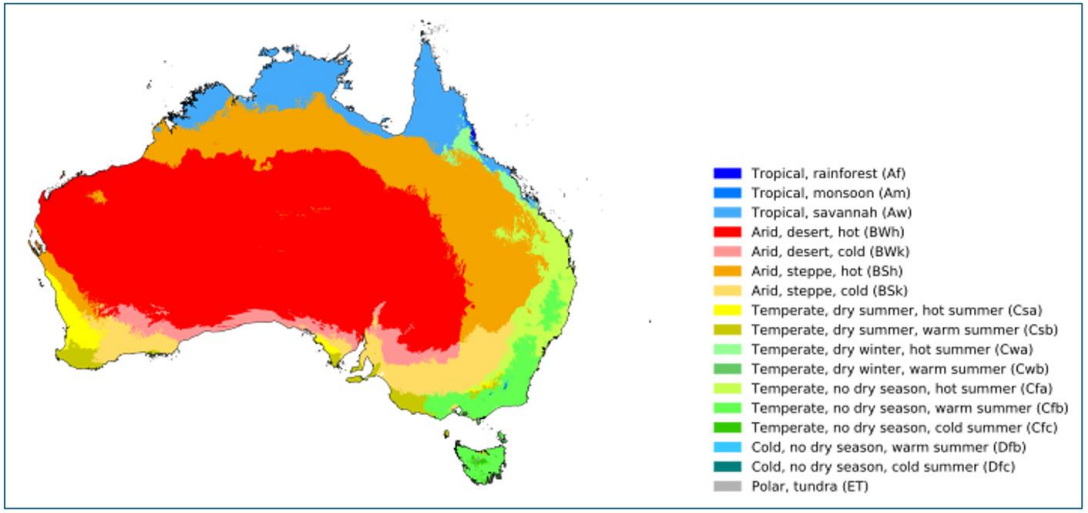
A Koppen-Gëiger analysis shows that most of the climate zones of the snow leopard's usual habitat are not present in Australia:

Dwa - Cold, dry winter, hot summer
Dwb - Cold, dry winter, warm summer
Dwc – Cold, dry winter, cold summer
ET – Polar tundra
EF - Polar frost
Dsb – Cold, dry summers, warm summer

Bsk (Arid, steppe, cold) and possibly Bwk (Arid desert cold) may also be included in the snow leopard's range, of which both are present in the southern regions of Australia.

In this case, the Climatch analysis using the lat/long coordinates corresponds closely with the K-G assessment.





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DRAFT National Risk Assessment: EXTREME

RISK ASSESSMENT FOR AUSTRALIA: Dyeing poison arrow frog (*Dendrobates tinctorius*)

Class - Amphibia, **Order -** Anura, **Family -** Dendrobatidae, **Genus –** *Dendrobates.*

SPECIES: *Dendrobates tinctorius* (Cuvier, 1797) **Synonyms:** *Calamita tinctorius* (Cuvier, 1797) *Dendrobates tinctorius* (Schneider, 1799*)* *Hyla tinctoria* (Cuvier, 1797) *Hylaplesia tinctoria* (Cuvier, 1797) *Rana tinctoria* (Cuvier, 1797) *Dendrobates tinctorius daudini* (Steindachner, 1864) *Dendrobates tinctorius azureus* (Hoogmoed, 1969) *Calamita tinctorius* (Schneider, 1799) *Dendrobates tinctorum* (Silverstone, 1975)) *Dendrobates tinctorum* (Cuvier, 1797*)* *Dendrobates azureus* (Hoogmoed, 1969) *Dendrobates machadoi* (Bokermann, 1958) *Dendrobates tinctorius daudini* (Steindachner, 1864) *Dendrobates tinctorius azureus* (Hoogmoed, 1969)	**Species description:** The dyeing poison arrow frog is a strikingly coloured Neotropical poisonous frog found in primary forests in the eastern Guiana Shield (Exo Terra, 2025; Rojas and Pašukonis, 2019). With a snout-vent length between 37 to 53 millimetres and weighing approximately 3 grams, the dyeing poison arrow frog is a medium sized frog species (Brown, 2004; Rojas and Endler, 2013). The dyeing poison arrow frog has a predominantly black base colour with individuals exhibiting a variety of spots, bands or patches (primarily located on the dorsal and head), in varying shades of blue, yellow, white and sometimes orange (Exo Terra, 2025). Rojas and Endler (2013) describe the general appearance of the dyeing poison arrow frog as having a "background dorsal colour [that] is black, with yellow dorsolateral lines that may fuse at the sacrum and extend to the vent. This often results in the appearance of a large ovoid black spot on the dorsum. The width of dorsolateral lines and completeness varies considerably covering between 7 and 60% of total dorsum. The lines can be interrupted between one and six times forming, in some cases, discontinuous patches" (Rojas and Endler, 2013). The dyeing poison arrow frog's bright colouration serves as a warning to potential predators of the frog's toxicity, known as aposematism (Corrêa et al., 2021). When threatened or stressed, the frog's skin secretes a potent chemical compound which deters predation by making the frog extremely unpalatable or dangerous to consume (Exo Terra, 2025). The effects of envenomation can lead to cardio-respiratory problems (Corrêa et al., 2021). Colour patterns vary both within and among populations, with each frog having an individual dorsal and ventral pattern acting as a unique identification or 'fingerprint' (Courtois et al., 2012; Rojas and Pašukonis, 2019). The dyeing poison arrow frog has four toes on each foot, each with an adhesive pad that enables the frog to climb. Males have a distinctive heart shaped toe whereas females have a rounded toe (Brown, 2004). Although they require water to raise their young, the dyeing poison arrow frog is a poor swimmer due to

Common Names: Dyeing Poison frog Dyeing Dart frog Dyeing Poison-arrow frog Tinging frog Blue poison-dart frog Cobalt Poison frog Tinc	its lack of toe webbing and therefore is not often found in the water (Howell, 2021). The dyeing poison arrow frog has a hunch backed and a relatively large round tympanum (Wollenberg et al., 2006). Sexual dimorphism is present within the dyeing poison arrow frog. Males have wider toe discs, a yellower dorsum and bluer limbs and are slender compared to the females (Born et al., 2010; Exo Terra, 2025; Rojas and Endler, 2013; Wollenberg et al., 2006). The dyeing poison arrow frog vocalizes rarely and at very low intensities. The vocalisation is used in courtship interactions or during agonistic interactions with other males (Born et al., 2010; Rojas and Pašukonis, 2019). There are more than 30 recognised colour morphs for the dyeing poison arrow frog (Wollenberg et al., 2006). One of the colour morphs *Dendrobates tinctorius azureus / Dendrobates azureus* is a junior synonym of the species (Wollenberg et al., 2006). *D. t. azureus* – also known as the blue poison dart frog, is a predominantly blue subspecies with black spots across its body (d'Orgeix et al., 2019; Hoogmoed, 2010). *D. t. azureus* has primarily azure-blue hues on the limbs, is a sky-blue on its dorsal surface, and has a darker blue on its ventral surface. It has an irregular pattern of dark blue to black spots across the dorsal and head and occasionally may have a mid-belly stripe on its ventral surface (Aquarium of the Pacific, 2025; Brown, 2004). **General information:** Distribution: The dyeing poison arrow frog is a resident species in Brazil (in the states of Amapá and Pará), French Guiana, Guyana and Suriname. They are typically found at elevations from sea level to 600 metres, where the environment is humid, and temperatures are consistently high (Amphibian Specialist Group, 2023; Born et al., 2010; Noonan and Gaucher, 2006). Habitat: The dyeing poison arrow frog is terrestrial and is limited to the tropical rainforests of northern South America (Courtois et al., 2012). These frogs occupy canopy gaps and are often found at water sources inside plant structures (called phytotelmata) (Fouilloux et al., 2021; Rojas, 2013). Suitable habitats include leaf litter, dead logs and fallen branches with the presence of structured water features for depositing offspring for metamorphosis (Rojas and Pašukonis, 2019). Tree falls, with the increase of new vegetation and freshwater holes available, are a particularly suitable area for the dyeing poison arrow frog (Rojas, 2015). The dyeing poison arrow frog is an adept climber, depositing its offspring in pools of water from the forest floor up to 20 metres in vertical height (Fouilloux et al., 2021; Rojas, 2015).

	Diet: The dyeing poison arrow frog is diurnal, actively foraging during the day for small invertebrates such as ants, termites, and other small insects (Courtois et al., 2012; Born et al., 2010). This specialised diet contributes significantly to the dyeing poison arrow frog's toxicity. The consumption of alkaloid-rich arthropods (such as ants) provides the frogs with their aposematic appearance and toxic defence mechanism (Corrêa et al., 2021). In captivity, the diet of the dyeing poison arrow is altered by removing insects that may increase the frog's toxin levels (Aquarium of the Pacific, 2025; New England Zoo, 2025). Reproduction: Females have an active role in the mating ritual for the dyeing poison arrow frog. Mating behaviour starts with the male calling from his position in tree leaves or on the ground. The female is attracted by his calls and will initiate the interaction by stroking the male's snout and back in a typical poison frog courtship sequence (Amphibia Web, 2018; Rojas and Pašukonis, 2019). The courting pair will move locations frequently, travelling to find an appropriate location for egg laying. Once a suitable location is found (generally moist and sheltered within the male's territory), the female lays a clutch of 4-5 eggs (Exo Terra, 2025; Rojas, 2015). The male will then fertilise the eggs. The male is the primary caretaker of the eggs, frequently checking on the clutch and moistening the eggs. However, it is not uncommon for the female to assist in caring for the clutch (Brown, 2004). The eggs hatch within 14 to 28 days (Amphibia Web, 2018; Ferrão et al., 2024). Upon hatching, the tadpoles are carried on the male's back (sometimes the female) one or two at a time, to a suitable pool of water where the tadpoles will complete their larval development, unattended (Brown, 2004; Rojas, 2013). Once the transportation of the tadpoles is completed, the male will end his care of the young. The tadpoles feed on other insect larvae (such as mosquitoes) and other tadpoles (including conspecific tadpoles) (Rojas, 2013, 2015). Metamorphosis typically occurs between 90 to 120 days after (Rojas and Pašukonis, 2019). **Longevity:** The record for longevity in captivity has not yet been established. Observations in captivity have indicated that the dyeing poison arrow frog can live up to 7.6 years, but it is proposed that their lifespan could be considerably longer (AnAge, 2023). In the wild, it is estimated that the dyeing poison arrow frog has a life span between 4 to 6 years (Brown, 2004). **Conservation status:** **IUCN:** Least Concern.

	CITES: Appendix II - species not necessarily threatened with extinction but may become so if trade isn't regulated.
DATE OF ASSESSMENT: March 2025 (Aimee Carter PIRSA; Vic Greentree DPINSW; Penny Fisher DEECA; Kristen Petrov, Jess Lyons, Veronica Blazely DCCEEW) **EIC ENDORSEMENT:** 17 July 2026 **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	0	CMRS = 100 x (0/19,236) = 0

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).*		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 waifs rather than an established population and have not been added to the statistics (Figure 2 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* • *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	*Species has not established an exotic population (including species not known to have been introduced anywhere).* There are no reports that this species has an established invasive population. Invasive.org (2025) reports that there is no reference that this species is invasive in North America.
C. Taxonomic Family Risk Score	30	*Dendrobatidae*
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	**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)	1	*Very Low climate match to Australia* Value X = 0 CMS = 1

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.*		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 waifs 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 exotic population ever established.* There are no reports that this species has an established invasive population. Invasive.org (2025) reports that there is no reference that this species is invasive in North America.
C. Overseas range size score (0–2) < 1 = 0; 1– 70 = 1; >70 = 2 *Estimate the species overseas range size* including currently and the past 1000 years; natural and introduced range in millions of square kilometres*	0	*Overseas range less than 1 million square kilometres.* Overseas natural range size is estimated at 720,000 km^2. The dyeing poison arrow frog is a resident species in Brazil (in the states of Amapá and Pará), French Guiana, Guyana and Suriname (Amphibian Specialist Group, 2023; Brown, 2004; Rojas, 2013).
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*	1	**LOW establishment risk**

ENVIRONMENT AND INVASIVES COMMITTEE ALLOCATED PEST RISK*	**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.	

ENVIRONMENT AND INVASIVES COMMITTEE THREAT CATEGORY	**EXTREME*** *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); Climatch world distribution map and world georeferenced records (GBIF); indicating where meteorological data was sourced for the climate analysis:

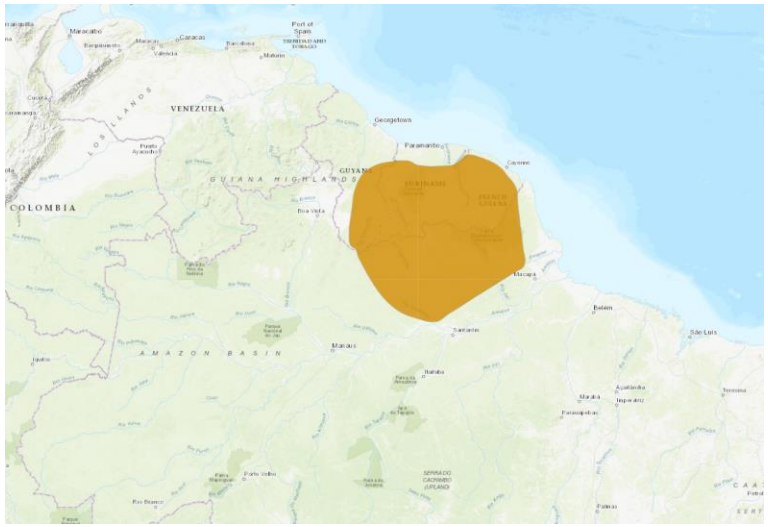


Figure 1 - World distribution map - IUCN Red List

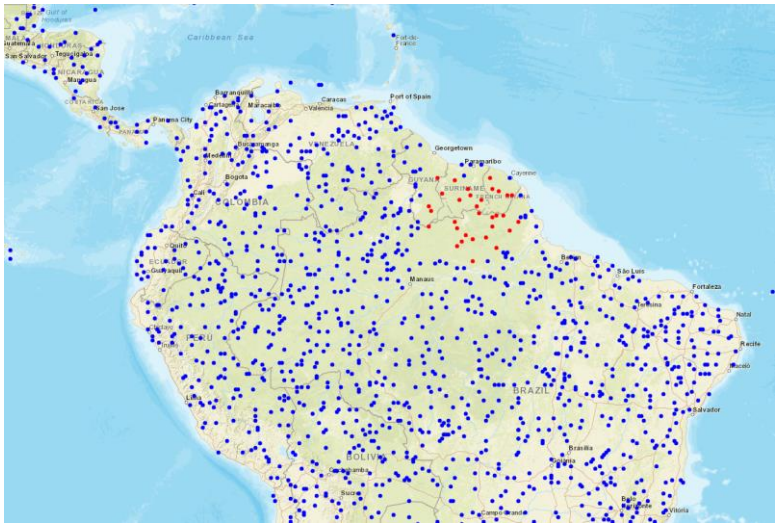


Figure 2 – World Distribution map – Climatch – current locations

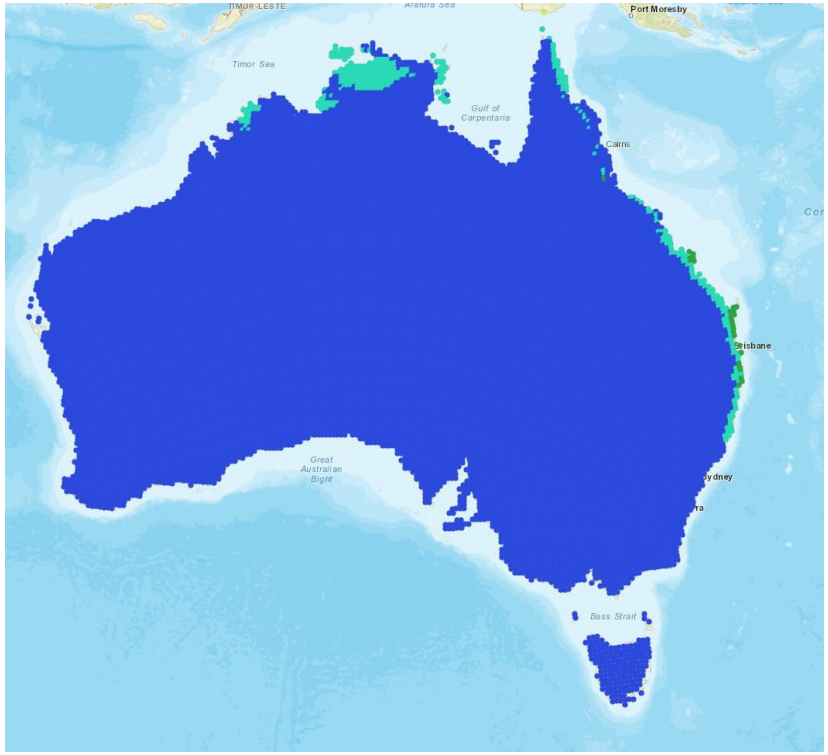


Figure 3 - World georeferenced records (GBIF)



Figure 4 - World georeferenced records (GBIF) – 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 *Dendrobates tinctorius*
CMS (Sum Level 7) = 0

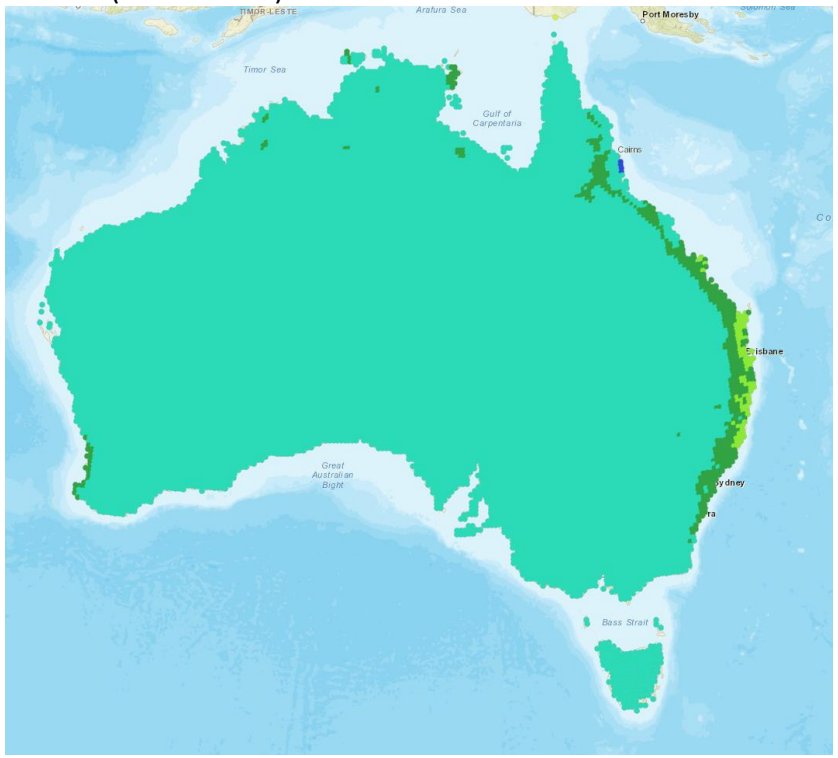


Score	Color	Count
0		18804
1		403
2		28
3		0
4		1
5		0
6		0
7		0
8		0
9		0
10		0

Species: Dendrobates tinctorius (Dyeing Poision-arrow Frog)
Algorithm: Euclidean
32 source features selected
19236 target features selected
Approximate selected area: 719,601 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 *Dendrobates tinctorius*

Value X (Sum Level 6) = 0



Score	Color	Count
0		4
1		18641
2		511
3		79
4		1
5		0
6		0
7		0
8		0
9		0
10		0

Species: Dendrobates tinctorius (Dyeing Poison Arrow Frog)
Algorithm: Closest Standard Score
32 source features selected
19236 target features selected
Approximate selected area: 719,601 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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DRAFT National Risk Assessment: EXTREME (*Lycodon aulicus, Lycodon capucinus*)

RISK ASSESSMENT FOR AUSTRALIA: Two wolf snake (*Lycodon*) species

Class - Reptilia, **Order** - Squamata, **Family** - Colubridae, **Genus** – *Lycodon.*

SPECIES: 1. *Lycodon aulicus* (Linnaeus, 1758) 2. *Lycodon capucinus* (H. Boie in F. Boie, 1827) **Synonyms:** **1. *Lycodon aulicus* (common wolf snake)** *Coluber aulicus* (Linnaeus, 1758) *Natrix aulica* (Laurenti, 1768) *Lycodon subfuscus* (Cantor, 1839) *Lycodon atropurpureus* (Cantor, 1839) *Lycodon aulicum* (Duméril, Bibron and Duméril, 1854) *Lycodon aulicus oligozonatus* (Wall, 1909) *Ophites aulicus* (Wall, 1921) *Lycodon anamallensis* (Günther, 1864) *Lycodon unicolor* (H. Boie in F. Boie, 1827) *Lycodon capucinus* (H. Boie in F. Boie, 1827) **2. *Lycodon capucinus* (island wolf snake)** *Coluber hebe* (Daudin, 1803)	**Species description:** The *Lycodon* genus can be recognised by the following characteristics: they are described as small to medium sized snakes that increase in size posteriorly. *Lycodon* species have a rounded orbit with a vertical elliptic pupil and large nostrils. Their heads are large, wide and dorsoventrally depressed with its neck distinct from its body. *Lycodon* species have smooth or weakly keeled dorsal scales, with apical pits in rows 17, 19 or 21 in the middle of the body and rounded ventrals. The upper maxillary bone is strongly arched bending inwards anteriorly and the anterior maxillary teeth are curved separated by a diastema between them and the subsequent teeth. There are no venomous grooves in the *Lycodon* species (Leviton, 1965; Malkmus et al., 2002; Uetz et al., 2025; Vogel et al., 2013; Vogel and Ganesh, 2018). Due to *Lycodon capucinus* being considered as a synonym or subspecies of *Lycodon aulicus* (the two species re almost indistinguishable), it is common for these snakes to be reported as each other depending on how the researcher classifies the snake (Maury et al., 2022; Vogel et al., 2021). *Lycodon aulicus* is often confused as being the common krait (*Bungarus caeruleus*) due to its similarity in appearance (Kumari, 2017; Nagdev et al., 2022). **1. *Lycodon aulicus* (common wolf snake)** The common wolf snake is a non-venomous, nocturnal colubrid species endemic to the Indian subcontinent. It is one of the most common species of snake found in human habitation and typically measures between 300 to 800 millimetres in length (Husain, 2020; Indian Snakes, 2025; Whitaker and Captain, 2004) with some reaching as long as 840 millimetres (Patil and Mirza, 2007). The common wolf snake is characterised by a light to dark blackish-brown dorsum with distinct creamy white cross bars. Most common wolf snakes have between 9 to 18 cross bars which are traditionally white sometimes yellow (Daniel, 1983). However, some common wolf snakes may have brown spots throughout the cross bar (Dutta et al., 2009; Lanza, 1999). The cross bars are either fully complete across the dorsum or “broad on the vertebral row before diverging into two lateral arms” (Ganesh and Vogel, 2018; Vogel et al., 2021). The cross bars are broadest on the sides of the

Lycodon hebe (Daudin, 1803) **Sub Species:** **1. *Lycodon aulicus* (common wolf snake)** *Lycodon aulicus capucinus* *Lycodon aulicus aulicus* (Smith, 1943) **2. *Lycodon capucinus* (island wolf snake)** Monotypic **Common Names:** **1. *Lycodon aulicus* (common wolf snake)** Common wolf snake Indian wolf snake House Snake **2. *Lycodon capucinus* (island wolf snake)** Island wolf snake Capuchin wolf snake Oriental wolf snake House wolf snake Common island wolf snake	common wolf snake and are narrower across the dorsum (Indian Snakes, 2025). Depending on how the cross bars fall, they may create triangular patches across the body of the common wolf snake (Lanza, 1999). These markings help with camouflaging the common wolf snake in its natural habitat. The common wolf snake has a slender body and a pointed tail with the cross bars gradually fading on the tail region. The common wolf snake has a clearly defined collar around its neck which extends towards the front of the head (Dutta et al., 2009; Ganesh and Vogel, 2018; Vogel et al., 2013). This collar may break into occipital blotches on the back of the head on either side of the midline and may extend to and connect with the supralabials (O'Shea et al., 2018). There are 9 supralabials on each side of the face that are white or spotted with brown (Bhakat et al., 2018; Vogel et al, 2013; Vogel and Ganesh, 2018; Whitaker and Captain, 2004). The scales of the common wolf snake are smooth and glossy. The ventral surface is usually lighter, and is off-white (Wickramasginhe et al., 2021). Subtle variations such as lack of bandings (Maharana et al., 2022b; Parmer et al., 2024), colour morphs (Ganesh et al., 2011; Mizra et al., 2011) and leucism (Maharana et al., 2022; Motiwala et al., 2022) have been reported in the common wolf snake. Juvenile common wolf snakes are similar in colour and pattern to the adults (Vogel et al., 2013) however, the juveniles cross bars are more prominent. Despite being a non-venomous species, the common wolf snake can be aggressive, often attacking when threatened (Deshmukh et al., 2020a, 2020b). This can cause serious injury to humans that may require hospitalisation (Nagdev et al., 2022). The common wolf snake will also implement defensive tactics including death-feigning (Deshmukh et al, 2020a; Mizra et al, 2011) and tail shaking (Deshmukh et al., 2020b) behaviour to protect itself from predators. The common wolf snake is primarily nocturnal and is known to be arboreal (Deshmukeh et al., 2018; Patel et al., 2019). **2. *Lycodon capucinus* (island wolf snake)** The island wolf snake is a non-venomous, nocturnal colubrid species endemic to Southeast Asia and the Indo-Malaysian region. The species is very common within Southeast Asia. The island wolf snake is a small snake, with adults rarely exceeding 600 millimetres in length (O'Shea et al., 2015), however some can measure 760 millimetres (Das, 2015) to 816 millimetres (Janssen et al., 2019). This island wolf snake's body is slender, with a characteristic smooth and shiny scale texture that helps it blend seamlessly into its natural environment. The island wolf snake is characterised by a brown or purplish brown dorsum with reticulated white or yellow marbled scales (O'Shea et al., 2018; Vogel et al., 2021). The reticulated pattern on the dorsum is a mix of blended and irregular spots with each scale having a light edge to them (Das, 2015). The reticulated pattern may form a chain-like cross bar, but it is less defined compared to the common wolf snake (O'Shea et al.,

	2018). The ventral surface is “dirty white” (Luu et al., 2019; Neang et al., 2014). The island wolf snake has a clearly defined collar around its neck often a pale yellow in colour (Ecology Asia, 2025) that may be spotted with brown (Das, 2015). Like the common wolf snake, the collar on the island wolf snake may break into occipital blotches on the back of the head on either side of the midline and may extend to and connect with the supralabials (O’Shea et al., 2018). There are 9-10 supralabials on each side of the face (Neang et al., 2014). The island wolf snakes head is wide and is slightly distinct from the body with the loreal not in contact with the eye (Luu et al., 2019). Male island wolf snakes’ average fewer ventrals but more subcaudal scales in comparison to the females. The males also have a longer average tail length compared to their standard length (Leviton, 1965). Subtle variations such as lack of markings and uniformity in colour have been reported in the island wolf snake’s (Daniel, 1983). The juvenile island wolf snake has less pattern across its dorsum or is unicoloured (O’Shea et al., 2018). Despite being a non-venomous species, the island wolf snake can be aggressive, often attacking when threatened or handled (Das, 2015). The common wolf snake will also implement defensive tactics including tail shaking (Fritts, 1993) and potentially death-feigning (though more research is required on this (Mizra et al., 2011)) behaviour to protect itself from predators. The island wolf snake is primarily nocturnal, secretive and is known to be semi arboreal (O’Shea et al., 2015). **General information:** 1. ***Lycodon aulicus*** **(common wolf snake)** Distribution: The common wolf snake is a resident to Bangladesh, India (but not the Andaman and Nicobar islands), Myanmar, Nepal, Pakistan and Sri Lanka (David and Vogel, 1996; Ganesh and Vogel, 2018; Wogan et al., 2021). The Catalogue of Life (2025) also reports populations of the common wolf snake on the Mascarene islands (GBIF, 2025), Bhutan (supported by Ganesh and Vogel, 2018; Uetz et al., 2025), and China (the provinces of Fujian and Yunnan) (Uetz et al., 2025) (however, the Chinese population is debated by Wang et al., 2021 and requires further comment according to O’Shea et al., 2018). Research undertaken by Vogel et al (2021) supports the establishment of exotic populations of the common wolf snake in the Mascarene islands (Réunion and Mauritius). The Global Biodiversity Information Facility reports that the common wolf snake has also been reported in the Philippines (GBIF, 2025; Lanza, 1999) in Olango islands (Mapalo, 2019). Ganesh and Vogel (2018) also reported that the common wolf snake is found in Hawaii. The common wolf snake was previously recorded as an introduced population in Comoros, but this species may have been incorrectly classified. Any introduced population to Comoros has now been classified as extinct (Hawlitschek, 2008;

	Wogan et al., 2021). According to the IUCN website, the common wolf snake was introduced and has established populations on Christmas island (however this is reported as subspecies *Lycodon aulicus capucinus* (DCCEEW, 2014; O'Shea et al., 2018; Uetz et al., 2025) which can be determined as its own species *Lycodon capucinus*) and the Maldives (however, this may also be reported as the species *Lycodon capucinus*). Further research is required to establish this population (MFA Maldives, 2016; O'Shea et al., 2018; Uetz et al., 2025; Wogan et al., 2021). Both the Christmas island, Australia, and Maldives populations have been included under *Lycodon capucinus* in this risk assessment. Habitat: The common wolf snake is found in high humidity and temperatures in both disturbed and undisturbed habitats (Jayakumar et al., 2018). Its habitat ranges from lowlands, forests and grasslands (Ansari, 2018) to urban areas and plantations (Jayakumar et al., 2018). The common wolf snake is a terrestrial species and can often be found beneath logs and leaf litter (Zug et al., 1998). The common wolf snake is frequently encountered by humans and is often seen in and around settlements and buildings (David and Vogel, 1996; Hakim et al., 2020; O'Shea et al., 2018), frequently observed in crevices, depressions or under objects. The common wolf snake is recorded from sea level to 2,100 meters in elevation within Nepal (Wogan et al., 2021). Diet: The diet of the common wolf snake consists primarily of lizards including geckos and skinks and small vertebrates like frogs (Auffenberg, 1980; O'Shea et al., 2018; Vogel et al., 2021), rodents and bats (Tank and Sharma, 2016). The snake employs constriction to subdue its prey. They will grasp the prey in the abdomen with their fangs, wrap coils around it and constrict the breathing of the prey until it is deceased (Snake Radar, 2023; Wangyall et al., 2021). Reproduction: The common wolf snake is oviparous (Vogel et al., 213). Females lay their eggs prior to the monsoon seasons (between February and July) and typically lay between 4 and 11 eggs (Daniel, 1983). Newborns measure between 140 to 190 millimetres in length (Das, 2015; Indian Snakes, 2025; Kumari, 2017) and sexual maturity is attained at two years (Daniel, 1983). **2. *Lycodon capucinus* (island wolf snake)** Distribution: This species is predominantly found in tropical forests and subtropical regions and is a resident in Brunei Darussalam, Cambodia, China (however, the Chinese population is debated by Wang et al., 2021 and requires further comment according to O'Shea et al., 2018), India (specifically the Andaman islands (Harikrishnan et al., 2012), and Nicobar islands (Lanza, 1999)), Indonesia, Lao People's Democratic Republic, Malaysia, Singapore, Thailand and Vietnam. The island wolf snake can also be found in Myanmar (O'Shea et al., 2018; Wogan et al., 2012; Uetz et al., 2025). The island wolf snake has also been reported as having

	introduced and established populations within Indonesian New Guinea (O'Shea et al., 2018), Lesser Sundas (Reilly et al., 2019) including Timor Leste (O'Shea et al., 2015), Hong Kong (Yang and Yeung, 2024) and in the Philippines (Lanza, 1999; Leviton, 1965; Weinell et al., 2019). The island wolf snake has an established population on Christmas island, Australia (DCCEEW, 2014; Fritts, 1993; O'Shea et al., 2018; Uetz et al., 2025), with the Online Zoological Collections of Australian Museums website listing the specimens taken from Christmas island as *Lycodon capucinus* (OZCAM, 2025). The introduction of the common wolf snake to Christmas island has contributed to the decline of the blue-tailed skink (DCCEEW, 2014). Populations of the island wolf snake have also been reported in Micronesia (Midtgaard, 2019). O'Shea et al., (2018) supports the establishment of exotic populations of the island wolf snake in the Mascarene islands (Réunion and Mauritius) (Rep Focus, 2025). The Maldives may also have a population of the island wolf snake. However further research is required to establish the species of this population (MFA Maldives, 2016; O'Shea et al., 2018; Uetz et al., 2025). Habitat: The island wolf snake is found in a variety of disturbed and undisturbed locations, often found within villages and agricultural settings and frequently observed in crevices, depressions or under objects. The island wolf snake is associated with lowland tropical forests (Wogan et al., 2012) and mid-hills and is a terrestrial species (Das, 2015). The island wolf snake can be found at a multitude of elevations ranging from lowland to montane forests (Gharat et al., 2021). Diet: The diet of the island wolf snake consists primarily of lizards including geckos and skinks (Emery et al., 2021; Jackson and Fritts, 2004) and small vertebrates like frogs and mice (Fritts, 1993). The snake employs constriction to subdue its prey. They will grasp the prey in the abdomen with their fangs, wrap coils around it and constrict the breathing of the prey until it is deceased (Snake Radar, 2023). Reproduction: The island wolf snake is oviparous with clutches of up to 11 eggs (David and Vogel, 1996) and an incubation period between 33 to 45 days (Das, 2015). Newborns measure between 170 to 190 millimetres in length and sexual maturity is attained at two years (Daniel, 1983). **Longevity:** ***1. Lycodon aulicus* (common wolf snake)** No record on life expectancy for the common wolf snake was found on AnAge, the World Life Expectancy or on the IUCN website.

	2. ***Lycodon capucinus*** **(island wolf snake)** No record on life expectancy for the island wolf snake was found on AnAge, the World Life Expectancy or on the IUCN website. AZ Animals (2024) estimate that the life span of the island wolf snake is around 10 years. **Conservation status:** **IUCN** 1. ***Lycodon aulicus*** **(common wolf snake)** – Least Concern 2. ***Lycodon capucinus*** **(island wolf snake)** – Least Concern **CITES** 3. ***Lycodon aulicus*** **(common wolf snake)** – Not listed 4. ***Lycodon capucinus*** **(island wolf snake)** – Not listed
DATE OF ASSESSMENT: March 2025 (Aimee Carter PIRSA; Vic Greentree DPINSW; Penny Fisher DEECA; Jess Lyons and Veronica Blazely DCCEEW; Win Kirkpatrick DPIRD) **EIC ENDORSEMENT:** 17 July 2026 **Risk assessment model used for the assessment:** • Bomford 2006, Risk assessment for the establishment of exotic vertebrates in Australia: recalibration and refinement of models	**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/.

• **Australian Reptile and Amphibian Model (Bomford 2008)** • Bird and Mammal Model for Reptiles and Amphibians (Bomford 2008)	

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		
D. 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).*	51.66 25.44	**1. *Lycodon aulicus* (common wolf snake)** CMRS = 100 x (9,938/19,236) = 51.6635475150759 CMRS = 51.66 As Christmas island is an external territory of Australia it has not been included in the Climatch analysis. There are no weather stations on the Maldives, Mascarene islands or Comoros; therefore, they have not been included in the Climatch statistics (Figure 2). **2. *Lycodon capucinus* (island wolf snake)** CMRS = 100 x (4,894/19,236) = 25.44187980869204 CMRS = 25.44 As Christmas island is an external territory of Australia it has not been included in the Climatch analysis. There are no weather stations on the Maldives, Mascarene islands or Comoros; therefore, they have not been included in the Climatch statistics (Figure 2).
E. Exotic Elsewhere Risk score (0, 15 or 30) *Score B = A species' Exotic Elsewhere Risk Score, calculated as follows:*	30	*Species has established breeding self-sustaining exotic population in another country.* **1. *Lycodon aulicus* (common wolf snake)**

• *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	Exotic self-sustaining populations have been found in: - Mascarene islands (GBIF, 2025; Vogel et al., 2021) - Bhutan (Ganesh and Vogel, 2018; Uetz et al., 2025) - China (the provinces of Fujian and Yunnan) (Uetz et al., 2025) - Philippines (GBIF, 2025; Lanza, 1999) such as Olango islands (Mapalo, 2019) - Hawaii (Ganesh and Vogel, 2018) - Comoros, but this species may have been incorrectly classified. Any introduced population to Comoros has now been classified as extinct (Hawlitschek, 2008; Wogan et al., 2021). According to the IUCN website, the common wolf snake was introduced and has established populations on Christmas island (however this is reported as subspecies *Lycodon aulicus capucinus* (DCCEEW, 2014; O'Shea et al., 2018; Uetz et al., 2025) which can be determined as its own species *Lycodon capucinus*). According to the IUCN website, the common wolf snake was introduced and has established populations on the Maldives (however, this may also be reported as the species *Lycodon capucinus*). Further research is required to establish this population (MFA Maldives, 2016; O'Shea et al, 2018; Uetz et al, 2025; Wogan et al, 2021). **2. *Lycodon capucinus* (island wolf snake)** Exotic self-sustaining populations have been found in: - Indonesian New Guinea (O'Shea et al., 2018 – Figure 5 map) - Lesser Sundas (Reilly et al., 2019) including Timor Leste (O'Shea et al., 2015 – Figure 5 map) - Hong Kong (Yang AND Yeung, 2024) - Philippines (Lanza, 1999; Leviton, 1965; Weinell et al., 2019 – Figure 5 map) - Christmas island, Australia (DCCEEW, 2014; Fritts, 1993; O'Shea et al., 2018; Uetz et al., 2025) - Micronesia (Midtgaard, 2019)

		O'Shea et al., (2018) supports the establishment of exotic populations of the island wolf snake in the Mascarene islands (Réunion and Mauritius). The Maldives may also have a population of the island wolf snake. However further research is required to establish the species of this population (MFA Maldives, 2016; O'Shea et al., 2018; Uetz et al., 2025).
F. Taxonomic Family Risk Score	10	*Colubridae*
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*	91.66 65.44	**SERIOUS establishment risk** **1. *Lycodon aulicus* (common wolf snake)** **2. *Lycodon capucinus* (island wolf snake)**

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.*	-0.15	**1. *Lycodon aulicus* (common wolf snake)** (including *Lycodon capucinus* as a subspecies)
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.*	0.75	**1. *Lycodon aulicus* (common wolf snake)** (including *Lycodon capucinus* as a subspecies) Based on the updated statistics from Kraus (2009) as directed by Bomford 2008. *Number of jurisdictions where a species successfully established = 6* *Total number of jurisdictions where species has been introduced = 8* *Prop.species Value = 0.75*

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. 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.*	1.35	**1. *Lycodon aulicus* (common wolf snake)** (including *Lycodon capucinus* as a subspecies) <u>Score reflecting the version of Climatch 2.0</u> Sum Euclidian match scores to Australia levels 6-10 = 14,633 Climate 6 score = 14,633/19,236 = 0.7607090871283011 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(0.7607090871283011) – 1.88. Figure 3.4 = 1.35
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*	0.93	**1. *Lycodon aulicus* (common wolf snake)** (including *Lycodon capucinus* as a subspecies) 1/(1 + exp(0.80 – 2.90(0.75) – 1.35 – -0.15) 1/(1 + exp(0.80 – 2.175 – 1.35 + 0.15)) 1/(1+EXP(-2.575)) **=0.9292351881** **=0.93** **EXTREME**

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.*	4	**1. *Lycodon aulicus* (common wolf snake)** *High climate match to Australia* Value X = 11,537 CMS = 4

	2	Note: The species has many GBIF georeferenced occurrences from outside its natural range (Figure 4). Whilst some of these occurrences are presumed to be waifs rather than established populations, Climatch modelling has been expanded to capture areas of most densely reported occurrence (Figure 2). **2. *Lycodon capucinus* (island wolf snake)** Low climate match to Australia Value X = 2,912 CMS = 2 Note: The species has many GBIF georeferenced occurrences from outside its natural range (Figure 4). Whilst some of these occurrences are presumed to be waifs rather than established populations, Climatch modelling has been expanded to capture areas of most densely reported occurrence (Figure 2).
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 4	**1. *Lycodon aulicus* (common wolf snake)** *Exotic population established on a larger island (>50,000km^2) or anywhere on the continent.* In the Mascarenes, it is believed that the common wolf snake has led to the decline and extinction of the Bojers skink (*Gonglomorphus bojerii*) (Emery et al., 2021; Jackson and Fritts, 2004 reported as *Lycodon aulicus capucinus*). **2. *Lycodon capucinus* (island wolf snake)** *Exotic population established on a larger island (>50,000km^2) or anywhere on the continent.* Christmas island has an area of 135km^2 (NNA, 2020). The island wolf snake has had a combined effect leading to the decline of four reptile species and the loss of 80% of Christmas islands native lizard assemblage over the past 20 plus years (Emery et al., 2021).
C. Overseas range size score (0–2) < 1 = 0; 1– 70 = 1; >70 = 2	1	*Overseas range estimated between 1 to 70 million square kilometres.* **1. *Lycodon aulicus* (common wolf snake)**

Estimate the species overseas range size including currently and the past 1000 years; natural and introduced range in millions of square kilometres	1	Overseas natural range size is estimated at 6.1 million km^2. The species also has many georeferenced occurrences recorded around the world (Figure 4 GBIF reporting). The Climatch modelling has therefore been expanded to incorporate areas where the common wolf snake has been reported and where invasive populations have been established (Figure 2). **2. *Lycodon capucinus* (island wolf snake)** Overseas natural range size is estimated at 5.01 million km^2. The species also has many georeferenced occurrences recorded around the world (Figure 4 GBIF reporting). The Climatch modelling has therefore been expanded to incorporate areas where the common wolf snake has been reported and where invasive populations have been established (Figure 2).
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*	9 7	**1. *Lycodon aulicus* (common wolf snake) - SERIOUS establishment risk** **2. *Lycodon capucinus* (island wolf snake) – MODERATE establishment risk**

ENVIRONMENT AND INVASIVES COMMITTEE ALLOCATED PEST RISK* *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.	**EXTREME**

ENVIRONMENT AND INVASIVES COMMITTEE THREAT CATEGORY	**EXTREME*** *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.

1a. World distribution map (IUCN Red List); world georeferenced records (GBIF); and Climatch world distribution map for *Lycodon aulicus* indicating where meteorological data was sourced for the climate analysis:

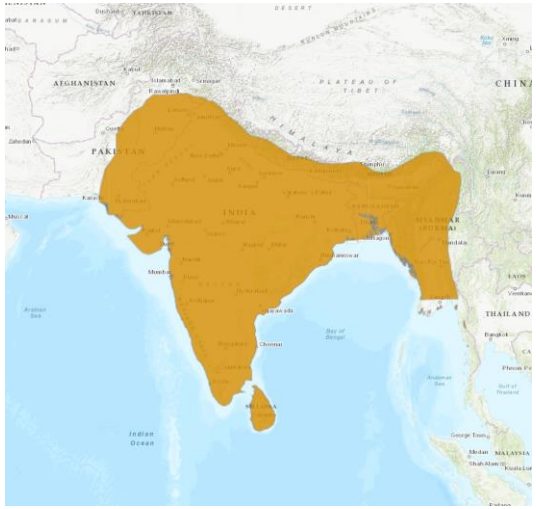


Figure 2 - World distribution map - IUCN Red List

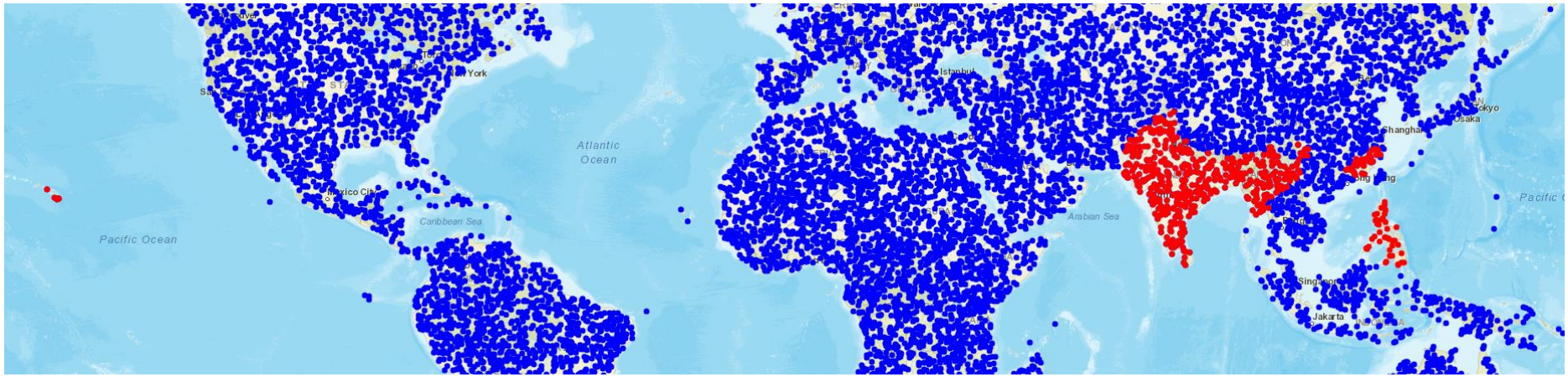


Figure 2 – World distribution map – Climatch – current locations



Figure 3 - World georeferenced records (GBIF)

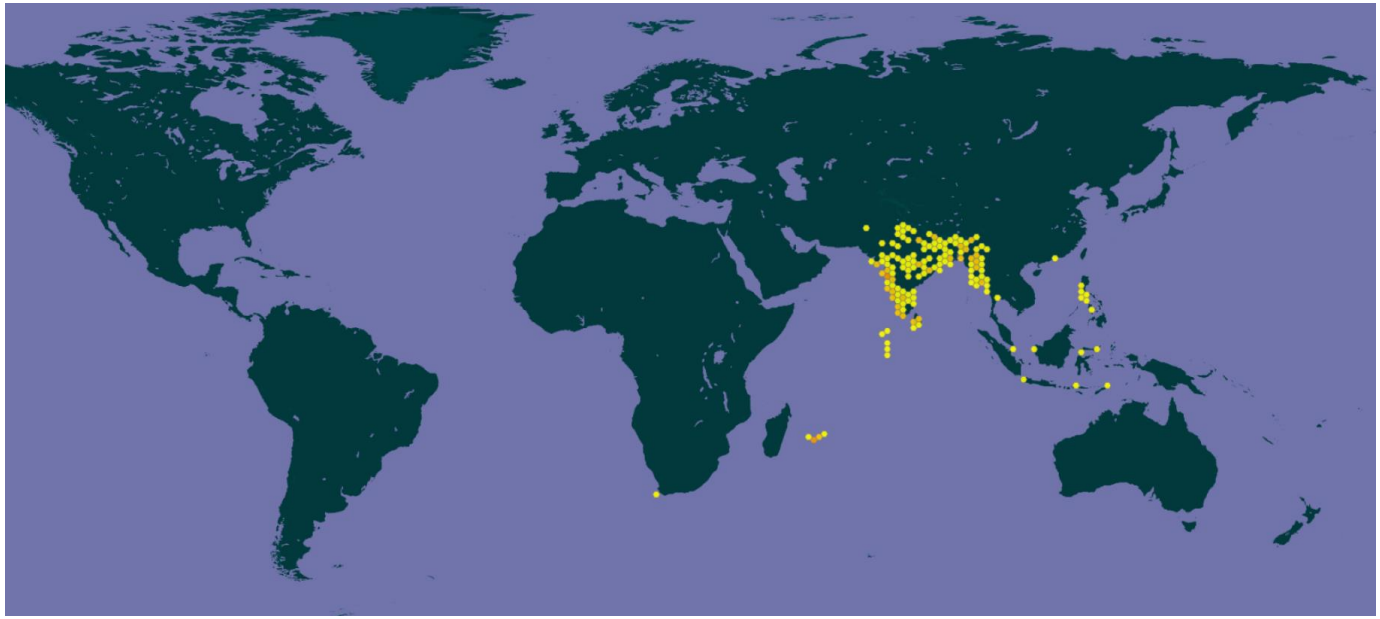
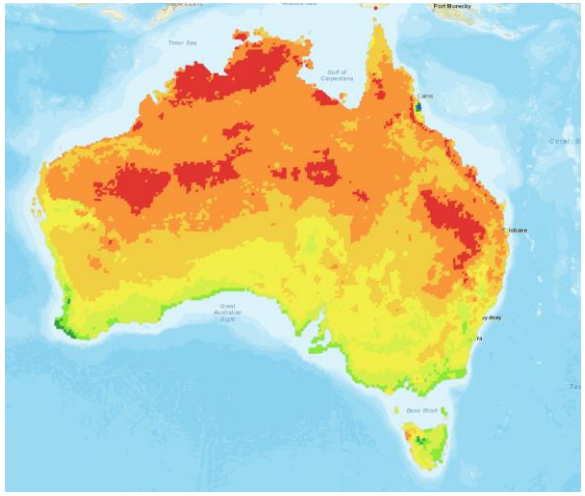


Figure 4 - World georeferenced records (GBIF) – All referenced locations

1b. 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 *Lycodon aulicus*

CMS (Sum Level 7) = 9,938



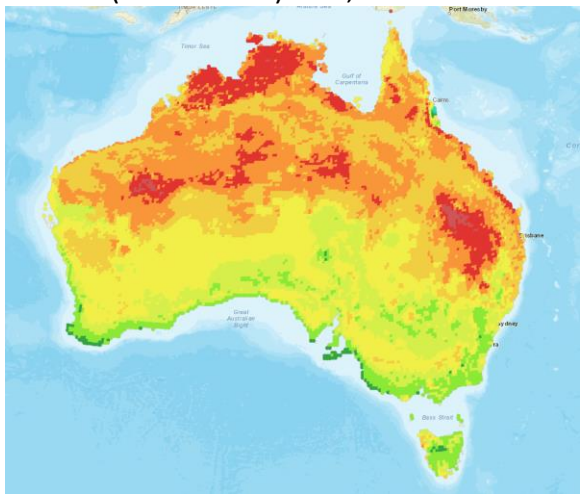
Score	Color	Count
0		2
1		0
2		26
3		268
4		1215
5		3092
6		4695
7		7843
8		2095
9		0
10		0

Species: Lycodon aulicus (Common Wolf Snake)
Algorithm: Euclidean
596 source features selected
19236 target features selected
Approximate selected area: 6,078,032 km^2

1c. 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 *Lycodon aulicus*

Value X (Sum Level 6) = 11,537



Score	Color	Count
0		0
1		4
2		88
3		895
4		2538
5		4174
6		4741
7		4987
8		1706
9		103
10		0

Species: Lycodon aulicus (Common Wolf Snake)
Algorithm: Closest Standard Score
596 source features selected
19236 target features selected
Approximate selected area: 6,078,032 km^2

2a. World distribution map (IUCN Red List); world georeferenced records (GBIF); and Climatch world distribution map for *Lycodon capucinus* indicating where meteorological data was sourced for the climate analysis for *Lycodon capucinus* (island wolf snake):



Figure 1 - World distribution Map - IUCN Red List

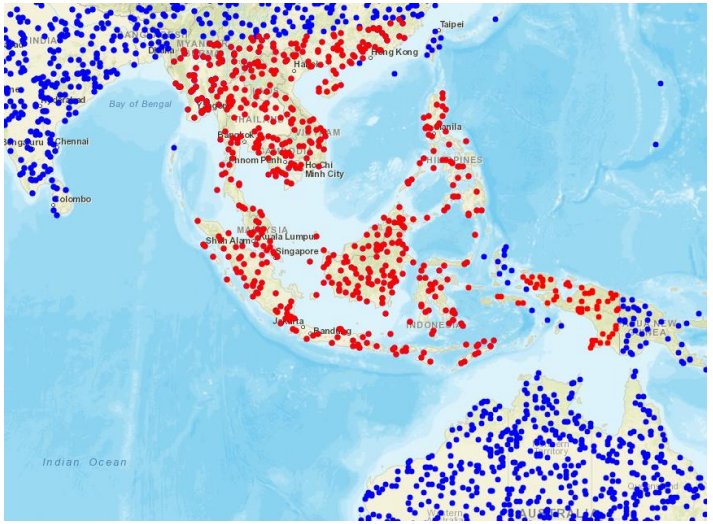


Figure 2 – World distribution map – Climatch – current locations



Figure 3 - World georeferenced records (GBIF)



Figure 4 - World georeferenced records (GBIF) – All referenced locations

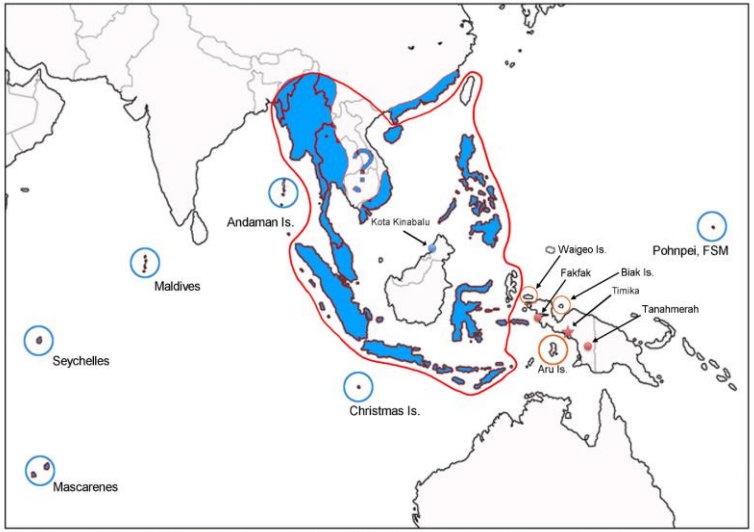


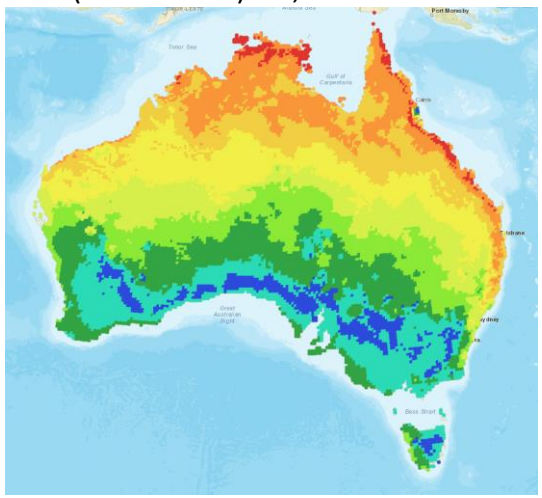
Fig. 2. The natural and naturalized range of *Lycodon capucinus* (blue) and *Eutropis multifasciata* (red), including naturalized island populations in the Indian and Pacific Oceans. Blue spots and blue-ringed islands indicate isolated populations of *L. capucinus*; red spots and red-ringed islands indicate isolated populations of *E. multifasciata*. The red star in southwestern New Guinea indicates the new locality at Timika, Papua, Indonesia. The precise boundaries of both species in the northwest (Assam, India, and northwestern Myanmar) cannot be confirmed with absolute accuracy.

Figure 5 – O'Shea et al., 2018. Figure 2 Map from: First Record of the island Wolfsnake, Lycodon capucinus (H. Boie in F. Boie, 1827), from New Guinea, with Comments on Its Widespread distribution and Confused Taxonomy, and a New Record for the common Sun Skink, Eutropis multifasciata (Kuhl, 1820), pg. 73.

2b. 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 *Lycodon capucinus*

CMS (Sum Level 7) = 4,894



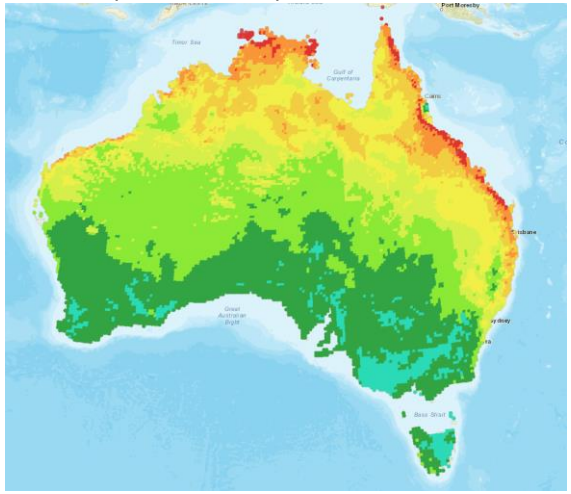
Score	Color	Count
0		861
1		2424
2		2727
3		2351
4		2394
5		2955
6		2772
7		2447
8		305
9		0
10		0

Species: Lycodon capucinus (Island Wolf Snake)
Algorithm: Euclidean
623 source features selected
19236 target features selected
Approximate selected area: 5,002,096 km^2

2c. 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 *Lycodon capucinus*

Value X (Sum Level 6) = 2,912



Score	Color	Count
0		0
1		805
2		5015
3		5031
4		2796
5		2677
6		1950
7		742
8		208
9		12
10		0

Species: Lycodon capucinus (Island Wolf Snake)
Algorithm: Closest Standard Score
623 source features selected
19236 target features selected
Approximate selected area: 5,002,096 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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DRAFT National Risk Assessment: EXTREME

RISK ASSESSMENT FOR AUSTRALIA: Boa constrictor (*Boa constrictor*)

Class - Reptilia, **Order** - Squamata, **Family** – Boidae, **Genus –** *Boa.*

SPECIES: *Boa Constrictor* (Linnaeus, 1758) **Sub Species:** 1. *Boa constrictor constrictor* (Linnaeus, 1758) 2. *Boa constrictor longicauda* (Price & Russo, 1991) 3. *Boa constrictor occidentalis* (Philippi, 1873) 4. *Boa constrictor ortonii* (Cope, 1877) **Synonyms:** **1. *Boa constrictor constrictor*** *Constrictor constrictor* (Dunn, 1923) *Boa eques* (Eydoux & Souleyet, 1842) *Boa constrictrix* (Schneider, 1801) *Euncetes murinus* (Berg, 1893) *Callopeltis guttatus* (Loennberg, 1894) *Constrictor auspex* (Laurenti, 1768) *Constrictor rexserpentum* (Laurenti, 1768) **2. *Boa constrictor longicauda*** *Boa constrictor longicauda* (Price and Russo, 1991) **3. *Boa constrictor occidentalis***	**Species description:** The boa constrictor is one of the world's largest snakes and is popular in the pet trade (over 15,131 individual boa constrictors were imported into the United States of America (USA) between 1989 to 2000* (Reed; 2005 – see * below). It is a heavy bodied snake with adults capable of reaching 5 metres in length and weighing more than 45 kilograms, although it is rare for wild and captive-bred individuals to reach this size (Agriculture Victoria, 2024; Greene, 1983). The average boa (snout-vent length) is typically between 2 to 3 metres in length (Savage, 2002; Christy, 2016; Wildlife Victoria, 2023). Its tail is short, ranging between 10 to 20% of the boa constrictor's total length (Ernst and Ernst, 2003; Savage, 2002). Snout-vent length can be used to estimate the age and the reproductive condition of a boa constrictor. Extensive morphological variation exists within and between subspecies. Dorsally, the background colour is typically cream or brown but can be tan, green, red or yellow, with dark "saddle-shaped" markings. These markings are more colourful and prominent towards the tail and are often reddish-brown with black or cream edging on both the dorsal and underside. Dark rhomboid-shaped markings are present along the sides of the body, and smaller spots may be present over the entire body. The underside of the boa constrictor is cream with many black dots of various sizes. Boa constrictors have an arrow-shaped head with small smooth scales and very distinctive stripes. Most subspecies have a stripe that runs dorsally from the snout to the back of the head, together with a dark triangle between the snout and the eye. An extension of this triangle occurs behind the eye, where it slants downward towards the jaw. The jaws are lined with small, hooked teeth which are used for catching prey, and holding prey while it is wrapped in the muscular body coils (Lindemann, 2009; National Geographic, 2025; Savage, 2002). They have vertical elliptical pupils and do not have labial pits (heat-sensing organs on the lips) (Castro-Herrera et al., 2021; Santos-Barrera, 2008; Savage, 2002). Greene (1997) states that "although the boa constrictors lack labial pits, their facial nerve endings are exquisitely sensitive to temperature variation, and perhaps other basal macrostomatans also have thermos-receptive abilities."

Boa occidentalis (Philippi, 1873) *Constrictor constrictor occidentalis* (Ihering, 1911) **4. *Boa constrictor ortonii*** *Boa ortonii* (Cope, 1878) *Constrictor constrictor ortonii* (Schmidt & Walker 1943) **common Names:** **1. *Boa constrictor constrictor*** Boa Constrictor Red-tailed Boa Red-tailed Boa Constrictor common Boa Boa **2. *Boa constrictor longicauda*** Peruvian Long-tailed Boa Long-tailed Boa Long-tailed Boa Constrictor **3. *Boa constrictor occidentalis*** Argentine Boa Constrictor Argentine Boa **4. *Boa constrictor ortonii*** Orton's Boa Constrictor Orton's Boa	The boa constrictor sheds its skin periodically as it ages, and an individual may gradually change colour over multiple shedding cycles (Lindemann, 2009). Its scales have an iridescent hue that is often seen by an observer across the dorsal and dorsal lateral sides (Verveen, 2007). The boa constrictor is ectothermic; it will regulate its body temperature by using an external source (McGinnis and Moore, 1969). Boas on islands tend to be dwarfed in size, averaging half the length and one fifth of the mass of mainland boas, and exhibit different head shapes, tail sizes and patterns (Boback, 2006). The coloured patterns (for both mainland and island populations) aid in camouflage under natural conditions, assisting the species with its sit-and-wait style of predation. There is clear sexual dimorphism in this species. Females are generally longer and larger in girth, and males typically have a proportionately longer tail, more subcaudals and larger pelvic spurs (the externally visible remnant of hind legs and pelvis) (Bertona and Chiaraviglio, 2003; Castro-Herrera et al., 2021; Price and Russo, 1991; Savage, 2002; Smith, 2007a). Newborn boa constrictors resemble their parents, although young snakes tend to have brighter colours and show a greater contrast between colours (Greene, 1983; Lindemann, 2009). Juveniles often have a pink over wash or hue across their scales (Chiaraviglio et al., 2003; Mattison, 1992). Previously included as a subspecies of Boa constrictor was *Boa imperator* (Central American Boa – *Boa constrictor imperator*). However, taxonomic revisions by Hynková et al. (2009), further supported by Reynolds et al. (2014) elevated *Boa imperator* as a full species. Henderson (2023) advises there are two subspecies of boa constrictor (*Boa constrictor constrictor* and *Boa constrictor occidentalis*), we follow Reynolds and Henderson (2018) recognising four subspecies: ***Boa constrictor constrictor*** **(red-tailed boa)** – the nominate species as described above. ***Boa constrictor longicauda*** **(Peruvian long-tailed boa)** – a subspecies of the boa constrictor based on its longer tail length, colour pattern (lack of red colouration on the tail) and scale characters (fewer midbody scale rows) with significant sexual dimorphism displayed. *B.c. longicauda* has a longer hemipenis, a "darker body pattern without tan colour and a grey blackspotted head in adults" (Price and Russo, 1991; Reynolds and Henderson, 2018). *B.c. longicauda* can be identified by a black and white or black and gold colouration (Reptifiles, 2025). *B.c. longicauda* can also be identified by a distinctive spear-shaped banding behind the eyes and an arrowhead shaped marking between the eyes (Reptifiles, 2025).

	***Boa constrictor occidentalis* (Argentine boa)** – has a darker body colouration in comparison to the nominate species (Obst et al., 1988). This darker body contrasts with a light pattern which increases in contrast as the boa ages (Reptifiles, 2025). ***Boa constrictor ortonii* (Orton's boa)** – similar in appearance to *B.c. longicauda* with some experts considering *B.c. longicauda* as a colour variant of *B.c. ortonii* (Stöckl, 2025). Cope (1878) described *B.c. ortonii* as having the "squamation of the head is like [a *Boa constrictor*] and that of the body resembles [a *Boa imperator*]." Although primarily terrestrial, the boa constrictor is semi-arboreal (Harrington et al., 2018), often found in trees or bushes. Juveniles are much more active in the trees compared to adults (Ceballos, 1994; Reptiles of Ecuador, 2025; Voort, 2021). In trees they have been found to eat prey, dropping from above or encircling on a branch (Cole et al., 2013; Reyerson and Goulet, 2021; Voort, 2021). Boa constrictors are both diurnal and nocturnal (Ceballos, 1994; Guedes et al., 2016). Defensive behaviour by the boa constrictor includes striking, S-coiling, long hisses and exhaling air from the lungs (Citeli et al., 2024; Santos-Costa et al., 2015; Verveen, 2014a). In captivity the boa constrictor is described as having a "mild temperament" (Smith, 2007a), however even as pets, the boa constrictor can cause serious injury to humans, requiring hospitalisation (Kleinman et al., 1998; Korn and Korn, 2005; PETA, 2025) and even death (PETA, 2025; White, 2022). Boa constrictors are hosts of endo and ectoparasites and diseases such as paramyxovirus, protozoan parasite *Entamoeba invadens*, inclusion body disease and ulcerative stomatitis which can be transferred to humans and domestic animals (Reed, 2005; Ritchie, 2025; Sie, 2001; Punzo, 1975; Verveen, 2006). **General information:** Distribution: Boa constrictors are primarily found in South America. The boa constrictor is a resident of Argentina, Plurinational States of Bolivia, Brazil, Colombia, Ecuador, French Guiana, Guatemala, Guyana, Paraguay, Peru, Suriname, Trinidad and Tobago and Venezuela (Arzamendia et al., 2021; Cole et al., 2013; GISD, 2025; Gonzalez et al., 2024; Nogueira et al., 2019; Reynolds and Henderson, 2018). The species has been introduced and established populations in Puerto Rico (Bushar et al., 2015; Quick et al., 2005), Aruba (Quick et al., 2005) and Florida in the USA (Lever, 2003; GISD, 2025). CITES (2025) has referenced that the boa constrictor can be found in Uruguay. This is supported by Greene (1997), Albino (2009) and McCranie (2012, cited McCranie, 2011).

	In the USA, a breeding population has established in Dade County, Florida, because of released or escaped pet snakes. This population is estimated to have been in Florida since 1990. People have deliberately released boa constrictors to establish a wild population in the Everglades National Park, Florida, however, it is not known to be established there (Ernst and Ernst, 2003; Greene, 1997; Lever, 2003). The boa constrictor was most likely introduced to Puerto Rico via the pet trade around 1992 and has been expanding its range within Puerto Rico (Berentsen et al., 2015; Bushar et al., 2015). The first boa constrictor was captured and recorded in Aruba in 1999, spread quickly across the island and established a self-sustaining population (Bushar et al., 2015; Quick et al., 2005; van Buurt, 2006). From 1999 to 2013, an average of 278 boa constrictors per year were captured in Aruba (Bushar et al., 2015). DNA analysis by Bushar et al. (2015) showed that the Aruba population was genetically related to the South American mainland boa constrictor population. Invasive species have impacts upon native flora and fauna, both positively and negatively. Goessling et al. (2015) demonstrated that "multiyear sampling reveals an increased population density of an endemic lizard after the establishment of an invasive snake in Aruba" compared to Powell et al. (2014) who note the serious threat the boa has caused on "local birds and other animals." Other recorded populations of boa constrictor include populations in Antigua (Daltry, 2007; Henderson, 2004; Pregill et al., 1994; Steadman et al., 1984), Guadeloupe (however, Powell et al., 2014, suggest this may be a different species of snake) and Martinique (Henderson, 2004). Daltry (2007) also writes that the boa constrictor has extinct populations on the islands of Barbuda and Redonnda. Other islands the boa has been reported include Bonaire (van Buurt cited in Powell et al., 2014) and Martinique (Breuil cited in Powell et al, 2014), St Martin (Powell et al., 2014). Boa constrictors have also been sighted in Curaçao, however this population has not become established (van Buurt 2005 cited in van Buurt, 2006). Species + (2025) lists that the boa constrictor can be found in Belize, Dominica, El Salvador, Honduras, Mexico, Nicaragua, Panama, and Saint Lucia (CITES, 2025). Following taxonomic changes, the species located in Belize, Costa Rica, El Salvador, Honduras, Mexico, Nicaragua and Panama (with cross over of species in Colombia and Guatemala) are *Boa imperator* (Central American boa) (Montgomery et al., 2018). The species is not considered to be native in the Caribbean and instead falls under *Boa nebulosus* (Dominica boa) in Dominica and *Boa orophias* (Saint Lucia boa) in St Lucia (Henderson and Powell, 2005). The four recognised subspecies are located throughout South America:

	Boa constrictor constrictor **(red-tailed boa)** – primarily found throughout the Guianas, Amazonia and Atlantic Forest of Brazil. ***Boa constrictor longicauda*** **(Peruvian long-tailed boa)** – known only from the Tumbes Province in coastal Peru in tropical wet forests (Price and Russo, 1991; Reynolds and Henderson, 2018). ***Boa constrictor occidentalis*** **(Argentine boa)** – the most northern boa found in Paraguay inhabiting Paraguayan Chaco and Pilcomayo regions (where it is considered a Vulnerable species) and Argentina (Reynolds and Henderson, 2018; Smith et al., 2024). Henderson (2023) states that *B.c occidentalis* can be found in Bolivia. ***Boa constrictor ortonii*** **(Orton's boa)** – endemic to Peru (Reynolds and Henderson, 2018). *B.c. ortonii* occurs through the Amazonas, Cajamarca, La Libertad, Lambayeque, and Piura west of the Andes and along the valley of the Marañón River. *B.c. ortonii* can be found at elevations between 0−2,000 metres above sea level (Koch et al., 2018). Due to its location, *B.c. ortonii* can tolerate lower than average temperatures in comparison to other boa constrictor species (Price and Russo, 1991; Reptifiles, 2025). Habitat: Boa constrictors occur in a wide range of habitats from sea level to moderate elevations around 1,000 metres (Greene, 1983). However, they have been found at elevations up to 2,000 metres (Arzamendia et al., 2021). They primarily inhabit dry, moist and wet lowland forests, tropical deciduous and semideciduous forests but also occur in arid pampas grasslands and scrub, mountainous tropical rainforest, coastal scrubs and marshes, and in second-growth forests (Savage, 2002; Smith, 2007a). The species is commonly found in or along rivers and streams and is a capable swimmer (McCranie and Orellana, 2012). The boa constrictor will occupy burrows and has been observed using tree hollows of medium-sized mammals, where it can hide from potential predators, find prey and protect its young (Berkunsky et al., 2023; de Oliveira Meneses et al., 2019). The species is frequently found close to human habitation and has been observed in urban and agricultural areas, including cultivated and crop fields such as sugar cane (Auguste and Fifi, 2021; Carrera et al., 2023; Greene, 1997; Obst et al., 1988; Sunyer and Galindo-Uribe, 2015). This species is unlikely to make long distance movements provided food and shelter are locally available. Greene (1997) estimates a boa constrictor "might crawl 20 to 85 metres through tropical forest, enter the hole of a large mammal and then coil there for two to four days, alertly facing the entrance." An individual

	tagged with a radio transmitter reportedly moved a total of only 135 metres in 12 days and spent most of its time underground in mammal burrows (Ernst and Ernst, 2003; Montgomery and Rand, 1978). Diet: The boa constrictor is a non-venomous generalist carnivore that constricts its prey by restricting movement and causing suffocation. The prey is seized by the boa constrictor's jaws before one or more coils are wrapped around the prey. The axial musculature then squeezes the prey creating an intense pressure that prevents both the heart and lungs from functioning. This causes almost instantaneous unconsciousness and death through cardiac arrest (Ryerson and Goulet, 2021; Ernst and Ernst, 2003; Lindemann, 2009; National Geographic, 2025). Boa constrictors are predominantly ambush predators that feed on a wide variety of vertebrates during both the day and night (Henderson, 2023). However, there have been recorded instances of boa constrictors actively hunting their prey (Hanscom et al., 2023; Sorrell et al., 2011). Prey includes small mammals, birds (such as the crested oropendola (*Psarocolius decumanus*) (Acosta-Ortiz, 2021) and the shiny cowbird (*Molothrus bonariensis*) (Carrera et al., 2022)) and their eggs, small lizards, Jamaican fruit bats (*Artibeaus jamaicensis*) (Sorrell et al., 2011), and occasionally amphibians. Larger individuals may also feed on mammals such as Kinkajous (*Potos flavus*) (Sunyer and Galindo-Uribe, 2015), monkeys (White-tailed Titi monkey (*Plecturocebus discolor*)), white-eared opossums (*Didelphis albiventris*) (Henderson, 2023), or the white-tailed deer (*Odocoileus virginianus*) (Greene, 1997). Examination of stomach contents of boa constrictors on Aruba island showed that birds comprised 40% of prey taken, lizards 35% and mammals 25%. In the study 52 separate prey items were identified (Quick et al, 2005). As opportunistic feeders, the boa constrictor will also feed on domesticated animals, such as cats (*Felis catus*), dogs (*Canis familiaris*) and domestic chickens (*Gallus gallus*) which causes economic losses and makes the boa constrictor a threat to primary producers (Henderson, 2023; Quick et al., Sironi et al., 2000; 2015; Tokuda, 2021). Reproduction: The boa constrictor reaches sexual maturity at an adult size of 1.8 to 3 metres around 3 to 4 years of age (NSW Government, 2025; Obst et al., 1988). They will continue to grow slowly throughout their lifespan (QLD Government, 2025; Smith, 2007). When mating, the boa constrictor uses chemical cues to find other conspecific species (Gabirot et al., 2012). Boa constrictors are polygynous (an individual may breed with multiple mates) and ovoviviparous (produces young by means of eggs which are hatched within the body of the parent). Males may take part in male-male combat for reproductive rights with a female (Pizzatto and Marques, 2007). Usually only about half the female population breeds, and females are only reproductively active when they are in good physical condition. Boa constrictors typically breed during the

	dry season from April to August, although the timing of the dry season varies across their range (Christy, 2016). Depending on local temperatures, gestation lasts for 5-8 months (Bertona and Chiaraviglio, 2003; Lindemann, 2009). Boas are very prolific breeders and give birth to numerous live young. Depending on the size of the female, litters can be of several dozen young, up to 60 individuals (Greene, 1997; Reed, 2005; Savage, 2002), or possibly 80 individuals (Chiaraviglio et al., 2003; Pizzatto and Marques, 2007; Smith, 2007). At birth, young range from 30 to 60 centimetres long, depending on the size of the female parent (Mehrtens, 1987; Smith, 2007a). Young are born fully developed and are independent within minutes of birth. Parthenogenesis (reproduction of viable young without fertilisation) has been reported in the sister species *Boa imperator* (Booth et al., 2010), although further research may be required to support this finding. **Longevity:** The maximum recorded longevity for this species in captivity is 40.4 years (AnAge, 2025) with Savage (2002) reporting that captive boas can live between 25 to 35 years. Life expectancy is between 30 to 35 years in the wild (World Life Expectancy, 2025). **Conservation status:** **IUCN:** Least Concern **CITES:** Appendix I – subspecies *B.c. occidentalis* - species that are the most endangered among CITES-listed animals and plants. Appendix II - Species that are not necessarily now threatened with extinction but that may become so unless trade is closely controlled. *Note: this figure may also include other species of Boa that were once considered a subspecies of *Boa constrictor*, e.g. *Boa constrictor imperator.*
DATE OF ASSESSMENT: May 2025 (Aimee Carter PIRSA; Vic Greentree DPINSW; Win Kirkpatrick DPIRD; Penny Fisher DEECA; Kristen Petrov, Veronica Blazely DCCEEW) **EIC ENDORSEMENT:**	**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

17 July 2026 **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		
G. 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).*	24.38	CMRS = 100 x (4,689/19,236) = 24.37616968184654 CMRS = 24.38 There are no weather stations in Aruba that could be used during Climatch analysis. Therefore, Aruba has not been including in the analysis.
H. Exotic Elsewhere Risk score (0, 15 or 30)	30	*Species has established breeding self-sustaining exotic population in another country.*

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*		In the USA, a breeding population has established in Dade County, Florida, because of released or escaped pet snakes. This population of boa constrictors is estimated to have been in Florida since 1990. People have deliberately released boa constrictors to establish a wild population in the Everglades National Park, Florida, however, it is not known to be established (Ernst and Ernst, 2003; Greene, 1997; Lever, 2003). The boa constrictor was most likely introduced to Puerto Rico via the pet trade around 1992. The boa constrictor has been expanding its range within Puerto Rico (Berentsen et al., 2015; Bushar et al., 2015). Boas were first documented on the island of Aruba in April 1999, although it is not certain when the species first reached the island or how; possibly as stowaways in shipments of plants from South America; released pet animals; or by natural invasion from South America. It is surprising that the species did not historically inhabit Aruba considering its colonising capabilities of more distant islands from mainland sources. The increasing occurrence, extensive distribution, and size diversity indicates that a large, reproductively successful population is established on the island. A government instituted, euthanization program for all captured boas has been ineffective at controlling the population. The current distribution encompasses the entire island (Bushar et al., 2015; Quick et al., 2005; van Buurt, 2006).
I. 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*	59.38	**MODERATE establishment risk**

Australian Reptile and Amphibian Model (Bomford 2008):

FACTOR	SCORE	DETAIL
STAGE A: RISKS POSED BY CAPTIVE OR RELEASED ANIMALS		
D. 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.*	-0.09	
E. Prop.species value *The number of jurisdictions where a species successfully established divided by the total number of jurisdictions where species has been introduced.*	0.15	Multiple attempts were successful at the species level. Based on the updated statistics from Kraus (2009) as directed by Bomford 2008 including *Boa constrictor* and synonym *Boa imperator*. *Number of jurisdictions where a species successfully established = 3* *Total number of jurisdictions where species has been introduced = 20* *Prop.species Value = 0.15*
F. 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. 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.*	1.685	<u>Score as reported in Bomford Model 2008</u> Sum Euclidian match scores to Australia levels 6-10 = 2,336 Climate 6 score = 2,336/2,785 = 0.8387791741472172 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(0.8387791741472172) – 1.88. Figure 3.4= 1.685 <u>Score reflecting the version of Climatch 2.0</u> Sum Euclidian match scores to Australia levels 6-10 = 16,694 Climate 6 score = 12,593/19,236 = 0.6546579330422125 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(0.6546579330422125) – 1.88.

		Figure 3.4= 0.9022962154294032 Figure 3.4= 0.90
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*	0.77	<u>Score as reported in Bomford Model 2008</u> 1/(1 + exp(0.80 – 2.90(0.15) – 1.685 – -0.09) 1/(1 + exp(0.80 – 0.435 – 1.685 + 0.09)) 1/(1+EXP(-1.23)) **=0.77** **SERIOUS**

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.*	4	*High climate match to Australia* Value X = 7,746 Climate Match Score = 4
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*	4	*Exotic population established on a larger island (> 50 000 km^2) or anywhere on a continent.* In the United States of America, a breeding population has established in Dade County, Florida, because of released or escaped pet snakes. This population of boa

fed or sheltered, even though they may be living in a highly disturbed environment with access to non-natural food supplies or shelter.		constrictors is estimated to have been in Florida since 1990. There have been other attempts of people deliberately releasing boa constrictors to establish a wild population in the Everglades National Park, Florida, however, it is not known to be established (Ernst and Ernst, 2003; Greene, 1997; Lever, 2003). The boa constrictor was most likely introduced to Puerto Rico via the pet trade around 1992. The boa constrictor has been expanding its range within Puerto Rico (Berentsen et al., 2015; Bushar et al., 2015). Boas were first documented on the island of Aruba in April 1999, although it is not certain when the species first reached the island or how; possibly as stowaways in shipments of plants from South America; released pet animals; or by natural invasion from South America. It is surprising that the species did not historically inhabit Aruba considering its colonising capabilities of more distant islands from mainland sources. A government instituted, euthanization program for all captured boas has been ineffective at controlling the population. The current distribution encompasses the entire island (Bushar et al., 2015; Quick et al., 2005; van Buurt, 2006).
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 estimated between 2 to 69 million square kilometres.* Overseas natural range size is estimated at 17 million km^2. Boa constrictors are primarily found in South America. The boa constrictor is a resident to the following countries Argentina, Plurinational States of Bolivia, Brazil, Colombia, Ecuador, French Guiana, Guatemala, Guyana, Paraguay, Peru, Suriname, Trinidad and Tobago and Venezuela (Arzamendia et al., 2021; Cole et al., 2013; GISD, 2025; Gonzalez et al., 2024; Nogueira et al., 2019; Reynolds and Henderson, 2018). The species has been introduced and established populations in Puerto Rico (Bushar et al., 2015; Quick et al., 2005), Aruba (Quick et al., 2005) and the United States of America, Florida (Lever, 2003; GISD, 2025). CITES (2025) has referenced

		that the boa constrictor can be found in Uruguay. This is supported by Greene (1997), Albino (2009) and McCranie (2012, cited McCranie, 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*	9	**SERIOUS establishment risk**

ENVIRONMENT AND INVASIVES COMMITTEE ALLOCATED PEST RISK* *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.	**EXTREME**

ENVIRONMENT AND INVASIVES COMMITTEE THREAT CATEGORY	**EXTREME*** *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); Climatch world distribution map and world georeferenced records (GBIF); indicating where meteorological data was sourced for the climate analysis:



Figure 3 - World distribution map - IUCN Red List

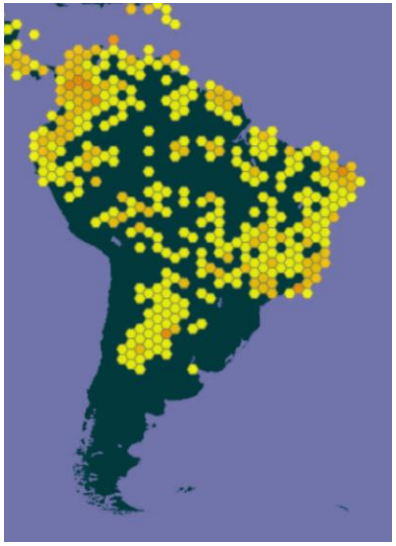


Figure 2 – World georeferenced records (GBIF)

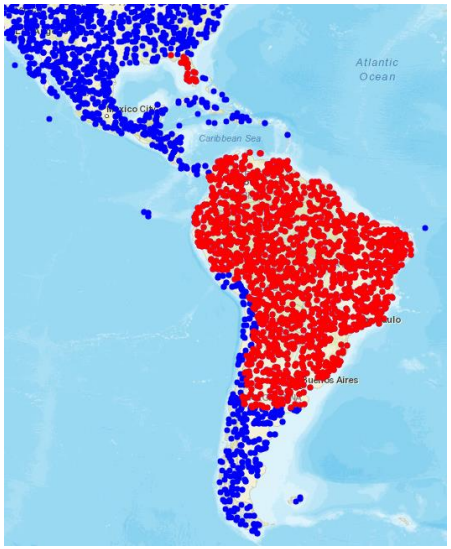


Figure 3 - World Distribution map – Climatch – current locations

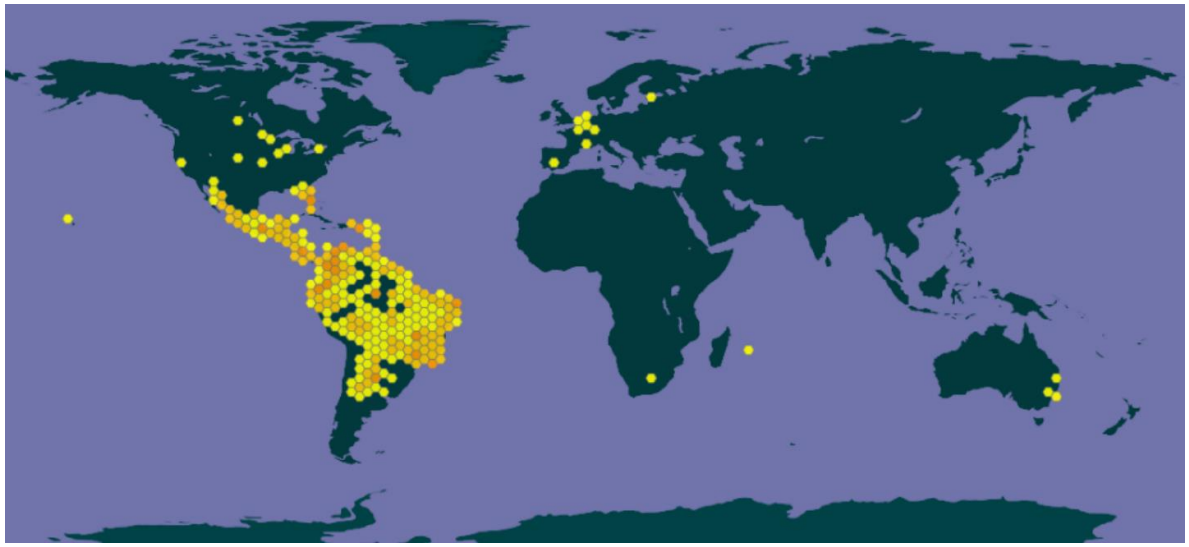
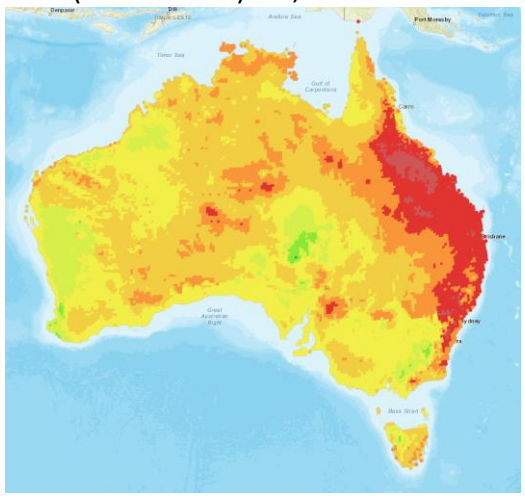


Figure 4 - World georeferenced records (GBIF) – All referenced locations

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 *Boa constrictor*

CMS (Sum Level 7) = 4,689



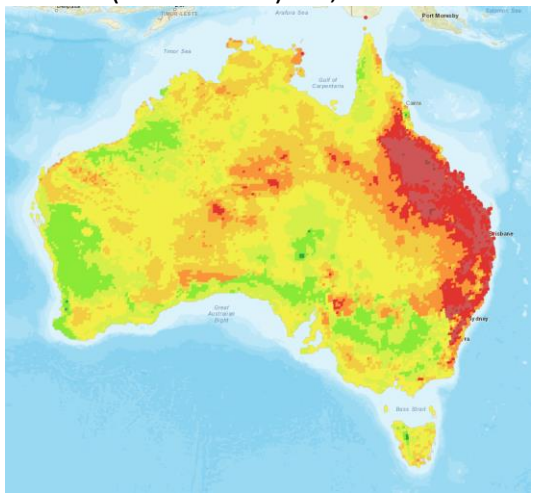
Score	Color	Count
0		0
1		0
2		1
3		111
4		1318
5		5213
6		7904
7		2778
8		1619
9		292
10		0

Species: Boa constrictor (Boa Constrictor)
Algorithm: Euclidean
1656 source features selected
19236 target features selected
Approximate selected area: 16,147,249 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 *Boa constrictor*

Value X (Sum Level 6) = 7,746



Score	Color	Count
0		0
1		0
2		10
3		1773
4		3007
5		6700
6		4194
7		1728
8		1049
9		765
10		10

Species: Boa constrictor (Boa Constrictor)
Algorithm: Closest Standard Score
1656 source features selected
19236 target features selected
Approximate selected area: 16,147,249 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**		

Adapted from:	DPIPWE (Department of Primary Industries, Park, Water and Environment). (2011). Pest Risk Assessment: Boa Constrictor (*Boa constrictor*). Department of Primary Industries, Parks, Water and Environment. Hobart, Tasmania. Boa Constrictor (Boa constrictor) risk assessment for Australia. Amanda Page, Win Kirkpatrick and Marion Massam, February 2008, Department of Agriculture and Food, Western Australia.	**By:** Aimee Carter	**Date:** May 2025

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DRAFT National Risk Assessment: EXTREME

RISK ASSESSMENT FOR AUSTRALIA: Rainbow Boa (*Epicrates cenchria*)

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

SPECIES: *Epicrates cenchria* (Linnaeus, 1758) **Synonyms:** *Boa cenchria* (Linnaeus, 1758) *Coluber tamachia* (Scopoli, 1788) *Boa cenchris* (Gmelin, 1788) *Boa aboma* (Daudin, 1803) *Boa annulifer* (Daudin, 1803) *Boa ternatea* (Daudin, 1803) *Epicrates cenchria* (Wagler, 1830; Chippaux, 1986) *Epicrates cenchris* (Dumeril & Bibron, 1844) *Epicrates cenchria maurus* (Gray, 1849) Columbia Rainbow Boa *Epicrates cenchria hygrophilus* (Linnaeus, 1758) *Cliftia fusca* (Gray, 1849) *Epicrates cenchria alvarezi* (Linnaeus, 1758) *Epicrates cenchria xerophilus* (Linnaeus, 1758) *Epicrates cenchria assisi* (Linnaeus, 1758)	**Species description:** The rainbow boa is a medium, non-venomous snake species native to South America, primarily distributed across Amazonia. This medium sized boid can reach approximately 2 metres in total length and weighs between 0.9 to 2.3 kilograms (Ernest and Zug, 1996; Solis et al., 2015; Garcia et al., 2022; Negron, 2023). Sexual dimorphism is present with females being slightly longer than males (Savage, 2002). The species is characterised by a thick, rounded muscular body and colouration that ranges from orange to reddish-brown. Their scales have an iridescent rainbow shine, particularly once sloughed (Langeveld, 1996). Across the dorsum, a series of tan, coppery or yellowish-brown rings delimited by a black ring are distributed along the length of the body. Laterally, colouration changes from orange reddish-brown to pale grey with a series of circular spots or ocelli that extend from neck to tail. These circular spots are black with an orange-yellow crescent located at the top, closest to the dorsal scales. Ventral scales are light grey with the spots fading or overlapping towards the medial scales. The ventral side of the snout and throat is a cream colour with the scales going black beneath the tail. The head is triangular, distinct from the neck, with three black longitudinal lines running parallel on top. Two of the lines start from behind the eyes running dorsolateral, and the other is a medial line that runs from the nose to the neck. Two smaller lines run from the naris region posteriorly to the corner of the mouth and may not be present in juveniles (Martins and Oliveira, 1998). Heat sensing labial pits are used to hunt prey at night and their iris is coppery brown to golden with vertically slit pupils. It has a vestigial pelvic bones and back legs that look like spines located near the tail. These are generally more evident in male (Arteaga, 2024; Col et al., 2013; de Fraga et al., 2013; Martins and Oliveira, 1998; Mattison, 1986; Negron, 2023; Passos and Fernandes, 2008; SeaWorld, 2019). Juveniles are similar in appearance to adults but are lighter in colour (Langeveld, 1996;(Martins and Oliveira, 1998).

Epicrates cenchria cenchria (Amarl, 1930; Perez-Santos & Moreno, 1988) *Epicrates cupreus* (Fischer, 1856) *Epicrates cenchria polylepis* (Linnaeus, 1758) *Epicrates cenchria* (Chippaux, 1986) *Epicrates cenchria hygrophilus* (Amaral, 1954) *Epicrates cenchria gaigeae* (Stull, 1938) *Epicrates cenchria gaigei* (Stull, 1938) *Epicrates cenchria hygrophilus* (Amaral, 1935) *Epicrates cenchria polylepis* (Amaral, 1935) *Epicrates cenchria barbouri* (Linnaeus, 1758) *Epicrates cenchria cenchria* (Linnaeus, 1758) *Epicrates cenchria crassus* (Cope, 1862) **Subspecies:** Monotypic **Common Names:** Rainbow Boa Western Rainbow Boa Brazilian Rainbow Boa Red Rainbow Boa Amazon Rainbow Boa	Although primarily nocturnal, it is active during the day (Santos-Costa et al., 2015). Males fight for access to females during breeding season (Garcia et al., 2022; Langeveld, 1996). As a defence mechanism, adults have a powerful bite and coils with the anterior third of its body, laterally coiling the tail tip. Juveniles will generally curl up to form a ball to protect the head (Carvalho et al., 2017; Martins and Oliveira, 1998; Reptiles of Ecuador, 2024; Santos-Costa et al., 2015). The rainbow boa has been observed performing "body bending" behaviour where "the snake exhibits crypsis by imitating branches or vines" (Maddock et al. 2011; Santos-Costa et al., 2015). Whether due to thermoregulation (Santos-Costa et al., 2015) or adaptation to arboreal habitat (Marques et al., 2006) or a defence tactic to avoid being detected (Maddock et al., 2011; Marques et al., 2006) requires further study. Boas can also swim and are often sighted in forest pools or streams (Martins and Oliveira, 1998). **General information:** Distribution: Resident of the Plurinational States of Bolivia, Brazil (Amazonas, Tocantins, Roraima, Rio de Janeiro, Pernambuco, Pará, Minas Gerais, Mato Grosso, Goiás, Bahia, Alagoas), the mainlands of Colombia, Ecuador and the Bolivarian Republic of Venezuela as well as French Guiana, Guyana, Peru and Suriname (Calderón et al., 2021; Passos and Fernandes, 2008; Uetz et al., 2025). CITES (2025) also lists the rainbow boa is a resident of Argentina (supported by Uetz et al., 2025). Habitat: Commonly found in the neotropical region of Central and South America in relatively undisturbed Amazonian and Atlantic rainforests (Nogueira et al., 2019 – see Figure 4). Its habitat consists of primary, secondary and gallery forests (Nogueira et al., 2020) extending into the plains and savannahs adjacent (Mehrtens, 1987). However, it has been found in anthropogenic habitats, such as cultivated land and plantations (Mehrtens, 1987; Pizzatto et al., 2009; Stafford, 1986). The rainbow boa can be found in humid and subhumid lowlands at elevations from sea level to 1,200 metres (Calderón et al., 2021; Savage, 2002). Due to its inability to bear high temperatures in open formations, this species is more vulnerable and potentially more selective on habitat compared to other *Epicrates* species (Coelho et al., 2020). The rainbow boa is semi arboreal (Harrington et al., 2018) using bushes and low-lying tree branches for resting and foraging (Savage, 2002). It utilises tree hollows and hollow trunks and is often found buried in the leaf litter (Martins and Oliveira, 1998). It is a shy and primarily terrestrial boa that is seldom seen due to its ability to blend into its surroundings. Diet: Carnivorous, with a generalist diet consisting of birds, small mammals, and amphibians (Negron, 2023; Pizzatto et al., 2009). They actively forage and ambush prey. The snake employs constriction to subdue its

	prey, wrapping its coils around the prey until it dies. Rainbow boas have been observed consuming bird eggs such as those from the Grey Tinamou (*Tinamus tao*) (Fiorillo and Batista, 2019; Negron, 2023). However, as noted by Fiorillo and Batista (2019), rainbow boas do not have the specialisations and adaptations required by other snake species in consuming and digesting eggs, which may explain why eggs may not be a staple in its diet. They have also been reported feeding on black squirrels (*Sciurus spadiceus*) (Solis et al., 2015), porcupines (Erethizontidae) (Cassimiro et al., 2010), large-headed rice rats (*Hylaeamys laticeps*) (Martins et al., 2018) and Seba's short-tailed bat (*Carollia perspicillata*) (Esbérard & Vrcibradic, 2007; Lemke, 1978). Rainbow boas have been reported to enter hen houses and eat domestic chickens (*Gallus gallus*) (Martinelli, 2011) which may lead them to be considered a minor pest to primary producers. Reproduction: Ovoviviparous. The rainbow boa reaches sexual maturity between 2 to 4 years and uses chemical cues to find conspecific species when mating (Gabirot et al., 2012). Females give birth to between 1 to 30 offspring (Negron, 2023). Females have a gestation period between 3 to 8 months and will not eat during pregnancy (Garcia et al., 2022). The young are born fully developed and measure between 28 to 50 centimetres in total length at birth (Mehrtens, 1987; Ernst and Zug, 1996). There is evidence of parthenogenesis within the rainbow boa species (Booth et al., 2015; Negron, 2023) with a recent report of a 13-year-old Brazilian boa giving birth to 14 neonates without the aid of a male (Barakett, 2024; Virata, 2024). **Longevity:** The longest life span recorded in captivity is 31 years (AnAge, 2023), however it is estimated to live between 20 to 25 years in the wild (CAH, 2023). World Life Expectancy (2025) estimates a life span of 10 years. **Conservation status:** **IUCN:** Least Concern **CITES:** Appendix II: species that are not currently threatened with extinction but may become so if trade is not closely regulated.
DATE OF ASSESSMENT: May 2025 (Aimee Carter PIRSA; Vic Greentree DPINSW; Penny Fisher DEECA; Kristen	**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

Petrov, Jess Lyons, Veronica Blazely DCCEEW) **EIC ENDORSEMENT:** 17 July 2026 **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)	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		
J. 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).*	3.07	CMRS = 100 x (591/19,236) = 3.072364316905802 CMRS = 3.07 Note: The species has many GBIF georeferenced occurrences from outside its natural range. Although the locations from Florida have been included, the records from Costa Rica (Savage and Bolaños, 2009), Panama and Trinidad and Tobago (Passos and Fernandes, 2008) (see Figure 4) have not been included in the Climatch score. This is

		because the species located in these areas is *Epicrates maurus* (Passos and Fernandes, 2008; Uetz et al., 2025).
K. 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.* Introduced into non-indigenous regions of Brazil and Chile through the pet trade and as stowaways. However, these populations have not established exotic populations (Eterovic and Duarte, 2002; Kruas, 2009). A popular species in the pet trade as they are easy to care for (Mattison, 2007). Through accidental or deliberate releases, the rainbow boa has been sighted and reported in multiple counties (such as Broward, Sumter and Miami-Dade) throughout Florida (Boundy et al., 2025; Krysko et al., 2011, 2016). Using Colautti and MacIsaac 2004 work on invasive species and the breakdown of the invasion process, Krysko et al. (2011, 2016) classified the rainbow boa as a Stage 2 species: "Potential invader survives transport, escapes or is released (i.e., becomes introduced), and is thus non-indigenous to the new area." Therefore, an established population of rainbow boas has been reported in Florida, United States of America (Asher and Krysko, 2024; EDDmaps, 2025).
L. 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*	38.07	**MODERATE establishment risk**

Australian Reptile and Amphibian Model (Bomford 2008):

FACTOR	SCORE	DETAIL

STAGE A: RISKS POSED BY CAPTIVE OR RELEASED ANIMALS		
G. 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.*	-0.09	
H. 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	Based on the updated statistics from Kraus (2009) as directed by Bomford 2008 including *Epicrates cenchria* and *Epicrates* Sp. Those reported with ? by Kraus have been reviewed and populations in Surinam have been included in the statistical analysis. *Number of jurisdictions where a species successfully established = 1* *Total number of jurisdictions where species has been introduced = 3* *Prop.species Value = 0.33*
I. 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. 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.*	-1.51	<u>Score reflecting the version of Climatch 2.0</u> Sum Euclidian match scores to Australia levels 6-10 = 1,682 Climate 6 score = 1,682/19,236 = 0.087440216261177 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(0.087440216261177) – 1.88. Figure 3.4= -1.508379080889998 Figure 3.4 = -1.51
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*	0.11	1/(1 + exp(0.80 – 2.90(0.33) – -1.51 – -0.09) 1/(1 + exp(0.80 – 0.97 + 1.51 + 0.09)) 1/(1+EXP(1.43)) **=0.1930986842** **= 0.19** **MODERATE**

Low	*≤ 0.16*		
Moderate	*0.17-0.39*		
Serious	*0.40-0.85*		
Extreme	*≥ 0.86*		

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 climate match to Australia* Value X = 814 CMS = 2 Note: The species has many GBIF georeferenced occurrences from outside its natural range. Although the locations from Florida have been included, the records from Costa Rica (Savage and Bolaños, 2009), Panama and Trinidad and Tobago (Passos and Fernandes, 2008) (see Figure 4) have not been included in the Climatch score. This is because the species located in these areas is *Epicrates maurus* (Passos and Fernandes, 2008; Uetz et al., 2025).
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 population established on a larger island (> 50,000 km^2) or anywhere on a continent.* Introduced into non-indigenous regions of Brazil and Chile through the pet trade and as stowaways. These populations have not been successful in establishing an exotic population (Eterovic and Duarte, 2002; Kruas, 2009). A popular species in the pet trade as they are easy to care for (Mattison, 2007). Through accidental or deliberate releases, it has been sighted and reported in multiple counties (such as Broward, Sumter and Miami-Dade) throughout Florida (Boundy et al., 2025; Krysko et al., 2011, 2016). Using Colautti and MacIsaac 2004 work on invasive species and the breakdown of the invasion process, Krysko et al. (2011, 2016) classified it as a Stage 2 species: "Potential invader survives transport, escapes or is released (i.e., becomes introduced), and is thus non-indigenous to the new area." Therefore, an established population of rainbow boas has been

		reported in Florida, United States of America (Asher and Krysko, 2024; EDDmaps, 2025).
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 between 2 – 69 million km^2.* Estimated to be 9 million square kilometres.
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*	7	**MODERATE establishment risk**

ENVIRONMENT AND INVASIVES COMMITTEE ALLOCATED PEST RISK* *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.	**EXTREME**

ENVIRONMENT AND INVASIVES COMMITTEE THREAT CATEGORY	**EXTREME*** *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); Climatch world distribution map and world Georeferenced records (GBIF); indicating where meteorological data was sourced for the climate analysis:

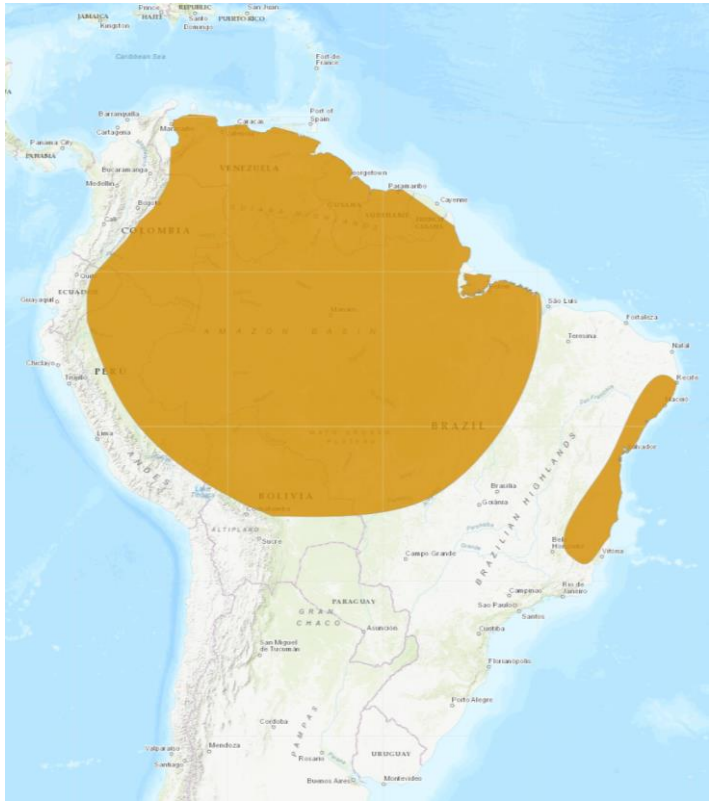


Figure 4 - World Distribution Map - IUCN Red List

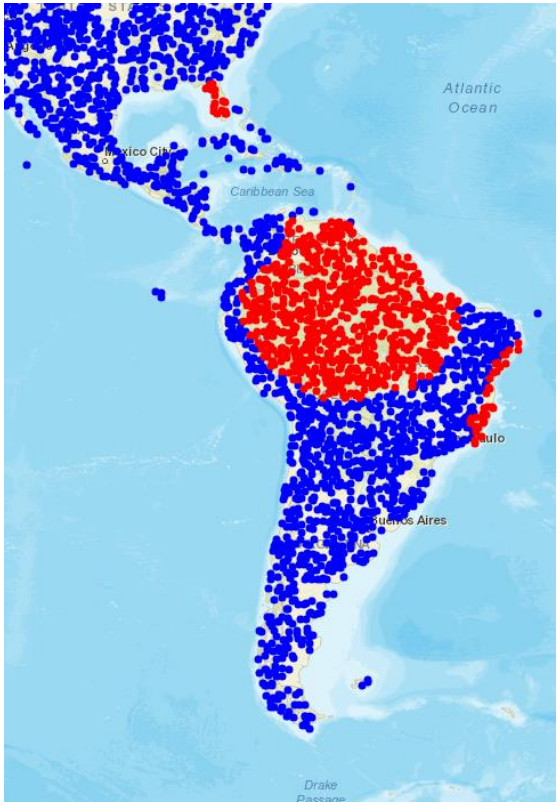


Figure 2 – World Distribution map – Climatch



Figure 3 - World Georeferenced records (GBIF)

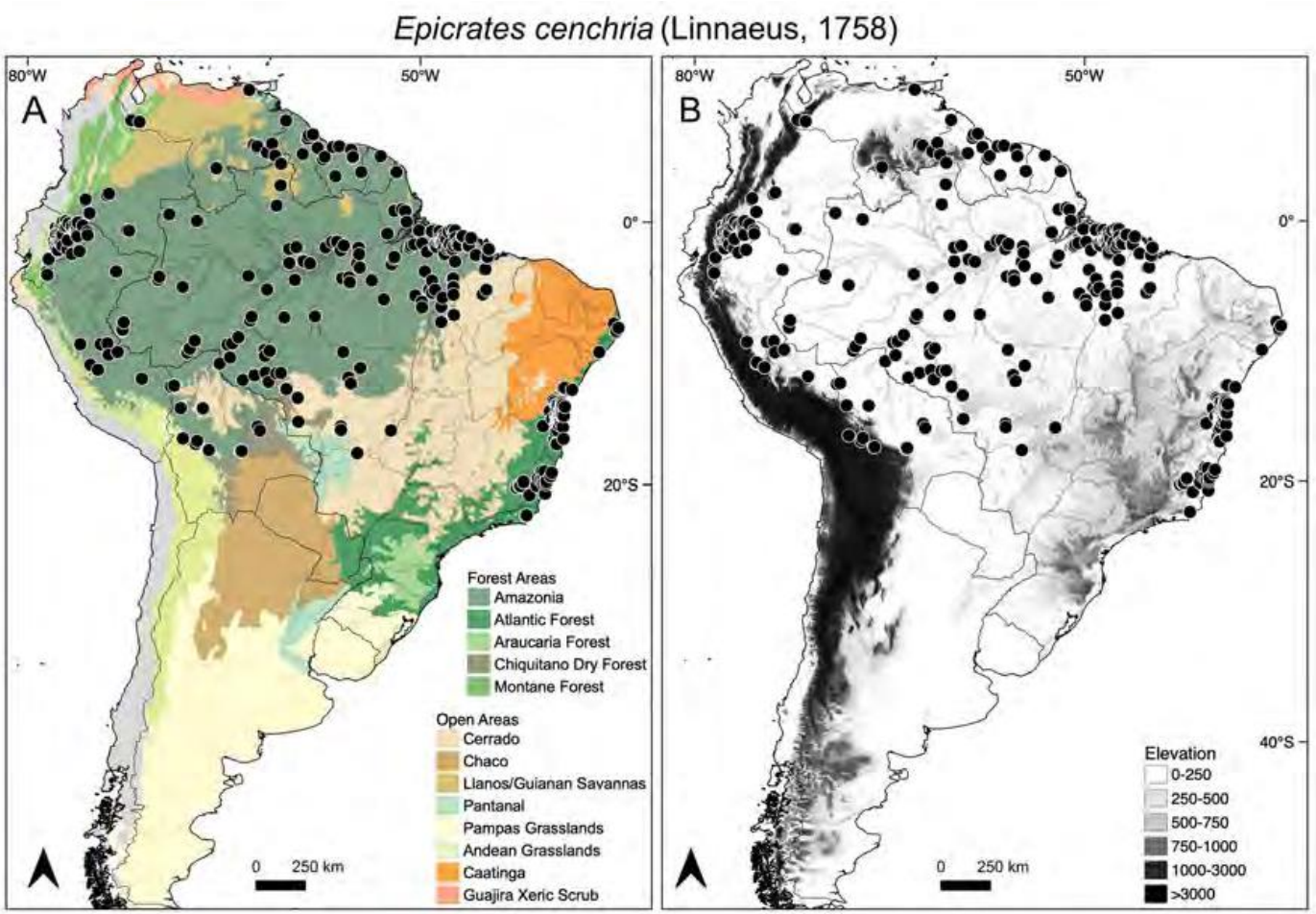


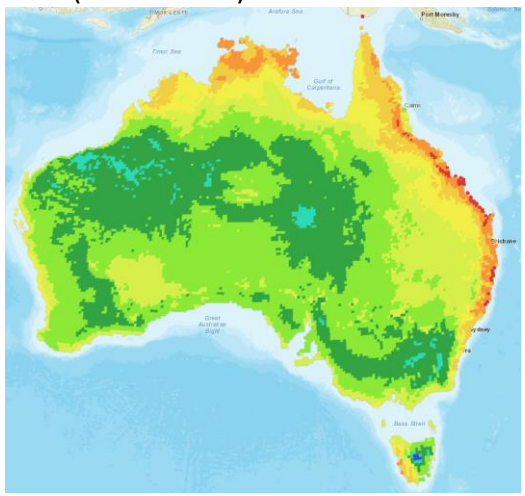
Plate 44. Distribution map of *Epicrates cenchria* in relation to **(A)** South American Ecoregions (adapted from Olson et al., 2001) and **(B)** elevation. Red star indicates type-locality, if precisely located.

Figure 4 – Distribution map of Epicrates cenchria from Atlas of Brazilian Snakes: Verified Point-Locality Maps to Mitigate the Wallacean Shortfall in a Megadiverse Snake Fauna by Nogueira et al., 2019.

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 *Epicrates cenchria*

CMS (Sum Level 7) = 591



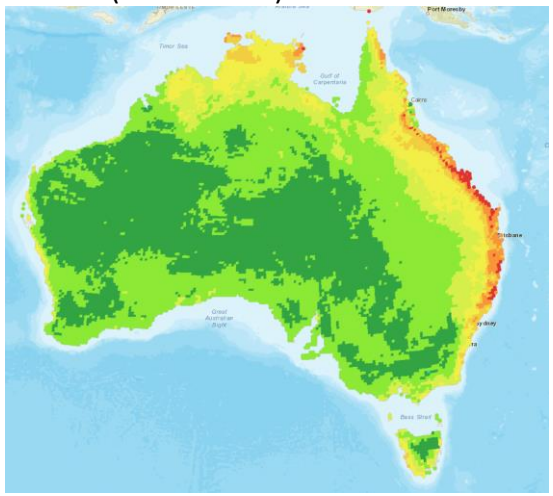
Score	Color	Count
0		5
1		340
2		5626
3		6781
4		3225
5		1577
6		1091
7		530
8		61
9		0
10		0

Species: Epicrates cenchria (Rainbow Boa)
Algorithm: Euclidean
782 source features selected
19236 target features selected
Approximate selected area: 8,997,552 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 *Epicrates cenchria*

Value X (Sum Level 6) = 814



Score	Color	Count
0		0
1		1
2		7481
3		7410
4		2005
5		1525
6		483
7		250
8		81
9		0
10		0

Species: Epicrates cenchria (Rainbow Boa)
Algorithm: Closest Standard Score
782 source features selected
19236 target features selected
Approximate selected area: 8,997,552 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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DRAFT National Risk Assessment: EXTREME

RISK ASSESSMENT FOR AUSTRALIA: Spectacled caiman (*Caiman crocodilus*)

Class - Reptilia, **Order -** Crocodylia, **Family -** Alligatoridae, **Genus -** *Caiman.*

SPECIES: *Caiman crocodilus* (Linnaeus, 1758) **Subspecies:** 1. *Caiman crocodilus crocodilus* (Linnaeus, 1758) 2. *Caiman crocodilus apaporiensis* (Medem, 1955) 3. *Caiman crocodilus fuscus* (Cope, 1868) 4. *Caiman crocodilus chiapasius* (Bocourt, 1876) **Synonyms:** *Caiman venezuelensis* (Fortier & Rincón, 2013) *Jacare hirticollis* (Gray, 1867) *Caiman crocodilus yacare* (Daudin, 1801)	**Species description:** The spectacled caiman is a medium-sized crocodilian native to Central and South America and is the most widely distributed New World crocodilian (Velasco and Ayarzagüena, 2010). Adults typically measure between 1.5 to 2.1 meters in length, with males larger than females (Terry, 2010; Thorbjarnarson, 1993a). A maximum length of 2.7 metres can be reached in males (Ayarzagüena, 1983). They can weigh up to 65 kilograms (Castro-Herrera et al., 2012; Savage, 2002). The spectacled caiman's coloration ranges from pale brown to olive brown, with dark dorsal and caudal bands which fade with age (typically adults are uniform in colour). Some caimans will have numerous dark brown or black flecks on the head, body and tail whereas others may have faint or no markings on the mandibles (Roque et al., 2024). This colouring aids in camouflaging them within their aquatic environments. The ventral surfaces are uniformly creamy white or yellow (Castro-Herrera et al., 2012; Ditmars, 1927; McCraine, 2018; Savage, 2002). Their most distinctive feature is an ossified crescent-shaped eyebrow anterior to the eyes and on the back of the snout resembling the nosepiece of spectacles. The upper eyelid is partially ossified forming a small, rounded projection with a wrinkled surface. The eye is moderately large, has a vertical pupil and the iris is gold. They possess a stout and robust, armoured body with a relatively short, broad snout that gradually converges on the sides. The ventral scales lack apical pits; however, they have double osteoderm buttons that underly the scutes on the mid-belly. The spectacled caiman has 5 series of transverse scales, 2 to 3 rows of postorbital scales and 8 enlarged nuchal tubercles grouped together (Castro-Herrera et al., 2012; Savage, 2002). They have 5 premaxillary teeth on each side. The fourth mandibular tooth (an enlarged tooth compared to the others) fits into a pit or cavity in the upper jaw. For most individuals, this tooth is not visible when the mouth is closed (Castro-Herrera et al., 2012; Ditmars, 1927; McCraine, 2018; Savage, 2002). They have 4 robust limbs with extensive webbing on the hind limbs and absent webbing on the forelimbs (McCraine, 2018). The tail has crests on the twelfth and thirteenth segments of the tail (Reptiles of Ecuador, 2023). (Castro-Herrera et al., 2012; Ditmars, 1927; McCraine, 2018; Savage, 2002)

Caiman crocodilus matogrossoiensis (Fuchs, 1971) *Caiman crocodilus paraguayiensis* (Fuchs, 1971) *Crocodilus americanus* (Andersson, 1900) *Crocodilus acutus* (McCraine, 2007) 1. ***Caiman crocodilus crocodilus* (Common Caiman)** *Caiman sclerops* (Schneider, 1801) *Crocodilus caiman* (Daudin, 1802) *Crocodilus sclerops* (Schneider, 1801) *Alligator sclerops* (Duméril & Bibron, 1836) *Lacerta crocodilus* (Linnaeus, 1758) *Jacaretinga crocodilus* (Linnaeus, 1758) *Caiman crocodylus* (Lehr, 2002) 2. ***Caiman crocodilus apaporiensis* (Apaporis River Caiman)** *Caiman sclerops apaporiensis* (Medem, 1955)	There are 4 subspecies recognised (Roberto and Botero-Arias, 2013) which can be differentiated through geographical locations and cranial characteristics (Falcón-Espitia et al., 2021): ***C.c. crocodilus*** – the nominate as described above. ***C.c. apaporiensis*** – has a very elongated and comparatively narrow snout (Gorzula, 2020), flat cranial table, large temporal vacuities and bright yellow-brownish colour, spotted with black vermiculation's, and unlike other *Caiman* subspecies, has the presence of several orange-coloured scutes on the side of the neck (Medem, 1955 cited in Balaguera-Reina, 2019 and Busack and Pandya, 2001). Note that Medem recognised that he may not have sufficient "materials from most localities" (Medem, 1955 cited in Busack and Pandya, 2001). As juveniles, skull characteristics of *C.c. apaporiensis* may look like *C.c. crocodilus,* often leading to misreporting (Balaguera-Reina, 2019). ***C.c. fuscus*** – has a broader snout as well as two crests on the first fourteenth and fifteenth segments of the tail (Reptiles of Ecuador, 2023). *C.c. fuscus* has a slightly shorter lateral length than either the nominate or *C.c. chiapasius* when the lateral length is held constant (Busack and Pandya, 2001). ***C.c. chiapasius*** – has a slightly wider snout and slightly taller lateral than the nominate when the head width and lateral length are held constant (Busack and Pandya, 2001). Juveniles often have a distinct pattern and are more vividly coloured than adults. They are a light brown to yellow in colour with dark crossbands on their back and tail. Although the spectacled caiman is primarily nocturnal, it is often seen basking in the sun to thermoregulate (Diefenbach, 1975; McCraine, 2018; Thorbjarnarson, 1995). It is territorial and will act in self-defence if threatened or protecting its nest (González-Desales et all., 2021). Defensive behaviour includes biting (9News, 2010), vocalisations (e.g. growling or hissing), thrashing the water with its head and tail as well as swimming around nesting sites (Allsteadt, 1994). It will also "death roll"; the spectacled caiman will grasp its prey in their jaws, twisting and rolling underwater to stun and confuse its prey, resulting in drowning or dismemberment (Savage, 2002). Spectacled caimans can be aggressive and unpredictable when angered. Although, they are not likely to attack unprovoked, they can cause serious injury (infections and lacerations) requiring hospitalisation (9News, 2010; González-Desales et al., 2021; Hertner, 2007) and even death (CrocAttack, 2025; de Klerk, 2017; Pooley et al., 2021). Spectacled caimans are hosts of internal and external parasites, viruses and diseases such as spectacled caiman poxvirus, *Trypanosoma cecili* parasite (AQIS, 2000) and *Amblyomma dissimile* (Charruau et al., 2016). They are also

3. ***Caiman crocodilus fuscus* (Brown Caiman)** *Perosuchus fuscus* (Cope, 1868) 4. ***Caiman crocodilus chiapasius* (Chiapas Caiman)** *Alligator (Jacare) chiapasius* (Bocourt, 1876) *Alligator chiapasius* (Bocourt, 1876) **Common Names:** 1. ***Caiman crocodilus crocodilus*** Spectacled Caiman Common Caiman White Caiman 2. ***Caiman crocodilus apaporiensis*** Rio Apaporis Caiman Apaporis River Caiman 3. ***Caiman crocodilus fuscus*** Brown Caiman 4. ***Caiman crocodilus chiapasius*** Chiapas Caiman	known to attract tabanids (flies) (Ferreira et al., 2002). These can spread to other species and have severe impacts on populations. **General information:** Distribution: The spectacled caiman is native to a vast range extending from southern Mexico through Central America to northern South America. It is distributed across 16 countries and has been introduced to 3. The spectacled caiman is a resident of Brazil, Colombia, Costa Rica, Ecuador, El Salvador, French Guiana, Guatemala, Guyana, Honduras, Mexico, Nicaragua, Panama, Peru, Suriname, Trinidad and Tobago and the Bolivarian Republic of Venezuela. It has been introduced to Cuba, Puerto Rico and Florida in the USA, (de Souza et al., 2024; Uetz et al., 2025; Velasco and Ayarzagüena, 2010). The presence of the spectacled caiman is uncertain in the countries of Belize and the Plurinational States of Bolivia (Balaguera-Reina et al., 2019). CITES (2025) and Species+ (2025) have listed the spectacled caiman as resident in Argentina, Paraguay, Uruguay and Plurinational State of Bolivia (supported by De Souza et al., 2024). There are 4 subspecies recognised (Velasco and Balaguera-Reina, 2019): ***C.c. crocodilus*** - prevalent throughout Venezuela (particularly in the Orinoco drainage and llanos) and the Amazon basin from Colombia through to Brazil, north and east of Plurinational State of Bolivia, Ecuador, Peru, Guyana, Trinidad and Tobago and French Guyana (Cole et al., 2013; GISD, 2025; Velasco and Ayarzagüena, 2010; Velasco and Balaguera-Reina, 2019). ***C.c. apaporiensis*** - inhabits the mid to upper Apaporis River in Colombia (GISD, 2025; Velasco and Ayarzagüena, 2010; Velasco and Balaguera-Reina, 2019). However, a small population may be present across Colombia and the Venezuelan llanos (Velasco and Ayarzagüena, 2010 – see article for reference; Velasco and Balaguera-Reina, 2019). ***C.c. fuscus*** - distributed from Nicaragua and south throughout Costa Rica, Panama, Colombia (both Pacific and Caribbean coasts) as well as the inter-Andean valleys, and western Venezuela and Ecuador (GISD, 2025; Velasco and Ayarzagüena, 2010; Velasco and Balaguera-Reina, 2019). ***C.c. chiapasius*** – recent research has limited the distribution of *C.c. chiapasius* from Pacific coastal Oaxaca and Chiapas in Mexico to El Salvador. Previous studies had indicated that *C.c. chiapasius* could be found in most of Central America from south Mexico to the Pacific coast of Colombia and Ecuador (GISD, 2025; Medem, 1983 cited in Escobedo-Galván et al., 2011; King and Burke, 1989; Velasco and Ayarzagüena, 2010).

	A feral population of spectacled caiman can be found on San Andres Island and Gorgona Islands, Colombia (Forero-Medina et al., 2006 cited in Balaguera-Reina, 2019; Velasco and Ayarzagüena, 2010; Velasco and Balaguera-Reina, 2019). Feral populations of spectacled caiman have established in Cuba and the Isla de Juventud, Cuba (McCraine, 2018; Velasco and Balaguera-Reina, 2019). The first introduction on the Isla de Juventud was in 1959, most likely individuals escaped from captivity. They have since become abundant on the island (Borroto-Páez et al., 2015). Borroto-Páez et al. (2015) has rated the spectacled caiman as having a moderate impact on the island, potentially preying on endemic fish species and competing for breeding grounds with native crocodiles. In the 1960s, it was introduced to Puerto Rico (Bontemps et al., 2016; McCraine, 2018). Through escaped or deliberately released individuals, the spectacled caiman has established a self-sustaining and breeding population, particularly around Tortuguero Lagoon Natural Reserve, which Thomas and Joglar (1996) state is its source of proliferation. Numbers of reported spectacled caimans in the Tortuguero Lagoon Natural Reserve and surrounding areas increased in 1985, leading to the establishment of a management plan. However, the population has continued to spread outside the boundaries of the Tortuguero Lagoon Natural Reserve and sightings and encounters are recorded through Puerto Rico's coastal plain and the satellite island of Vieques (Bontemps et al., 2016). Florida (USA) – The spectacled caiman has an established exotic population in southern Florida with the earliest recorded introduction in 1950. From December 2012 to June 2019, over 150 spectacled caimans were removed from southern Florida (Godfrey et al., 2019). It was brought into the state through the pet trade and has become established due to escaped or released individuals. The spectacled caiman has been seen as far south as Dade County and north to Seminole Country. Mitochondrial analysis completed by Roberto et al. (2021) showed the individuals from Florida were the *C.c. fuscus* lineage. The spectacled caiman has a similar appearance in colour to the American crocodile (*Crocodylus acutus*), however the spectacled caiman has a shorter, rounded snout (Ellis, 1980; FFWCC, 2025; Roberto et al., 2021; McCraine, 2018). Reports of escaped or released pets have been documented throughout other states within the USA (Christiansen, 2001; Kraus, 2009; USFWS, 2015). Due to the cooler climates or a stricter eradication program, none of these populations have established. Habitat: Found primarily in tropical and subtropical habitats, the spectacled caiman is extremely adaptable and is often found in lowland moist and arid forests and always near bodies of water (McCraine, 2018; Velasco and Ayarzagüena, 2010). In Ecuador, it inhabits Chocoan tropical rainforests and Amazonian tropical rainforests (Torres-Carvajal et al., 2019). In Costa Rica, it is primarily found in high rainfall regions but also in lowland dry forests (Savage, 2002). It thrives in a variety of freshwater habitats including river channels, lakes, streams, lagoons, borrow pits and marshes. It will also frequent man-made water bodies such as canals. The spectacled caiman prefers slow moving water bodies and can be found in both deep and shallow waters, requiring enough water to submerge its body. It can

	also be found in some brackish saltwater habitats. Although primarily found at elevations from sea level to 280 metres in Honduras and 600 metres in Brazil, the spectacled caiman has been found at elevations as high as 1,000 metres above sea level (Balaguera-Reina et al., 2019; Brazaitis et al., 1996; McCraine, 2018). Migration is determined by changes in the water level. They will either follow the water courses available by migrating overland or, at the end of the dry season or periods of drought, they can be found buried in the mud until the rains return (CSG, 2025; Ouboter and Nanhoe, 1988; Reptiles of Ecuador, 2023). They often return to the exact location they were in before the rainy season. Ouboter and Nanhoe (1988) noted that 68% of first- and second-year caimans and 52% of older caimans were found to have returned to the same spot. During the dry season (December to April) spectacled caimans may concentrate in smaller bodies of water due to reduced water availability (Thorbjarnarson, 1995). The highest abundance of spectacled caimans are seen in undisturbed areas with low impacts by humans and with a habitat of good quality (Parra-Torres et al., 2020). Ouboter and Nanhoe (1988) suggest that aquatic and shore vegetation, shallow water and shelter provided by inlets are important in habitat selection. The spectacled caiman lives in sympatry with other members of its Order (Da Silveira et al., 1997; Rebélo and Lugli, 2001). Da Silveira et al., (1997) noted that the spectacled caiman was found in all bodies of water inhabited by the black caiman (*Melanosuchus niger*). Diet: Spectacled caimans are carnivorous and have a generalist diet. According to Marioni et al. (2008), spectacled caimans have multiple hunting strategies, both active and passive, including trapping (where it will place its body perpendicular to the shoreline to block underwater prey from traversing before capturing it), searching (an active foraging technique where the spectacled caiman will hunt for its prey within the water) and jumping (where spectacled caimans use their hind legs and tail to propel their body forward and partially out of the water) (Thorbjarnarson, 1993b). They are aggressive and opportunistic feeders, with diet composition varying seasonally and with age. Analysis from stomach contents, taken in 2009, showed there was a 560% increase in the proportion of fish consumed from high-water season (May-June) to low-water season (July-August) (Laverty and Dobson, 2013). Juveniles (less than 1 metre) will feed primarily on smaller prey such as crustaceans (*Trichodactylus dentatus*, freshwater crab), snails (*Pomacea doliodes*, Amazonian apple snail) and insects compared to the adults who have a more extensive range (Bontemps et al., 2016; Castro-Herrera et al., 2012; Reptiles del Ecuador, 2025; Thorbjarnarson, 1993a). Adults prey on terrestrial invertebrates and vertebrates such as fish (*Hoplosternum littorale*, catfish), amphibians (*Rhinella marina,* marine toad), crustaceans and vertebrates such as reptiles (*Iguana iguana*, common green iguana), small birds and mammals. Larger individuals are capable of preying on larger mammals, such as primates (Barão-Nóbrega et al., 2016; Batista, 2011; Laverty and Dobson, 2013; Thorbjarnarson, 1993a). Vegetation such as grasses and leaves are also consumed

	(Thorbjarnarson, 1993a). As opportunistic feeders, the spectacled caiman will also feed on domesticated animals, such as chickens (*Gallus gallus*) and pets. They are known to feed from/in aquaculture farms causing economic losses and making the spectacled caiman a threat to primary producers (González-Desales et al., 2021; Pooley et al., 2021). Reproduction: Female spectacled caimans reach sexual maturity at approximately 1.2 meters between the ages of 4 and 7 years (Hertner, 2006; Ouboter and Nanhoe, 1989; Velasco and Ayarzagüena, 2010). Males mature around the same age as females (Da Silveira et al., 2013; Thorbjarnarson, 1991; 1994). Mating takes place during the high wet season with egg laying during the peak flooding season, depending on local climatic conditions (egg laying: July-August in Llanos and January-February in Colombian Amazon) (Ojasti 1996; Staton and Dixon 1977; Terry 2010; Thorbjarnarson, 1994). Females construct mound nests from dense vegetation in flooded forests or varzea with clutch sizes averaging 28-32 eggs (Allsteadt, 1994; Medem, 1981 cited in Roque et al., 2024; Velasco and Ayarzagüena, 2010) though they can range from 14 to 40 (Herner, 2006). These nests can be located either close to the water's edge or hundreds of metres away (Barão-Nóbrega et al., 2016). If the water rises too high, females will either abandon their young or move their nesting site (CSG, 2025). Incubation can last up to 90 days, at a temperature between 28 to 30 degrees centigrade. Temperature-dependent sex determination occurs, with higher temperatures producing males and lower temperatures producing females (Lang et al., 1989; Savage, 2002). When it is time for the eggs to hatch, the young will emit a call to the mother and the mothers will open the nest to release the young. Hatchlings typically occur in November when water levels are rising (CSG, 2025; Staton and Dixon 1977). Females exhibit maternal care, guarding the nest (often reducing their feeding intake) (Barão-Nóbrega et al., 2014, 2016) and accompanying pods of hatchlings (Allsteadt, 1994; Magnusson and Sanaiotti, 1994). Hatchlings measure between 21 to 26 centimetres (Savage, 2002). Juveniles often form crèches, with females caring for multiple offspring (CSG, 2025). These juvenile groups can remain together under female care for 12-18 months (Magnusson and Sanaiotti, 1994; Velasco and Ayarzagüena, 2010; Velasco and Balaguera-Reina, 2019). **Longevity:** The recorded longevity in captivity for the spectacled caiman is 40 years (AnAge, 2023). The World Life Expectancy (2025) states that the life expectancy for the spectacled caiman is 20 to 30 years. **Conservation status:** **IUCN:** Least Concern **CITES:** Appendix II - species that are not necessarily threatened with extinction but require controlled international trade to prevent utilization incompatible with their survival.

	Subspecies *C.c. apaporiensis* is under CITES Appendix I - species that are the most endangered among CITES-listed animals and plants.
DATE OF ASSESSMENT: April 2025 (Aimee Carter PIRSA; Vic Greentree DPINSW; Penny Fisher DEECA; Kristen Petrov, Jess Lyons, Veronica Blazely DCCEEW) **EIC ENDORSEMENT:** 17 July 2026 **Risk assessment models 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		
M. Climate match risk score	3.08	CMRS = 100 x (592/19,236) = 3.077562902890414

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).*		CMRS = 3.08 Note: The species has many GBIF georeferenced occurrences from outside its natural range. Whilst most of these singular occurrences are presumed to be waifs rather than established populations, Climatch modelling has been expanded to capture areas of most densely reported occurrence.
N. 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.* The spectacled caiman has been introduced to Cuba, Puerto Rico and the United States of America, in the state of Florida (Uetz et al., 2025).
O. Taxonomic Family Risk Score	10	*Alligatoridae.*
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*	43.08	**MODERATE establishment risk**

Australian Reptile and Amphibian Model (Bomford 2008):

FACTOR	SCORE	DETAIL
STAGE A: RISKS POSED BY CAPTIVE OR RELEASED ANIMALS		
J. 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.*	0.43	
K. Prop.species value *The number of jurisdictions where a species successfully established divided by the total number of jurisdictions where species has been introduced.*	0.50	Based on the updated statistics from Kraus (2009) as directed by Bomford 2008 including *Caiman crocodilus* and synonym *Caiman sclerops*. Those reported with a question mark or considered unknown by Kraus have been included in the statistical analysis as having an established population (Colombia: Isla de San Andres, Puerto Rico: Vieques and USA: Arizona). *Number of jurisdictions where a species successfully established = 6* *Total number of jurisdictions where species has been introduced = 12* *Prop.species Value = 0.50*
L. 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. 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.*	-1.006	<u>Score as reported in Bomford Model 2008</u> Sum Euclidian match scores to Australia levels 6-10 = 573 Climate 6 score = 573/2,785 = 0.2057450628366248 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(0.2057450628366248) – 1.88. Figure 3.4= -1.005583482944345 Figure 3.4= -1.006 <u>Score reflecting the version of Climatch 2.0</u> Sum Euclidian match scores to Australia levels 6-10 = 2,214 Climate 6 score = 2,214/19,236 = 0.1150966936993138

		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 (0.1150966936993138) – 1.88. Figure 3.4= -1.390839051777916 Figure 3.4= -1.391
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*	0.52	1/(1 + exp(0.80 – 2.90(0.50) – -1.006 – 0.43) 1/(1 + exp(0.80 – 1.45 + 1.006 - 0.43)) 1/(1+EXP(0.80 - 1.45 + 1.006 - 0.43)) **=0.5184915625** **=0.52** **SERIOUS**

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 climate match to Australia,* Value X = 962 Climate Match Score = 2 Note: The species has many GBIF georeferenced occurrences from outside its natural range. Whilst most of these singular occurrences are presumed to be waifs rather than established populations, Climatch modelling has been expanded to capture areas of most densely reported occurrence.

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 population established on larger islands (>50,000 km^2) or anywhere on a continent.* The spectacled caiman has been introduced to Cuba, Puerto Rico and the United States of America, in the state of Florida (Uetz et al., 2025).
C. 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 natural range size is estimated at 10 million km^2.* The species also has many georeferenced occurrences recorded around the world. The Climatch modelling has therefore been expanded to incorporate areas most densely reported.
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*	7	**MODERATE establishment risk**

ENVIRONMENT AND INVASIVES COMMITTEE ALLOCATED PEST RISK* *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.	**EXTREME**

ENVIRONMENT AND INVASIVES COMMITTEE THREAT CATEGORY	**EXTREME*** *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); Climatch world distribution map and world Georeferenced records (GBIF) indicating where meteorological data was sourced for the climate analysis:



Figure 5 - World Distribution Map - IUCN Red List

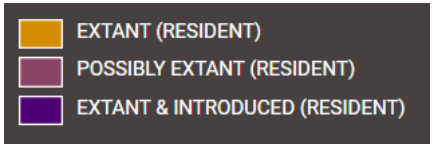


Figure 2 – IUCN Red List Key

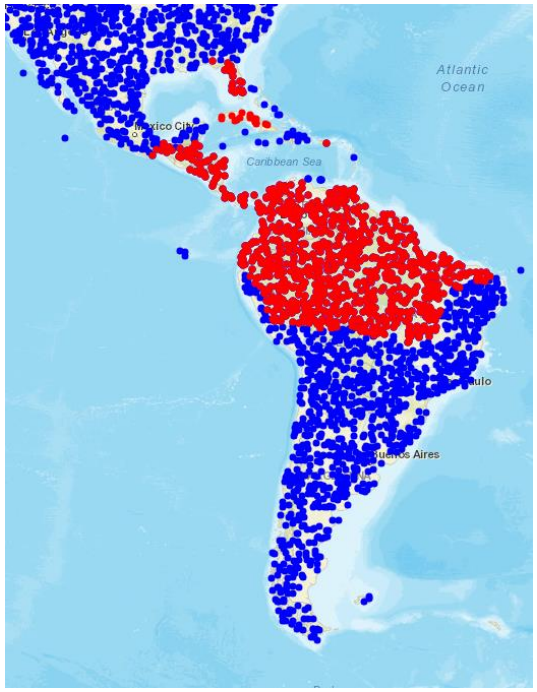


Figure 3 – World Distribution map – Climatch



Figure 4 - World Georeferenced records (GBIF)

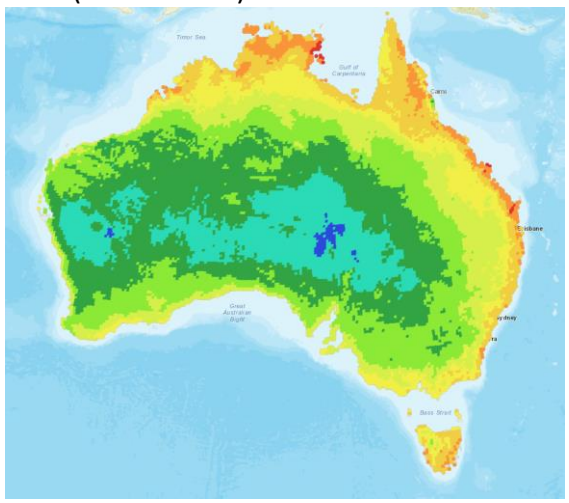


Figure 5 - World Georeferenced records (GBIF) – All referenced locations

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 *Caiman crocodilus*

CMS (Sum Level 7) = 592



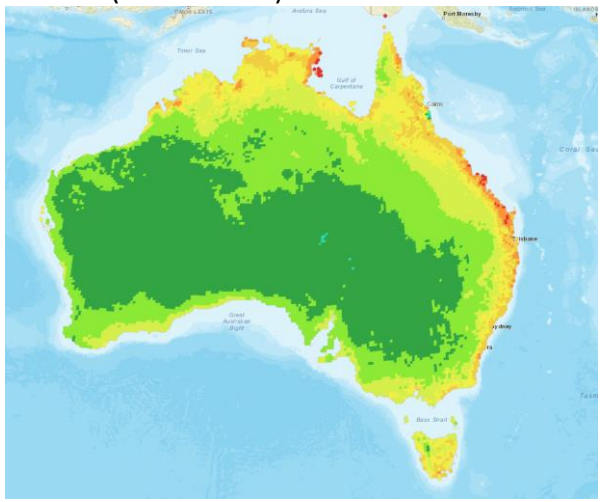
Score	Color	Count
0		100
1		2881
2		5489
3		4279
4		2477
5		1796
6		1622
7		569
8		23
9		0
10		0

Species: Caiman crocodilus (Spectacled Caiman)
Algorithm: Euclidean
932 source features selected
19236 target features selected
Approximate selected area: 9,994,261 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 *Caiman crocodilus*

Value X (Sum Level 6) = 956



Score	Color	Count
0		0
1		11
2		8977
3		5388
4		2236
5		1662
6		759
7		177
8		26
9		0
10		0

Species: Caiman crocodilus (Spectacled Caiman)
Algorithm: Closest Standard Score
932 source features selected
19236 target features selected
Approximate selected area: 9,994,261 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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DRAFT National Risk Assessment: EXTREME

RISK ASSESSMENT FOR AUSTRALIA: Patagonian mara (*Dolichotis patagonum*)

Class - Mammalia, **Order** - Rodentia, **Family** - Caviidae, **Genus** - *Dolichotis*.

SPECIES: *Dolichotis patagonum* (Zimmerman, 1780) **Synonyms:** *Cavia patagonum* (Zimmerman, 1780) *Cavia magellanica* (Kerr, 1792) *Cavia patachonica* (Shaw, 1801) *Mara magellanica* (Lesson, 1830) *Dolichotis patagona patagona* (Zimmerman, 1780) *Dolichotis patagona centricola* (Thomas, 1902) *Dolichotis magellanicus centricola* (Thomas, 1902) **Subspecies:** *Dolichotis patagonum patagonum* (Zimmerman, 1780) *Dolichotis patagonum centricola* (Thomas, 1902) **Common names:** Patagonian Mara Patagonian Cavy Patagonian Hare	**Species description:** The Patagonian mara is a distinctive rodent, endemic to central and southern Argentina, spanning latitudes from approximately 28 to 50 degrees south (Honacki et al., 1982). It is the second-largest member of the Caviidae family, after the capybara (*Hydrochoerus hydrochaeris)* (Judas, 2023). Patagonian mara have a total length between 610 to 810 millimetres and weigh on average 8 kilograms. (Redford and Eisemberg, 1992; Macdonald et al., 2007; Mascow, 2011). Males are often larger in size and heavier than females (Mascow, 2011). It exhibits a unique morphology that blends features of lagomorphs, caviomorphs and ungulates (Genest and Dubost, 1974). The Patagonian mara has a similar appearance to the jackrabbit, with long, upright ears, short tail, long limbs and elongated, muscular hind limbs that are longer than the forelimbs. The head and ears are large in comparison to the body. The dorsal coat is grey, with a distinctive white patch on the rump which is surrounded by black hair. The underparts are white, with orange to reddish markings on the chin, cheeks and flanks. The tail is short, depressed, and almost hairless. Patagonian mara have feet that are compressed and hoof-like, contributing to its cursorial movement. There are 3 digits on the hindfeet and 4 on the forefeet (Ellerman, 1940). Due to its long hind limbs, they can run to speeds of 45 kilometres per hour (Rood, 1972 cited in Das Chagas et al., 2019) with some reaching speeds of 60 kilometres per hour (Parr, 2025). Unlike most other caviids, the anal glands are located between the anus and the base of the tail (BIS, 2025; Cabrera, 1953 cited in Campos et al., 2001a; Campos et al., 2001a; Ellerman, 1940; Kessler et al., 2009; Macdonald et al., 2007; Redford and Eisemberg, 1992; Vilalta, 2020). Patagonian mara “pronk” or “stott” as a form of defence against predators. They will jump upwards and forwards with all four legs off the ground. This behaviour is used as either an alarm (to warn other Patagonian mara of a predator) or a fitness signal (as a signal of strength and ability to escape or to attract a mate) (Das Chagas et al., 2019).

	General information: Distribution: Endemic to Argentina, from Bolson de Pipanaco, Catamarca Province at approximately 28 degrees south to 50 degrees south (Roach, 2016). Due to habitat alteration and hunting, the population has become locally extinct in the Buenos Aires Province and in the southwest of Córdoba, Argentina (Campos et al., 2001a; Rosacher, 2009 cited in Baechli et al., 2021). They are found at elevations below 1,000 metres (Mares and Ojeda, 1982a). There are 2 subspecies: ***D. p. centricola*** - occurs in the Catamarca Province, the eastern region of La Rioja Province, the northwest of Córdoba Province, and the southwest of Santiago del Estero Province (Cabrera, 1953 cited in Roach, 2016; Campos et al., 2001a; Roach, 2017). ***D. p. patagonum*** - occurs in the central area of Buenos Aires Province, the south of Cordoba Province, San Luis and Mendoza Provinces, and to the south of Argentina to Santa Cruz Province (Cabrera, 1953 cited in Roach, 2016; Campos et al., 2001a; Roach, 2017). Invasive populations in the United Arab Emirates (Dubai and Abu Dhabi; Saadiyat Island). It is suspected populations were formed due to released or escaped pets. The first reported appearance in the United Arab Emirates was in 2020, when a call for sightings was issued in the Dubai Natural History Group Newsletter *Gazelle* (Hellyer and Judas, 2020). Patagonian mara roam the grounds of Al Qudra Lakes, which is 55 kilometres from the centre of Dubai (MOCCAE, 2025), where they are often seen sleeping or eating grass (Judas, 2023). Judas (2023) has commented that although Patagonian maras prefer temperatures around 20 degrees Celsius, the absence of their usual predators may make their establishment in modified habitats (with tree plantations, lawns and ponds) more successful (Hellyer and Judas, 2020; Judas, 2023). Habitat: Adapted to survive in harsh environmental conditions characterised by unpredictable rainfall and extreme temperatures (Taber and MacDonald, 1992a). It prefers semi-arid open landscapes inhabiting open grasslands, brush, sandy-areas, herbaceous steppe, shrubland steppes and semi-arid areas (Baldi, 2007). In northwestern Argentina, they occur in lowland habitats, including forest and creosote bush (*Larrea*) flats (Campos et al., 2001a). Low strata open habitats are preferred as this allows for effective predator detection and easier ability to find a mate (Baldi, 2007; Rodríguez, 2009).

	Patagonian mara use a diverse range of habitats varying in both size and distance with some home range sizes up to 200 hectares (Macdonald et al., 2007). Rodríguez (2009) noted that in the Monte Desert, habitat varied from "large size areas (up to 30 hectares) separated by long distances (3,200 metres) to small patches (0.88 hectares) situated very close to one another (200 metres)." Patagonian maras are found in monogamous pairs with each couple having its own territory during the non-breeding period. These territories are also mobile. Therefore, there are often multiple micro-territories that overlap between pairs (Genest and Dubost, 1974; Macdonald et al., 2007; Taber and MacDonald, 1992a). During the dry season, once resources have been depleted, Patagonian maras will relocate and multiple pairs will congregate in resource rich areas (Kessler, 2009; Macdonald et al., 2007). Territories will also overlap for communal breeding (Taber, 1987). During the breeding season, they select warrens in either open or closed habitats. Baldi (2007) noted that on Península Valdés, 58% of active warrens were observed in open grassland habitats, compared to 42% that were found in close habitats dominated by tall shrubs. Open warrens had more burrows and a higher reproductive success rate (Baldi, 2007). Although multiple pairs can inhabit the warrens, only 1 pair will breed in a burrow at one time (Baldi, 2007; Genest and Dubost, 1974). Males will not tolerate another male coming within 10 metres of his female. Bachelor males will often be seen closer together, particularly during resting, as the "10 metre rule" does not apply. Bachelor males will often lack aggressiveness and will be submissive to the dominant male in a pair (Genest and Dubost, 1974). Diet: Generalist and an opportunistic herbivore (Kufner et al., 1992 cited in Puig et al., 2010; Rodríguez and Daca, 2008; Kessler, 2009). They primarily consume grasses (such as *Poa* and *Stipa*) and dichotomous plants (like *Lycium* and *Prosopis* species) (Bonino et al., 1997; Campos et al., 2001b; Puig et al., 2010). Feeding constitutes a significant portion of their daily activities with females spending more time feeding than males, likely due to the demands of gestation and lactation (Taber, 1987). The Patagonian mara can be classified as both a browser and a grazer, depending on the season and the availability of food resources. As the regions become more arid and grass becomes depleted, it will adapt its diet and have a higher reliance on shrubs (Puig et al., 2010). Sombra and Mangione (2005) suggest that they may consume cacti as a source of water. Their feeding habits play a role in seed dispersal, particularly for *Prosopis flexuosa*, aiding in the regeneration of plant communities in their habitat (Campos and Ojeda, 1997). Reproduction: Viviparous (gives birth to live young). In southern Argentina, breeding is from August to January and these pairs often share communal dens, which can be occupied by up to 29 pairs (Baldi, 2007; Taber and

	Macdonald, 1992a). In Patagonia, most births occur between late August to October (Taber, 1987). Females are sexually mature by 8 months (Gatica et al., 2019; Mascow, 2011). In semi-captivity, reproduction is characterised by a highly unusual oestrous cycle, occurring once every 3 to 4 months and lasting only about half an hour (Genest and Dubost, 1974). In the wild, females typically produce 1 litter per year, however, more than 1 litter has been reported (Gatica et al., 2019). Gestation period varies between 91 to 111 days (Genest and Dubost, 1974; Gatica et al., 2019; Taber, 1987) and litters range from 1 to 3 pups (Gambrell, 2024) with an average of 2 pups (AnAge, 2023; Campos et al., 2001a). Females rear the young, and the male (who is always close to his female partner) will assist in protecting the young against external threats (Genest and Dubost, 1974). Pups are precocial, born fully furred with their eyes open and are weaned after 11 weeks (Kleiman, 1974 and Dubost and Genest, 1974 cited in Kessler, 2009; Taber, 1987). Adults will nurse their offspring outside the den and will often take turns watching the pups in "nurseries" as the other females go out to feed (BIS, 2025; Ganslosser and Wehnelt, 2009; Gatica et al., 2019). **Longevity:** The maximum recorded longevity for this species in captivity is 14.4 years (AnAge, 2023). The World Life Expectancy (2025) estimates the life span of the Patagonian mara is 14 years. **Conservation status:** **IUCN:** Near Threatened **CITES:** Not listed
DATE OF ORIGINAL ASSESSMENT: June 2025 (Aimee Carter) **Reviewers:** Jess Lyons and Veronica Blazely, DCCEEW **EIC ENDORSEMENT:** 17 July 2026	**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.

Risk assessment model used for the assessment: Bomford 2008, Australian Bird and Mammal Model	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/.

Australian Bird and Mammal Model:

FACTOR	SCORE	DETAIL
STAGE A: RISKS POSED BY CAPTIVE OR RELEASED ANIMALS		
A1. Risk to people from individual escapees (0–2) *Assess the risk that individuals of the species could harm people. (NB, this question only relates to aggressive behaviour shown by escaped or released individual animals. Question C11 addresses the risk of harm from aggressive behaviour if the species establishes a wild population).* *Aggressive behaviour, size, plus the possession of organs capable of inflicting harm, such as sharp teeth, claws, spines, a sharp bill, or toxin-delivering apparatus may enable individual animals to harm people. Any known history of the species attacking, injuring or killing people should also be taken into account. Assume the individual is not protecting nest or young.*	0	*All other animals posing a lower risk of harm to people (ie animals that will not make unprovoked attacks causing injury requiring medical attention, and which, even if cornered or handled, are unlikely to cause injury requiring hospitalisation).* The Patagonian mara is a relatively large, fast and flighty animal (Kessler, 2009) but they are not dangerous to people and unlikely to cause an injury that will require medical attention (Willard, 2024). However, they can be a vector of viruses, diseases and infections which can be transferred to both humans and livestock, such as leptospirosis, cowpox virus, *Toxoplasma gondii* and pulmonary besnoitiasis (Juan-Sallés et al., 2004; Kessler, 2009; Kik et al., 2006; Østevik et al., 2019; Wells et al., 2024). These pathogens can be transferred through cuts or bites.
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*	0	*Nil or low risk (highly unlikely or not possible).*

a public safety risk (excluding the safety of anyone entering the animals' cage/enclosure or otherwise coming within reach of the captive animals)		
STAGE A PUBLIC SAFETY RISK SCORE **SUM A1 - A2 (0-4)**	0	**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.*	3	*Moderate climate match to Australia* Value X = 5,825 Climate Match Score = 3 Endemic to Argentina (Roach, 2016). Península Valdés is not shown on the IUCN map, however Baldi (2007) reports an established population. Therefore, it has been included.
B2. Exotic population established overseas (0–4) *An established exotic population means the introduced species must have bred outside of captivity and must currently maintain a viable free-living population where the animals are not being intentionally fed or sheltered, even though they may be living in a highly disturbed environment with access to non-natural food supplies or shelter.*	4	*Exotic population established on a larger island (> 50 000 km^2) or anywhere on a continent (including elsewhere on the land mass where the natural distribution of the animal is, if this population is due to human introduction and is geographically separate from the natural range of the species).* Endemic to Argentina (Roach, 2016). Self-sustaining populations are established in Dubai and Abu Dhabi (Saadiyat Island) likely from released or escaped pets. Escaped and released individuals are reported on occasions from other countries such as Florida (USA) including Makinson Island (Figure 3) (EDDMaps, 2025; Invasive.org, 2025; Richards, 2025; Willard, 2024). However, these occurrences have not established self-sustaining populations and therefore have not been included on the risk assessment.

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.* Estimated overseas range of approximately 1.5 million km^2.
B4. Taxonomic Class (0–1) *Bird = 0; mammal = 1*	1	*Mammal*
B. ESTABLISHMENT RISK SCORE SUM OF B1- B4 (1–13)	9	**SERIOUS establishment risk**
Model 2: SEVEN-FACTOR MODEL FOR BIRDS AND MAMMALS (Bomford 2008)		
B5. Diet score (0–1) *Specialist = 0; generalist = 1*	1	*Generalist with a broad diet of many food types.* A generalist and an opportunistic herbivore (Kufner et al., 1992 cited in Puig et al., 2010; Rodríguez and Daca, 2008). Primarily consume grasses, such as *Poa* and *Stipa*, and dichotomous plants, such as *Lycium* and *Prosopis* species (Bonino et al., 1997; Puig et al., 2010).
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.* Often sighted on agricultural (cattle and sheep stations) and human modified lands. Rodríguez (2009) noted that in the La Pampa Province in Argentina, 94.4% of the areas where they were located were on human-modified habitats. In the United Arab Emirates, it has adapted to living in human modified habitats. Judas (2023) found although they prefer temperatures around 20 degrees Celsius, the absence of their usual predators may make their establishment in modified habitats with tree plantations, lawns and ponds more successful (Hellyer and Judas, 2020; Judas, 2023).
B7. Migratory score (0–1) *Always migratory = 0; non-migratory = 1*	1	*Non-migratory.*
B. ESTABLISHMENT RISK SCORE SUM OF B1- B7 (1–16)	12	**SERIOUS establishment risk**

STAGE C: 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 (Rodentia) = 2.*
C2. Overseas range size including current and past 1000 years, natural and introduced range (0–2) *Estimate the species overseas range size (including current and past 1000 years, natural and introduced range) in millions of square kilometres*	0	*Overseas geographic range less than 10 million square kilometres.* Approximately 1.5 million km^2.
C3. Diet and feeding (0–3)	3	*Mammal that is a primarily a grazer or browser.* A generalist and an opportunistic herbivore (Kufner et al., 1992 cited in Puig et al., 2010; Rodríguez and Daca, 2008; Kessler, 2009). Sombra and Mangione (2005) found that in Sierra de las Quijadas National Park (San Luis, Argentina), Patagonian maras consumed at least 24 different plant items of grasses and 22 items of shrubs plus forbs. A diverse range of vegetation was consumed including *Pappophorum* species, leaves of *Prosopis* species, fruit of *Prosopis torquate* and *Geoffroea decorticans* to name a few (Sombra and Mangione, 2005).
C4. Competition with native fauna for tree hollows (0–2)	0	*Does not use tree hollows.* Does not use tree hollows but instead uses burrows and warrens in open areas as breeding areas to protect their young against predators (Baldi, 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?*	1	*Minor environmental pest in any country or region.* Feeds on new herb growth and fruits (Kessler, 2009) which could have an impact on primary producers planting crops. They can reduce plant cover and the proportion of grasses in their habitat particularly during seasons of drought (Puig et al., 2018).

		Considered as an ecosystem engineer, they burrow to make warrens and dens for the protection of their offspring. These are only inhabited by the Patagonian mara during the breeding season, with other species (such as the Chaco tortoise (*Chelonoidis chilensis*)) utilising them as refuges or feeding sites at other times (Gatica et al., 2020).
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 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 (DCCEEW Protected Matters Search Tool) include: *Dasyurus hallucatus* (Northern Quoll) – Endangered *Myrmecobius fasciatus* (Numbat) – Endangered *Onychogalea fraenata* (Bridled nailtail wallaby) – Endangered *Duma horrida abdita* (Remote Thorny Lignum) – Critically Endangered *Hibbertia abyssus* (Bandalup Buttercup) – Critically Endangered *Anomalopus mackayi* (Five-clawed work-skink) – Vulnerable Patagonian maras can compete with native species in competition for habitat space (Numbat; Five-clawed worm-skink), food resources (Bridled nailtail wallaby) and overgrazing (Remote Thorny Lignum; Bandalup Buttercup).
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.* Prefer bare ground habitat which results in an increased presence of mara in grazed areas (Kufner and Chambouleyron, 2008). They often compete with sheep for similar grazing areas and found collocated on properties, particularly during the dry season (Macdonald et al., 2007). This may have an impact on resources available for herds. May have an impact on young crops as they eat new growth on herbs and fruits. Their feeding habits also play a role in seed dispersal, particularly for *Prosopis flexuosa*, aiding in the regeneration of plant communities in their habitat (Campos and Ojeda, 1997). This could result in the potential dispersal of invasive vegetation throughout Australia.

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 = 172.10 (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).* Leptospirosis was reported in 3 individuals kept in captivity (Wells et al., 2024). Leptospirosis can spread in both domestic and wild animals. Humans can become infected through contact with water, food or soil of an infected animal as well as through cuts and abrasions. In rare circumstances, leptospirosis can cause death (NSW Health, 2021). Kik et al. (2006) reported confirmed cases of "generalized cow pox infections in Patagonian mara" at an educational park in the Netherlands. The authors noted that the likely transmission was from rats in the park. Although, there were no confirmed cases of transmission from the maras to humans, the authors did note the possibility of a public health risk if the virus was not recognised quickly (Kik et al., 2006). Other pathogens reported in captive mara include *Toxoplasma gondii* (Østevik et al., 2019), *Graphidioides affinis* which could possibly transmit from mara to human (Sutton and Dureette-Desset, 1995) and pulmonary besnoitiasis associated with interstitial pneumonia (Juan-Sallés et al., 2004). 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-$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.		No known adverse effects on humans (Mascow, 2011). However, as burrowers, they could cause problems to ornamental gardens.
C11. Harm to people (0–5) *Assess the risk that, if a wild population established, the species could cause harm to or annoy people. Aggressive behaviour, plus the possession of organs capable of inflicting harm, such as sharp teeth, tusks, claws, spines, a sharp bill, horns, antlers or toxin delivering organs may enable animals to harm people. Any known history of the species attacking, injuring or killing people should also be taken into account (see Stage A, Score A1).*	2	*Injuries, harm or annoyance likely to be minor and few people exposed: Low risk = 2.* Could become a reservoir or vector for endemic parasites or diseases that could be transmitted too and seriously affect people such as leptospirosis, cowpox virus, *Toxoplasma gondii* and pulmonary besnoitiasis (Juan-Sallés et al., 2004; Kessler, 2009; Kik et al., 2006; Østevik et al., 2019; Wells et al., 2024). Could be a social nuisance to farmers who have livestock such as sheep by reducing the availability of resources (Kufner and Chambouleyron, 2008; Macdonald et al., 2007).
C. PEST RISK SCORE SUM C 1 TO C 11 (1–37)	22	**EXTREME pest risk**
STAGE A. PUBLIC SAFETY RISK RANK – RISK TO PUBLIC SAFETY POSED BY CAPTIVE OR RELEASED INDIVIDUALS *0 = Not dangerous; 1 = Moderately dangerous; ≥ 2 = Highly dangerous*	0	NOT dangerous
STAGE B. ESTABLISHMENT RISK RANK – RISK OF ESTABLISHING A WILD POPULATION **MODEL 1: FOUR-FACTOR MODEL FOR BIRDS AND MAMMALS (BOMFORD 2008)** *≤ 5 = low establishment risk; 6-8 = moderate establishment risk; 9-10 = serious establishment risk; ≥ 11-13 = extreme establishment risk*	9	SERIOUS establishment risk
STAGE B. ESTABLISHMENT RISK RANK – RISK OF ESTABLISHING A WILD POPULATION **MODEL 2: SEVEN-FACTOR MODEL FOR BIRDS AND MAMMALS (BOMFORD 2008)**	12	SERIOUS establishment risk

≤ 6 = low establishment risk; 7-11 = moderate establishment risk; 12-13 = serious establishment risk; ≥14 = extreme establishment risk		
STAGE C. PEST RISK RANK - RISK OF BECOMING A PEST FOLLOWING ESTABLISHMENT *< 9 = low pest risk; 9-14 = moderate pest risk; 15-19 = serious pest risk; > 19 = extreme pest risk*	22	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

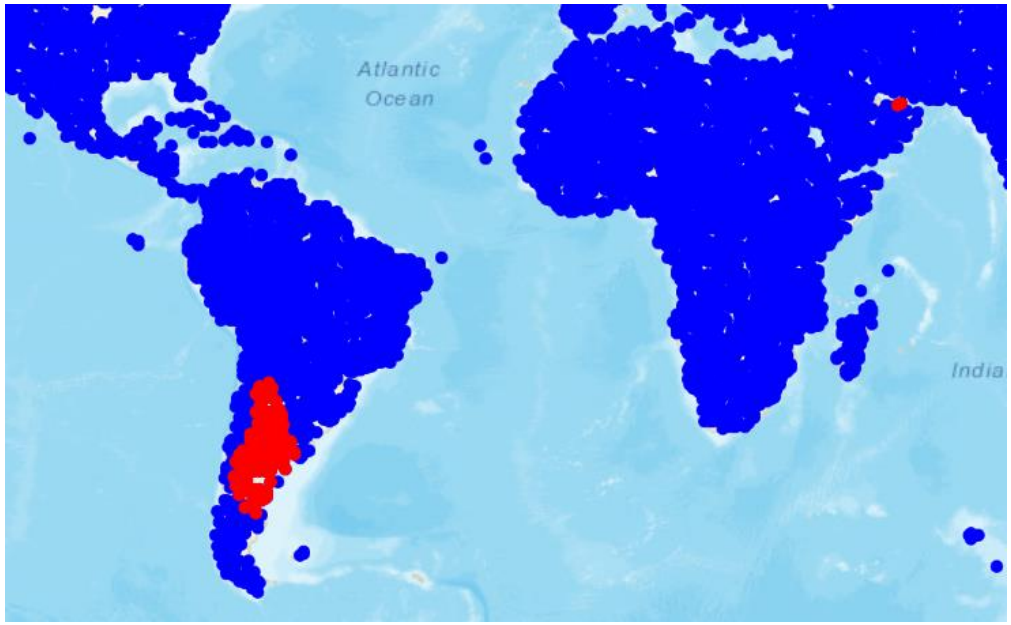


Figure 2 - World Distribution Map - Climatch

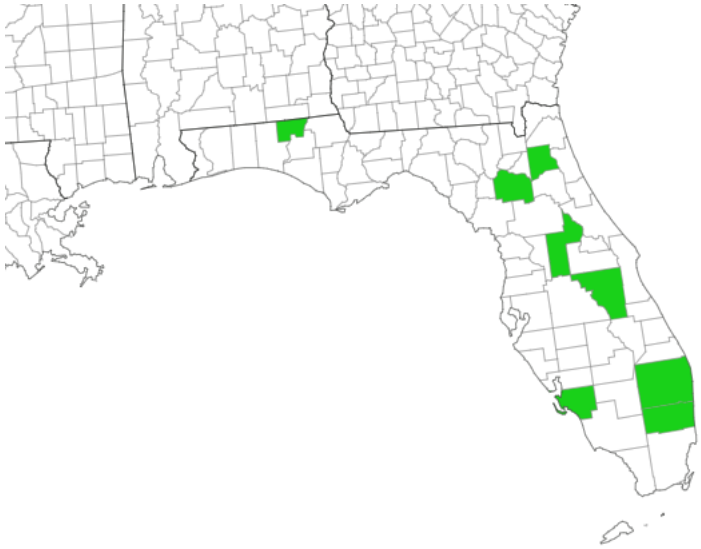


Figure 3 – EDDMaps – Florida reporting of Patagonian Mara



Figure 4 – Key for EDDMaps

Climate match between world distribution of species and Australia:

Areas of Australia where the climate appears suitable for *Dolichotis patagonum*

Value X = 5,825

Climate Match Score = 3 (Moderate)

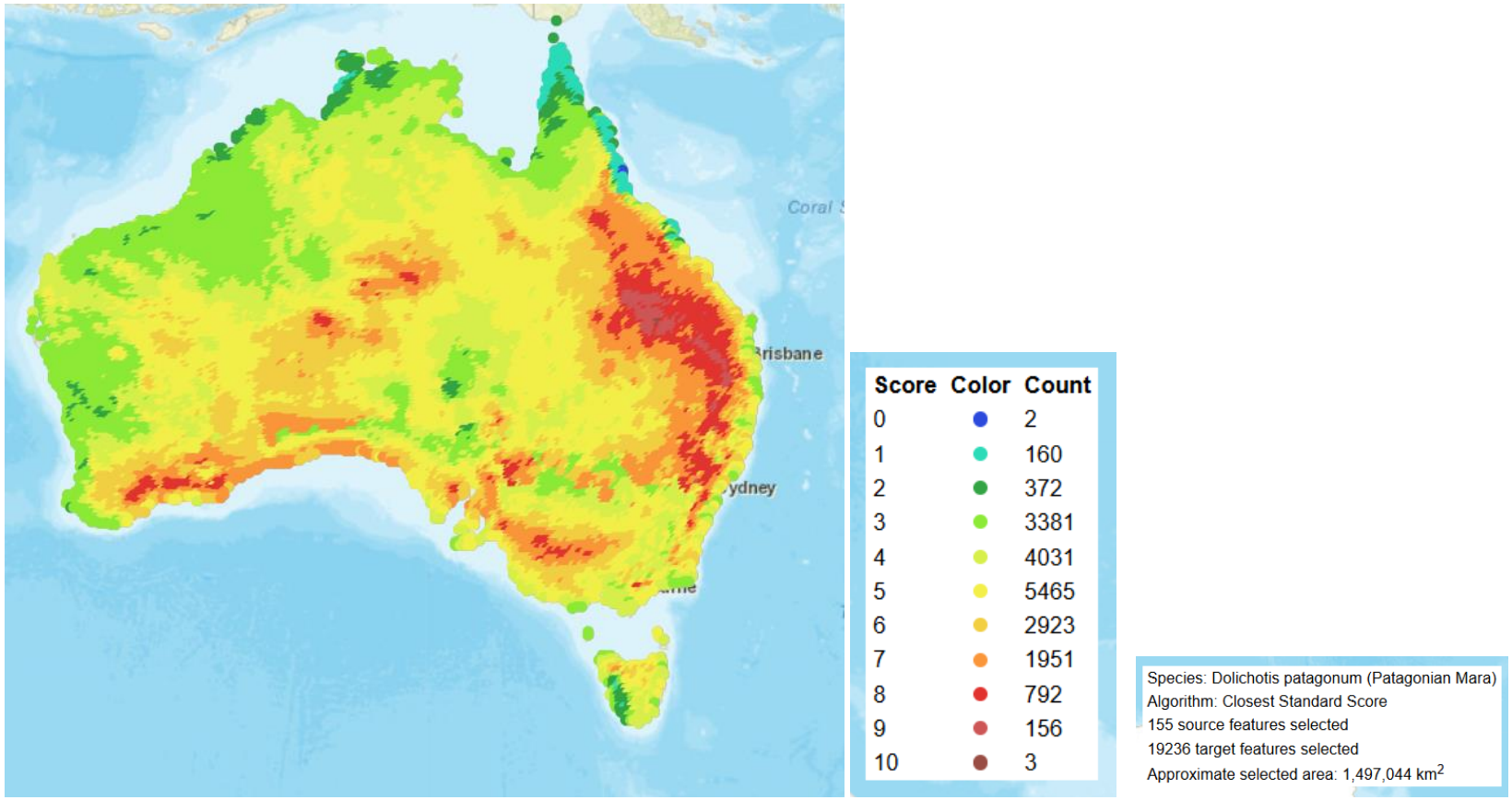


Table 1: ABARES recalibration thresholds

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	4	52
Forestry (includes hardwood and softwood)	2			
Cereal grain (includes wheat, barley, sorghum, corn, oats etc)	10	1	4	40
Sheep (includes wool and sheep meat)	5	1	3	15
Fruit and nuts (includes wine grapes)	5	1	4	20
Vegetables	3			
Poultry and eggs	3			
Fisheries products	2			
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	3	5	45
Pigs	1			
Other livestock (includes goats, deer, camels, rabbits)	0.1	1	1	0.1
Bees (includes honey and beeswax)	0.1			
Total Commodity Damage Score (TCDS)				172.10

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:

4. *Nil (species does not have attributes to make it capable of damaging this commodity)*
5. *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*
6. *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)*
7. *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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DRAFT National Risk Assessment: EXTREME

RISK ASSESSMENT FOR AUSTRALIA: Madagascar day gecko (*Phelsuma madagascariensis*)

Class - Reptilia, **Order** - Squamata, **Family** - Gekkonidae, **Genus –** *Phelsuma.*

SPECIES: *Phelsuma madagascariensis* (Gray, 1831) **Subspecies:** 1. *Phelsuma madagascariensis boehmei* (Meier, 1982) 2. *Phelsuma madagascariensis madagascariensis* (Gray, 1831) **Synonyms:** *Gekko madagascariensis* (Gray, 1831) *Phelsuma madagascarensis* (Gray, 1831) *Phelsuma sarrube* (Wiegmann, 1834) *Phelsuma madagascariensis martensi* (Mertens, 1962) *Phelsuma madagascariense* (Boulenger, 1885) **Common names:** Madagascar day gecko Boehme's giant day gecko	**Species description:** *Phelsuma madagascariensis* (Gray, 1831), commonly known as the Madagascar day gecko is a diurnal species of gecko native to Madagascar (Rocha et al., 2010). This species is not to be confused with the Madagascar Giant Day Gecko, *Phelsuma grandis* (Gray, 1870) which was split from *Phelsuma madagascariensis* in 2007 and elevated to its own species by Raxworthy et al., 2007 (Rocha et al., 2009, 2010). Geckos within the *Phelsuma* genus can be recognised by their smooth ventralia and subcaudalia, keeled dorsal and lateral scales, absence of nostril-rostril contact and size reduced vertebral scale (Rocha et al., 2010). Adult Madagascar day geckos typically measure between 22 to 24 centimetres in total length with males slightly larger than females. The average weight for an adult is 20.70 grams (AnAge, 2023). They are colourful geckos, predominantly green in colour adorned with a weakly coloured dorsal pattern (Rocha et al., 2010). The dorsal surface features red coloured dots, which often extend to the head. Its ventral surface ranges in colour from greyish white to greenish tones (BIOPARC, 2025). Their tail colouration ranges from bluish green to yellow. The Madagascar day gecko has a rust-coloured stripe extending from the nostril through the eye to the neck and a red V-mark on the forehead (Raxworthy et al., 2007; van Heygen, 2004; UNEP-WCMC, 2020). The intensity of their coloration and markings can quickly change when stressed, particularly as juveniles. This can impact whether certain characteristics (such as the red V-mark) can be seen, as they may vanish when the gecko is in the "bright" phase, i.e. when it is showing its full, vivid colouration (Raxworthy et al., 2007; UNE-WCMC, 2020). The Madagascar day gecko has large, round pupils and lacks eyelids, using its tongue to clean its eyes (BIOPARC, 2025; Boulenger, 1885; Gray, 1831; Rocha et al., 2010). They possess adhesive toe pads with an undivided toe lamellae facilitating their arboreal lifestyle (Rocha et al., 2010). The Madagascar day gecko does not have claws and instead uses the adhesive toe pads (which consist of thousands of tiny hair-like structures called setae, that branch off into even smaller bristles) to cling to various surfaces including smooth vertical surfaces like glass panes (Gray, 1831; Zhuang and Highman, 2016),

	There are two subspecies within *Phelsuma madagascariensis*: ***P.m. madagascariensis*** –a maximum total length of 24 centimetres and a maximum snout-vent length of 120 millimetres. The number of supralabials for *P.m. madagascariensis* range from 6 to 10. The number of infralabials range from a 6 to 9 (Rocha et al., 2010). The skin between the scales of *P.m. madagascariensis* is pale and the spots on the back are absent or tend to form longitudinal rows (UNEP-WCMC, 2020). ***P.m. boehmei*** - a maximum total length of 22 centimetres and a maximum snout-vent length of 99 millimetres. The number of supralabials for *P.m. boehmei* range from a minimum of 7 to a maximum of 8. The number of infralabials range from a minimum of 7 to a maximum of 8 (Rocha et al., 2010). *P.m. boehmei* also has darker skin between body tubercles (Raxworthy et al., 2007). The skin between the scales of *P.m. boehmei* is black and the spot pattern on the back is often irregular, rarely comprises longitudinal rows. The spots may also be absent (UNEP-WCMC, 2020). Juvenile Madagascar day geckos are morphologically like adults but have a darker dorsal ground colour with more intensive markings. The juvenile's underside is brick red with the colour fading as the gecko ages (UNE-WCMC, 2020). The Madagascar day gecko exhibits territorial behaviour and can be very aggressive towards each other, sometimes resulting in serious injury or death (BIOPARC, 2025; Demeter, 1976; Pavia, 1999). It can autotomise (voluntarily shed part of its body) if there is a danger or threat by shedding its tail (Zhuang and Highman, 2016; UNE-WCMC, 2020). The Madagascar day gecko is also very vocal; it will emit a distress cry when handled and vocalise during courtship (Demeter, 1976). Like all reptiles, it could play a role in the spread of diseases or parasites to other animals. **General information:** Distribution: The Madagascar Day Gecko is endemic to eastern Madagascar. It can be found from Ambohitsara to Ankalampo, and on Nosy Boraha (Rocha et al., 2010). It has been reported in the areas of Perinet, Andasibe, Ranomafana, Tamatave, Antanambe, Ambodiriana, Vohibola, Sahafina, Vatomandry, Mahanoro, Ambodiharina, Ambohitsara (Gehring et al., 2010; Rocha et al., 2009; Uetz et al., 2025). The two subspecies are in slightly different areas of Madagascar. ***P.m. madagascariensis*** – predominantly found across the east coast of Madagascar (D'Cruze, 2009).

	P.m. boehmei – found in the Andasibe and Perinet region of Madagascar (Berghof, 2014 cited in Glaw and Roesler, 2015; D'Cruze, 2009; Raxworthy et al., 2007). The species *Phelsuma grandis* (Madagascar giant day gecko (Gray, 1870) was previously reported as a subspecies of *Phelsuma madagascariensis* (*Phelsuma madagascariensis grandis*) but is now recognised as its own species (EDDMapS, 2025; Gardner, 1988; Hillyer, 2007; Krysko and Daniels, 2005; Krysko et al., 2003; Uetz et al., 2025). *Phelsuma grandis* has been introduced and established self-sustaining populations in Florida and Hawaii (USA) and may be mistaken for the Madagascar day gecko (*P. madagascariensis*) (Species+b 2025). The Madagascar day gecko can be easily transported into Australia on the "inside or underside of a sea container" (DAFF, 2018). Habitat: The Madagascar day gecko is predominantly found on the east coast of Madagascar, inhabiting primarily coastal and low-elevation areas (Raxworthy et al., 2011). It can be found in primary forest, including both dry and deciduous forests, as well as anthropogenically altered habitats such as buildings and plantations (Andersson, 1910; D'Cruze, 2009; Fulgence et al., 2022; Glaw and Vences, 2007). It is usually found dwelling on trees (ABDragons, 2025; BIOPARC Valencia, 2025). Although Madagascar day geckos can be found at elevations up to 1,000 metres, they thrive in low and mid-altitude humid forests (Raxwothy et al., 2011; Rocha et al., 2009). For elevations higher than 800 metres above sea level, the Madagascar day gecko is found only in rainforests, typically on large, hollow, dead trees (Raxworthy et al., 2011). Raxworthy et al. (2011) advise that the higher-elevation populations belong to the subspecies *P.m. boehmei*. Diet: The Madagascar day gecko has an omnivorous diet, consuming a variety of arthropods, fruits, and nectar (BIOPARC Valencia, 2025). Reproduction: Sexual maturity is reached between 1.5 to 3 years. During breeding season, from November to early May in their native range, the female will lay 6 clutches of generally 2 eggs (BIOPARC, 2025; Hallman et al., 1997 cited in Wanger et al., 2009; Rabotovao, 2004). As they are oviparous, females lay small, round eggs with brittle, inflexible shells (Packard and Hirsch, 1989), which they deposit in the earth or sand (Osadnik, 1984; Raxworthy et al., 2011). Incubation is at approximately 28 °C (Rabotovao, 2004) and in captivity can last between 46 to 66 days (Demeter, 1976). *Phelsuma madagascariensis* is suspected of having temperature-dependent sex determination, with an ambient temperature over the breeding season between 20 to 23 °C

	(Cornejo-Páramo et al., 2020). However, more data is required as this is inconclusive (Gamble, 2010; Viets et al. 1994). **Longevity:** The recorded longevity in captivity is 13.6 years (AnAge, 2023). The World Life Expectancy (2025) states the life expectancy for the Madagascar day gecko is between 10 to 15 years. Life span is estimated to be 6 years in the wild (Fry and Roycroft, 2009). **Conservation status:** **IUCN:** Least Concern. **CITES:** Appendix II - - species that are not necessarily threatened with extinction but require controlled international trade to prevent utilization incompatible with their survival.
DATE OF ASSESSMENT: June 2025 (Aimee Carter PIRSA; Vic Greentree DPINSW; Penny Fisher DEECA; Kristen Petrov, Jess Lyons, Kristen Blazely DCCEEW) **EIC ENDORSEMENT:** 17 July 2026 **Risk assessment model used for the assessment:** • Bomford 2006, Risk assessment for the establishment of exotic vertebrates in Australia: recalibration and refinement of models	**The risk assessment model:** Models for assessing the risk that exotic vertebrates could establish in Australia have been developed for mammals and 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 , 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 the 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 in Australia. Worldwide, data from approximately 19,000 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 19,236 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/.

• **Australian Reptile and Amphibian Model (Bomford 2008)** • Bird and Mammal Model for Reptiles and Amphibians (Bomford 2008)	

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		
P. 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).*	10.03	CMRS = 100 x (5/19,236) = 0.0259929299230609 As there are less than 12 meteorological stations, the score needs to be increased by 10 percentage points. CMRS = 0.0259929299230609 + 10 CMRS = 10.03 Note: The species has several GBIF georeferenced occurrences from outside its natural range (Figure 4). These occurrences are presumed to be waifs, escaped and released pets rather than established populations. The populations reported on GBIF, in Florida and Hawaii (USA), Seychelles and Mauritius are presumed to *P. grandis* as no exotic populations have been reported for *P. madagascariensis* (Krysko and Daniels, 2005; Krysko et al., 2003).
Q. 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*	0	*Species has not established an exotic population (including species not known to have been introduced anywhere).* The Madagascar day gecko is endemic to eastern Madagascar. It can be found from Ambohitsara to Ankalampo and Nosy Boraha (Rocha et al., 2010). It has been reported in the areas of Perinet, Andasibe, Ranomafana, Tamatave, Antanambe,

• *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*		Ambodiriana, Vohibola, Sahafina, Vatomandry, Mahanoro, Ambodiharina, Ambohitsara (Gehring et al., 2010; Rocha et al., 2009; Uetz et al., 2025).
R. 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*	40.03	**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 climate match to Australia* Value X = 9 Climate Match Score = 1 As there are less than 12 meteorological stations, the score needs to be increased by 1. Climate Match Score = 2
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 exotic population ever established.* The Madagascar day gecko is endemic to eastern Madagascar. It can be found from Ambohitsara to Ankalampo as well as on Nosy Boraha (Rocha et al., 2010). It has been reported in the areas of Perinet, Andasibe, Ranomafana, Tamatave, Antanambe, Ambodiriana, Vohibola, Sahafina, Vatomandry, Mahanoro,

		Ambodiharina, Ambohitsara (Gehring et al., 2010; Rocha et al., 2009; Uetz et al., 2025).
C. Overseas range size score (0–2) < 1 = 0; 1– 70 = 1; >70 = 2 *Estimate the species overseas range size including currently and the past 1000 years; natural and introduced range in millions of square kilometres*	0	*Overseas natural range size is estimated less than 1 million km^2.* Madagascar has a total land area of 587,295 km^2 (Worlddata.info, 2025). The Madagascar day gecko is found primarily on the eastern coast of Madagascar. It has been found over an area of nearly 79,750 km^2 (Raxworthy et al. 2011). Note: The species has several GBIF georeferenced occurrences from outside its natural range (Figure 4). These occurrences are presumed to be waifs, escaped or released pets rather than established populations. The populations reported on GBIF, in Florida and Hawaii (USA), Seychelles and Mauritius are presumed to *P. grandis* as no exotic populations have been reported for *P. madagascariensis* (Krysko and Daniels, 2005; Krysko et al., 2003).
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 ALLOCATED PEST RISK* *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.	**EXTREME**

ENVIRONMENT AND INVASIVES COMMITTEE THREAT CATEGORY	**EXTREME*** *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.

Figure 1: World distribution map (IUCN Red List); Figure 2: Climatch world distribution map indicating where meteorological data was sourced for the climate analysis; and Figure 3: world Georeferenced records (GBIF):



Figure 6 - World Distribution Map - IUCN Red List



Figure 2 – World Distribution Map – Climatch

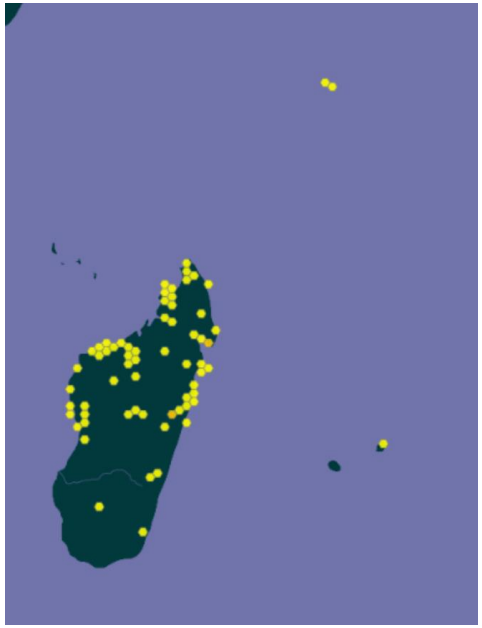


Figure 3 - World Georeferenced records (GBIF) – Madagascar



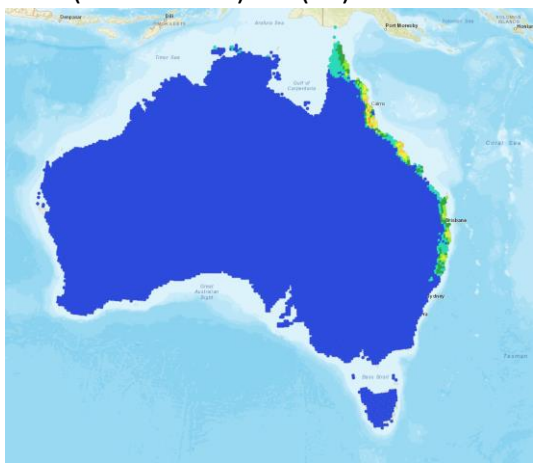
Figure 4 - World Georeferenced records (GBIF) – All referenced locations

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 *Phelsuma madagascariensis*

Only 4 matching points on Climatch (Figure 2)

CMS (Sum Level 7) = 5 (10)



Score	Color	Count
0		18761
1		221
2		113
3		59
4		33
5		27
6		17
7		5
8		0
9		0
10		0

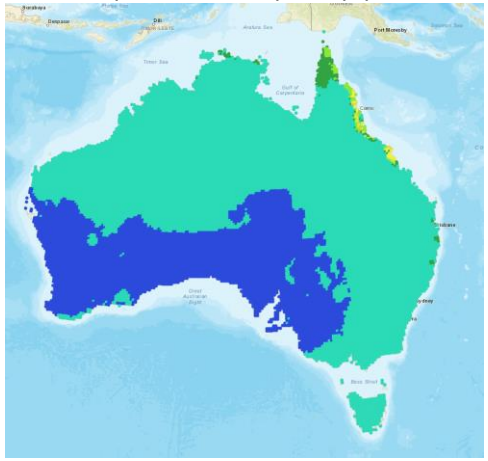
Species: Phelsuma madagascariensis (Madagascar Day Gecko)
Algorithm: Euclidean
4 source features selected
19236 target features selected
Approximate selected area: 171,589 km^2

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 *Phelsuma madagascariensis*

Only 4 matching points on Climatch (Figure 2)

Value X (Sum Level 6) = 9 (1)



Score	Color	Count
0		5507
1		13420
2		185
3		73
4		22
5		20
6		8
7		1
8		0
9		0
10		0

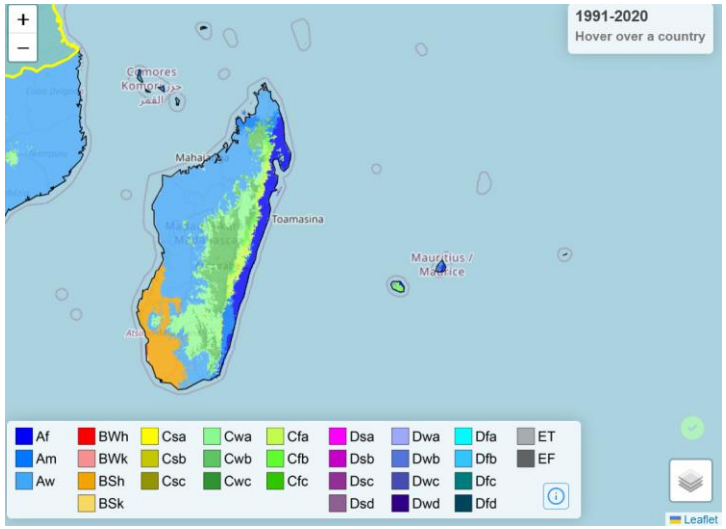
Species: Phelsuma madagascariensis (Madagascar Day Gecko)
Algorithm: Closest Standard Score
4 source features selected
19236 target features selected
Approximate selected area: 171,589 km^2

Köppen-Geiger Analysis

A Köppen-Geiger analysis shows that the major climate zones on the eastern side of Madagascar (the Madagascar day gecko's usual habitat) are present within the north and eastern coastlines of Australia:

Af – Tropical, rainforest
Aw – Tropical, savannah
Cfa – Temperate, no dry season, hot
Cfb - Temperate, no dry season, warm summer
Cfc - Temperate, no dry season, cold summer

In this case, the Climatch analysis using the lat/long coordinates corresponds closely with the K-G assessment.



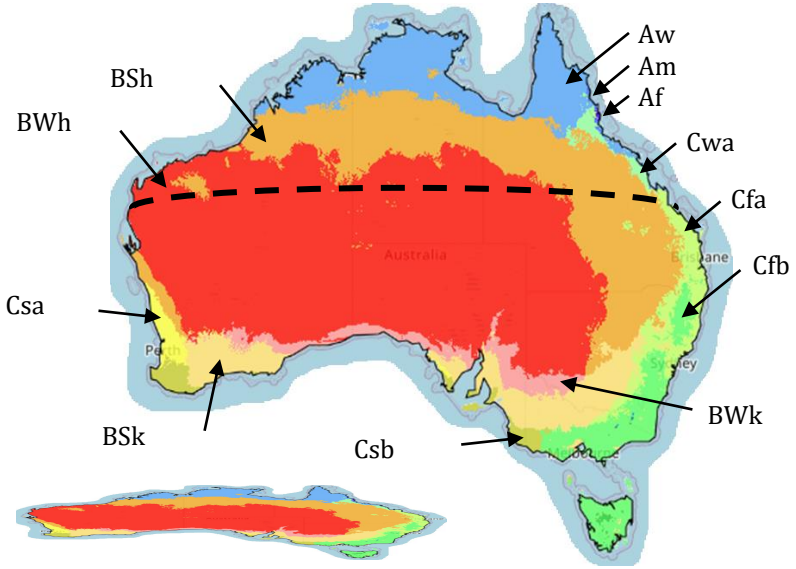


Table 1: ABARES recalibration thresholds

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 a default 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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DRAFT National Risk Assessment: SERIOUS

RISK ASSESSMENT FOR AUSTRALIA: Japanese fire-bellied newt (*Cynops pyrrhogaster*)

Class - Amphibia, **Order** - Caudata, **Family** - Salamandridae, **Genus –** *Cynops.*

SPECIES: *Cynops pyrrhogaster* (Boie, 1826) **Synonyms:** *Molge pyrrhogaster* (Boie, 1826) *Cynops immaculiventris* (Krefft, 1898; Raffaëlli, 2013) *Cynops sasayamae* (Mertens, 1969; Raffaëlli, 2013) *Cynops shataukokensis* (Freytag and Eberhardt, 1977) *Cynops subcristatus* (Temminck and Schlegel, 1838; Tschudi, 1838) *Diemictylus pyrrhogaster* (Boie, 1826; Cope, 1889) *Diemyctylus pyrrhogaster* (Boie, 1826; Stejneger, 1907) *Molga pyrrhogatra* (Boie, 1826) *Molge pyrrhogastra* (Boie, 1826; Boulenger, 1882) *Salamandra pyrrhogastra* (Boie, 1826; Geerts, 1881) *Salamandra subcristata* (Temminck and Schlegel, 1838)	**Species description:** The Japanese fire-bellied newt is a small amphibian species that is stoutly built and renowned for its distinctive colouration. Six local clades were previously reported (Atsumi, Hiroshima, Kanto, Sasayama, Tohoku and Intermediate) based on morphological and ethological traits by Sawada (Sawada, 1963 cited in Tominaga et al., 2013). However, further analyses have now reported these clades as Northern, Central, Western and Southern and one additional subclade of Southern Izu Lineage (Tominaga et al., 2013, 2015). Adults typically measure between 8 to 12 centimetres in total length, with females (10-12 centimetres) generally being larger than males (8-10 centimetres) (Sparreboom, 2014). The body is dark brown to black dorsally, adorned with small reddish or yellow spots and stripes ranging from the shoulder along the flanks dorso-laterally (AmphibiaWeb, 2025; Sparreboom, 2014; Stejneger, 1907; Thorn and Raffaelli, 2001). Ventrally their colour ranges from pale yellow (in juveniles) to orange or dark red, with an irregular pattern of small to large black spots or patches (Morchida, 2012). They exhibit pattern and colour morphs ventrally; they can be uniform in colouration, have minimal or no spots or patches or are predominantly black with little orange or red colouration (Matsui et al., 2003a; Sparreboom, 2014; Stejneger, 1907). Some individuals have been reported as having an exceptionally red ventral colouration (Matsui et al., 2003a; Sawada, 1963 cited in Mochida, 2009). These colour and pattern morphs could be due to their locality (Matsui et al., 2003a). The head is longer than it is broad with laterally placed eyes and anteriorly placed nostrils. The soles of the feet are brown to black with long, depressed, non-webbed digits. The Japanese fire-belled newt is described as having a smooth vertebral ridge from neck to tail, running continuous with a dorsal fin ridge. Parotoid glands are large, compressed and almost continuous with a dorso-lateral glandular ridge which is cut by transverse grooves into a series of beadlike glands. A ventro-lateral glandular ridge extends from the axilla to groin. A circular gland is also present at the antero-dorsal insertion point of the thigh between the two previously mentioned glandular rows (Thorn and Raffaelli, 2001 cited on AmphibiaWeb, 2025; Stejneger, 1907). The tail is laterally compressed, equipped with fin-like structures on both the dorsal and ventral sides, which are parallel and taper at the posterior end. They exhibit a unique

Triton subcristatus (Temminck and Schlegel, 1838; Duméril, Bibron, and Duméril, 1854) *Triton subcristatus immaculiventris* (Krefft, 1898) *Triton subcristatus typica* (Kefft, 1898) *Triturus pyrrhogaster* (Boie, 1826; Strauch, 1870) *Triturus pyrrhogaster sasayamae* (Mertens, 1969) *Triton pyrrhogaster* (Boie, 1826) *Triton pyrrhogaster typica* (Wolterstorff, 1906) *Cynops pyrrhogaster popei* (Inger, 1947) (AMNH, 2025; ITIS, 2025) **Common Names:** Japanese fire-bellied newt Japanese newt Japanese fire belly newt Hiroshima fire-bellied newt Shau Tau Kok newt Tamba fire-bellied newt Kagoshim fire-bellied newt Japanese common newt	regenerative ability, capable of regrowing limbs, the lens of the eye and tail (Chiba et al., 2012; Inoue et al., 2012; Tsutsumi et al., 2015). The species is sexually dimorphic, with males having longer toes and less rugose skin on the anterior portion of the head, limbs and tail, and a "filament" at the end of the tail compared to females (Thorn and Raffaelli, 2001 cited on AmphibiaWeb, 2025; Stejneger, 1907)(AmphibiaWeb, 2025). During breeding season, a grey to blue-purplish sheen can be found on the tail, belly, and other parts of the male's body and their glandular system becomes more prominent with large flap-like parotoid glands. The male's skin becomes slimy to touch and occasionally there may dark patches on their tail (AmphibiaWeb, 2025; Sparreboom, 2014). Females have lesser developed parotoid glands as well as lateral glandular ridges, and the scapular gland and the caudal filament are absent (Stejneger, 1907). Japanese fire-bellied newts produce tetrodotoxin as a defensive behaviour; this neurotoxin inhibits sodium channels in nerve cells of most vertebrates and is secreted through the skin glands present on the dorsal surface and tail (Brodie, 1977; Tsuruda et al., 2002). When threatened, they also display the "Unken reflex". This is a defensive posture where the aposematic red colouration of their venter is seen when the tail and head are elevated (Brodie, 1977; Mochida, 2009). Juveniles are dark brown to black and have a pale-yellow or creamy ventral. The juvenile develops its vibrant ventral colour as it matures (Chiba et al., 2012; Matsui et al., 2002). Some juveniles may also have yellow orange stripe over their body and the dorsal and ventral sides of their tail (AmphibiaWeb, 2025; Sparreboom, 2014; Stejneger, 1907; Thorn and Raffaelli, 2001). **General information:** Distribution: Endemic to Japan (except Hokkaido and Okinawa Prefectures) and widely distributed throughout Honshu, Shikoku and Kyushu. Also located on several smaller islands including Sado, Awaji, Iki, and Naga; the Goto and Koshikijima archipelagos as well as Oki, Amakusa and Yakushima Islands (ASG, 2021; Sparreboom, 2014; Stejneger, 1907; Tominaga et al., 2015). An established population was introduced to Hachijojima Island (the Izu Islands) and has been recorded there since the 1970s. However, its origin of arrival is unknown (CABI Compendium, 2025; ISJ, 2025; Tominaga et al., 2016). An alien population has also been reported in Yokohama city based on mitochondrial DNA sequences (Senzaki et al., 2022).

	CABI Compendium reports invasive introduced populations in South Africa. As of December 2019, work undertaken by Zengeya and Wilson (2021) describes the Japanese fire-bellied newt as including "a range of species from those in quarantine to those that are reproducing outside of captivity or cultivation but where there is no clear evidence of having formed self-sustaining populations". Invasive introduced populations are also reported in Germany (first recorded in 1900, it is now presumed extinct in Germany), and Spain (first reported in 2002 and has been classified as having a "casual" status with no self-sustaining populations) (CABI Compendium, 2025; DAISIE, 2025; Seebens et al., 2017). Japanese fire-bellied newts have been reported in Florida (deliberately released pets) and Massachusetts (released or escaped pets) in the United States of America. These populations have not established a breeding self-sustaining exotic population (CABI Compendium, 2025; King and Krakauer, 1966; McKercher, 2025). Due to its popularity in the pet trade, it has been found during post-border interceptions in Australia (CISS, 2020). Habitat: An adaptable amphibian living in both disturbed and undisturbed habitats and found at levels ranging from 30 to 2,020 metres above sea level (ASG, 2021). Primarily nocturnal (Mochida, 2009), it occurs in a variety of habitats including grasslands and forests as well as cultivated areas such as rice paddies (Sate, 1934 cited on ASG, 2021; Sparreboom, 2014). For breeding purposes, they must inhabit areas located near an aquatic environment, such as streams, ponds, reservoirs, puddles and roadside drains to assist with larvae development. Once metamorphosed, juveniles will predominantly live on land until they reach sexual maturity (Sparreboom, 2014). Hibernation may take place on land or in the mud on the bottom of a pond. Breeding begins after hibernation and when the water temperatures begin to rise (Sparreboom, 1998). Diet: A generalist insectivore, consuming a diverse diet that includes aquatic insects, soil-dwelling invertebrates like *Collembola* and *Acari*, brine shrimp (*Artemia* species), and amphibian eggs, including their own (Mastui et al., 2003b, 2003c; Yasuda et al., 2024). They derive their red ventral colour from carotenoid pigments. Their body pigmentation is due to their diet (Matsui et al., 2003c; Mochida, 2009). Reproduction: Sexual mature is reached at approximately 3 years old (Sparreboom, 2014). Courtship can be observed from October to June with most of the breeding occurring from April to June (Kikuyama et al., 1998; Nakada et al., 2017; Yasuda et al., 2024). Males and females release pheromones to signal readiness to mate (Kikuyama et al., 1998; Nakada et al., 2017). Males tail-fan their pheromones (produced in their dorsal glands) via their cloaca to a female (Van Bocxlaer et al., 2016). This elaborate display of courtship will often vary between local populations; some males may place their hindlimbs on the scapular of the female when tail fanning, a behaviour not common in other populations (Tagami et al., 2015). Female newts are oviparous

	(reproduce by laying eggs, with the embryos developing and hatching outside the mother's body) (AnAge, 2023), with the ability to store sperm (Akiyama et al., 2011). "Eggs are laid individually and are folded in and between leaves in shallow parts of water bodies" (Sparreboom, 2014). Females can lay dozens up to hundreds of eggs, with an average clutch size of 200 (AnAge, 2023). After approximately 3 to 4 weeks, larvae hatch and undergo metamorphosis into juvenile newts within 3 to 4 months. Hybridisations between local clades have been known to take place in the wild (Tominaga et al., 2018). Japanese fire-bellied newts are vectors of disease, infection (democystid (Kawahara et al., 2022)) and virus (papilloma (Asashima et al., 1982)) transmission. **Longevity:** The maximum recorded longevity in captivity is 25 years (AnAge, 2023) with the World Life Expectancy (2025) estimating longevity between 10 to 15 years. IUCN reports that the generation length of the Japanese fire-bellied newt as 10 years (ASG, 2021). In the wild, they could live between 7 to 23 years (Marunouchi et al., 2000). **Conservation status:** **IUCN:** Near Threatened. **CITES:** Not Listed.
DATE OF ASSESSMENT: July 2025 (Aimee Carter PIRSA; Vic Greentree DPINSW; Penny Fisher DEECA; Kristen Petrov, Jess Lyons, Kristen Blazely DCCEEW) **EIC ENDORSEMENT:** 17 July 2026 **Risk assessment model used for the assessment:** Bomford 2006, Risk assessment for the establishment of exotic	**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'

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)	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).*	0.09	CMRS = 100 x (18/19,236) = 0.0935745477230193 CMRS = 0.09 Note: The species has several GBIF georeferenced occurrences from outside its natural range. However, these occurrences are presumed to be waifs or released and escaped pets rather than established populations.
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	*Species has not established an exotic population (including species not known to have been introduced anywhere).* An introduced and established population has been reported on Hachijojima Island (the Izu Islands), Japan (ISJ, 2025; Senzaki et al. 2022; Tominaga et al., 2016). However, as this population has not been established in another country as proposed by the Bomford Model (2008), it has been scored as 0.

C. Taxonomic Family Risk Score	15	*Salamandridae.*
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*	15.09	**LOW 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.*	1	*Very Low climate match to Australia.* Value X = 135 Climate Match Score = 1 Note: The species has several GBIF georeferenced occurrences from outside its natural range. However, these occurrences are presumed to be waifs or released and escaped pets rather than established populations.
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.*	2	*Exotic populations only established on small island (< 50,000 km2; Tasmania is 67,800 km^2).* An introduced and established population has been reported on Hachijojima Island (the Izu Islands), Japan (ISJ, 2025; Senzaki et al. 2022; Tominaga et al., 2016).
C. Overseas range size score (0–2) < 1 = 0; 1– 70 = 1; >70 = 2 *Estimate the species overseas range size including currently and the past 1000 years; natural and introduced range in millions of square kilometres*	0	*Overseas range is estimated to be below 1 million square kilometres.* Estimated to be 300,000 km^2.

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 ALLOCATED PEST RISK* *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.	**EXTREME**

ENVIRONMENT AND INVASIVES COMMITTEE THREAT CATEGORY	**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.

Figure 1: World distribution map (IUCN Red List); Figure 2: Climatch world distribution map indicating where meteorological data was sourced for the climate analysis and Figures 3 and 4: world Georeferenced records (GBIF):



Figure 7 - World Distribution Map - IUCN Red List

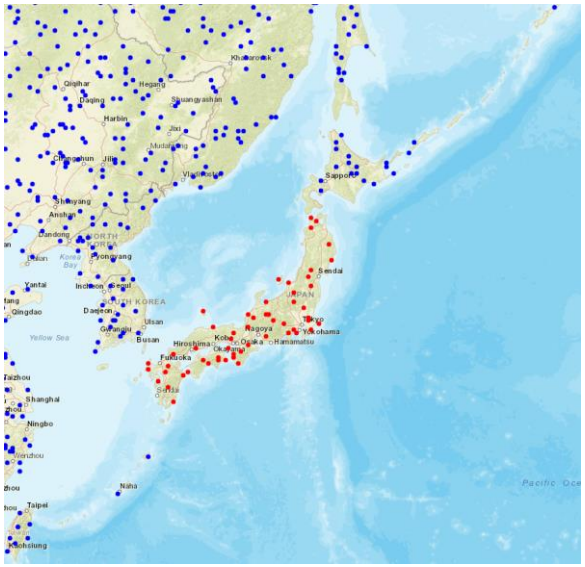


Figure 2 – World Distribution map – Climatch

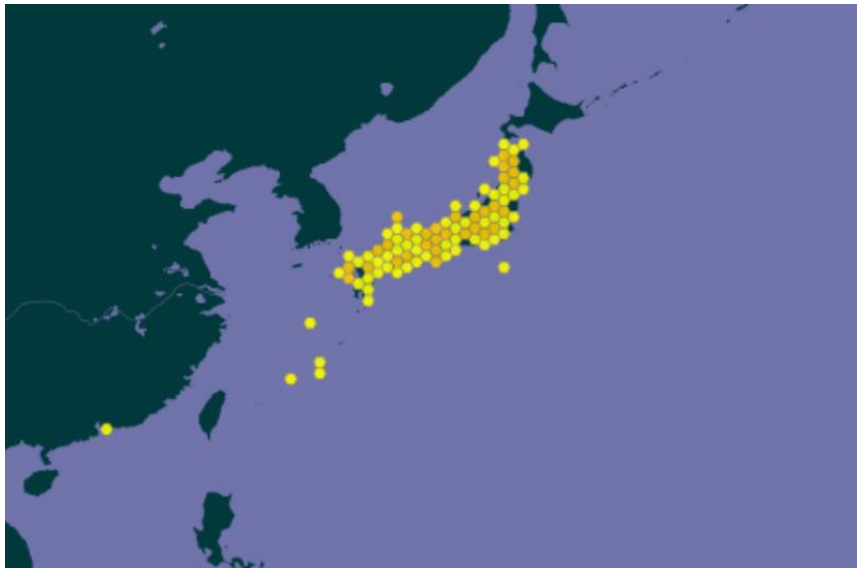


Figure 3 - World Georeferenced records (GBIF)

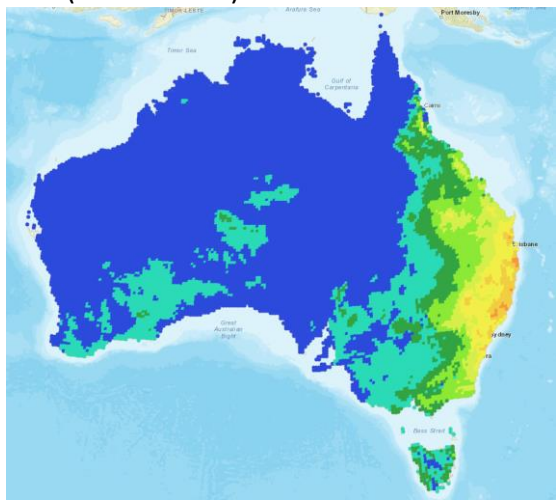


Figure 4 - World Georeferenced records (GBIF) – All referenced locations

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 *Cynops pyrrhogaster*

CMS (Sum Level 7) = 18



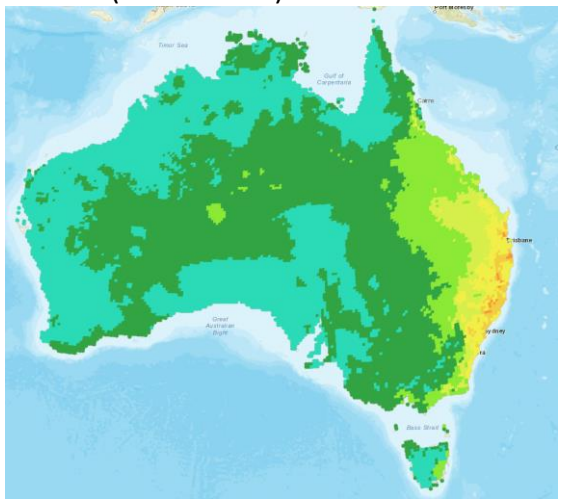
Score	Color	Count
0		13296
1		2867
2		1160
3		838
4		485
5		416
6		156
7		18
8		0
9		0
10		0

Species: Cynops pyrrhogaster (Japanese Fire-bellied Newt)
Algorithm: Euclidean
55 source features selected
19236 target features selected
Approximate selected area: 291,668 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 *Cynops pyrrhogaster*

Value X (Sum Level 6) = 135



Score	Color	Count
0		0
1		7368
2		8949
3		1723
4		673
5		388
6		117
7		18
8		0
9		0
10		0

Species: Cynops pyrrhogaster (Japanese Fire-bellied Newt)
Algorithm: Closest Standard Score
55 source features selected
19236 target features selected
Approximate selected area: 291,668 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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Reviewers:	

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DRAFT National Risk Assessment: EXTREME

RISK ASSESSMENT FOR AUSTRALIA: Corn Snake (*Pantherophis guttatus*)

Class - Reptilia, **Order** - Squamata, **Family** - Colubridae, **Genus** -*Pantherophis.*

SPECIES: *Pantherophis guttatus* (Linnaeus, 1766) **Synonyms:** *Callopeltis guttatus* (Loennberg, 1894) *Coluber carolinianus* (Shaw, 1802) *Coluber compressus* (Donndorf, 1798) *Coluber floridanus* (Harlan, 1827) *Coluber guttata sellatus* (Cope, 1888) *Coluber guttatus* (Linnaeus, 1766) *Coluber laetus* (Boulenger, 1894) *Coluber maculatus* (Bonnaterre, 1790) *Coluber molossus* (Daudin, 1803) *Coluber pantherinus* (Daudin, 1803) *Coluber rosaceus* (Cope, 1888) *Coryphodon pantherinus* (Duméril, Bibron & Duméril, 1854) *Elaphe emoryi intermontana* (Woodbury & Woodbury, 1942) *Elaphe guttata* (Linnaeus, 1766) *Elaphe guttata guttata* (Conant & Collins, 1991) *Elaphe laeta* (Burt, 1935) *Elaphis guttatus* (Duméril, Bibron & Duméril, 1854) *Pantherophis guttata* (Fitzinger, 1843)	**Species description:** Corn snakes are small to medium sized snake with a length between 61-182 centimetres. They are typically orange or brownish yellow, with large, black-edged red blotches down the centre of the back. They have alternating rows of black and white marks on their belly which can resemble a checkerboard pattern. Much variation occurs in the colour and patterns of individual snakes, often depending on its age, and region where it is found. Hatchlings are often duller than adults. The corn snake is not venomous as it generally kills its prey via constriction. The corn snake is reported as the most popular pet snake in the world (Hogrefe 2012; GISD, 2010). **General information:** The corn snake is a popular pet in both the United States of America and in Europe (Mehrtens, 1987). Distribution: Corn snakes are often found in the eastern United States from southern New Jersey south through Florida, west to Louisiana and sections of Kentucky. They are most abundant in Florida and the south-eastern United States (Hogrefe 2012). Corn snakes have been introduced throughout the Caribbean, to parts of Europe, Hawaii and some mainland US states. All known introductions are via stowaways in cargo, plants shipments and pet trade invasion pathways (Kraus, 2009; Giery, 2013). Habitat: Corn snakes can be found in diverse range of habitats including wooded groves, rocky hillsides and cliffs, meadowlands, woodlots, agricultural land, and semi urban areas. In colder regions they will hibernate in winter. Corn snakes are generally difficult to detect and will often hide under objects and can also climb trees (Hogrefe, 2012; GISD, 2010). Its name derives from their behaviour visiting the storage structures of corn which are often the breeding ground for mice and rodents.

Scotophis guttatus (Baird & Girad, 1853) *Elaphe guttata guttata* (Linnaeus, 1766) **Common Names:** Corn Snake North American corn snake American corn snake Red Cornsnake Red rat snake Emory's rat snake Great Plains Rat Snake (IUCN Redlist, IUCN-GISD, Fisher & Csurhes, 2009). Eastern Corn Snake (ITIS)	Diet: The corn snake is a generalist carnivorous predator. It feeds on a broad variety of prey such as rodents, ground nesting birds, and sometimes lizards and unguarded bird eggs. It has potential to impact a variety of native species (GISD, 2010). Reproduction: The corn snake is ovoviviparous, and sexual maturity is reached between 18-36 months (Hogrefe, 2012). Mating occurs from March to May with a gestation period between 60-65 days. 10-30 eggs are laid from late May to July in locations with sufficient warmth and humidity to incubate them (i.e., rotting stumps, decaying matter). ISSG's Global Invasive Species Database (GISD, 2010) notes that the corn snake is a potential host for alien pests and diseases that could threaten other animals. An example given by Csurhes & Fisher (2009/16) is the reptile tick spread bacterium that causes Heartwater disease (*Ehrlichia ruminantium*), which can result in the death of grazing animals. The corn snake is also known as a vector of cryptosporidium (a parasite that can cause gastroenteritis in infected animals and humans) (Xioa *et al*., 2004; in Csurhes & Fisher, 2009/16). **Longevity:** The average life span for the corn snake is 10 years, although one was documented to be 21 years old (Kaplan, 1994; Ernst and Ernst, 2003). In the wild, life expectancy can exceed 20 years (de Magalhaes & Costa, 2009). The record longevity for the corn snake in captivity is 32.3 years (HAGR Human Ageing Genomic Resources, 2006). **Conservation status:** **IUCN:** Least Concern. Rationale: Listed as 'Least Concern' on the IUCN Red List of Threatened Species, in view of the large extent of occurrence, area of occupancy, number of subpopulations, and population size, and because the species is probably not declining fast enough to warrant listing in any of the threatened categories (Echternacht & Hammerson, 2016). Adult population size is unknown but presumably exceeds 10,000 and probably exceeds 100,000 (NatureServe, 2008). **CITES:** Not Listed
DATE OF ASSESSMENT: February 2024	**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,

(Jodi Buchecker) **EIC ENDORSEMENT:** 17 July 2026 **Risk assessment model used for the assessment:** Bomford 2006, Reptiles Bomford 2008, Bird and Mammal Model for Reptiles and Amphibians	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/.

Reptile Model (2006):

FACTOR	SCORE	DETAIL
STAGE A: RISKS POSED BY CAPTIVE OR RELEASED ANIMALS		
D. 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).*	37.82	CMRS = 100 x (7,276/19,236) = 37.82 Note: The species has many GBIF georeferenced occurrences from outside its natural range. Whilst most of these occurrences are presumed to be waifs rather than established populations, Climatch modelling has been expanded to capture areas of most densely reported occurrence.

E. 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	*Self-sustaining exotic populations established on several islands.* Considered as naturalised on the Grand Cayman Island, West Indies. It is thought the species was probably introduced from Miami, Florida, around 1985 (Schwartz and Henderson, 1991; Lever, 2006; Hammerson, 2007; NatureServe, 2008). Specimens have been collected from Saint Thomas, the Virgin Islands, United States of America. Evidence suggests they may have arrived in cargo containers originating from Florida. Repeated sightings, as well as the capture of juveniles at the site, suggest a population in the process of establishing. This is a first documented record for this part of the Caribbean (Perry et al., 2003; Hammerson, 2007; NatureServe, 2008). Introduced to Grand Bahama Island, Bahamas with the arrival date uncertain (Hayes et al., 2004; Hammerson, 2007; NatureServe, 2008). From IUCN: "Introduced populations have been recorded on several islands of the Caribbean, with established introduced populations in the Bahamas (New Providence and Grand Bahama), Grand Cayman (Cayman Islands), the United States of America, Virgin Islands (Saint Thomas), and the Lesser Antilles (Saint Barthélemy; and Guana Cay of Pelikan, a satellite of Sint Maarten) (Buckner and Franz, 1994; Henderson and Powell, 2009; Perry et al., 2003; Powell and Henderson, 2012; Seidel and Franz, 1994; R. Powell pers. comm., 2016). It is unknown whether all these introduced populations are extant (R. Powell pers. comm., 2016), although it is still (uncommonly) recorded on Grand Cayman, Cayman Islands. Isolated records, presumed to be waifs rather than established populations, are known from multiple additional islands within most of these island groups and from Grand Turk in Turks and Caicos Islands (R. Powell pers. comm., 2016)."
F. Taxonomic Family Risk Score	10	*Colubridae*

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*	77.82	**SERIOUS 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 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 = 8,843 Climate Match Score = 4 Note: The species has many GBIF georeferenced occurrences from outside its natural range. Whilst most of these occurrences are presumed to be waifs rather than established populations, Climatch modelling has been expanded to capture areas of most densely reported occurrence.
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.*	2	*Exotic population only established on small islands less than 50,000 km^2.* Considered as naturalised on the Grand Cayman Island, West Indies. It is thought the species was probably introduced from Miami, Florida, around 1985 (Schwartz and Henderson, 1991; Lever, 2006; Hammerson, 2007; NatureServe, 2008). Specimens have been collected from Saint Thomas, the Virgin Islands, United States of America. Evidence suggests they may have arrived in cargo containers originating from Florida. Repeated sightings, as well as the capture of juveniles at the site, suggest a population in the process of establishing. This is a first documented record for this part of the Caribbean (Perry et al., 2003; Hammerson, 2007; NatureServe, 2008).

		Introduced to Grand Bahama Island, Bahamas with the arrival date uncertain (Hayes et al., 2004; Hammerson, 2007; NatureServe, 2008). From IUCN: "Introduced populations have been recorded on several islands of the Caribbean, with established introduced populations in the Bahamas (New Providence and Grand Bahama), Grand Cayman (Cayman Islands), the United States of America, Virgin Islands (Saint Thomas), and the Lesser Antilles (Saint Barthélemy; and Guana Cay of Pelikan, a satellite of Sint Maarten) (Buckner and Franz, 1994; Henderson and Powell, 2009; Perry et al., 2003; Powell and Henderson, 2012; Seidel and Franz, 1994; R. Powell pers. comm., 2016). It is unknown whether all these introduced populations are extant (R. Powell pers. comm., 2016), although it is still (uncommonly) recorded on Grand Cayman, Cayman Islands. Isolated records, presumed to be waifs rather than established populations, are known from multiple additional islands within most of these island groups and from Grand Turk in Turks and Caicos Islands (R. Powell pers. comm., 2016)."
C. 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 kilometres squared.* Overseas natural range size is estimated at 2.7 million km^2. The species also has many georeferenced occurrences recorded around the world. The Climatch modelling has therefore been expanded to incorporate areas most dense reported occurrence. The natural distribution extends from New Jersey to Delaware, Maryland, Virginia, southern Tennessee, North and South Carolina, Georgia, Florida, Alabama, Mississippi, southeastern Louisiana in the United States of America. Isolated populations occur in Kentucky, southern Arkansas, northwestern Louisiana, and southeastern Texas, United States of America (Thompson, 1982; Schwartz and Henderson, 1991; Kaplan, 1994; Vaughan et al., 1996; Hudson, 1998; Sontag, 1998; Williams, 1998; Ernst and Ernst, 2003; Van Dyke and Grace, 2005; Florida Museum of Natural History, 2006; Lever, 2006; Jackson and Lee, 2007; NatureServe, 2008; Woodland Park Zoo, 2008).

		The species occurs from sea level to around 1,800 metres in elevation (Ernst and Ernst, 2003; Virginia Department of Game and Inland Fisheries, 2008; Woodland Park Zoo, 2008). Introduced populations occur on Grand Cayman Island (Cayman Islands), Saint Thomas Island (Virgin Islands, United States of America), and Grand Bahama Island (Bahamas) (see B2 for details). From IUCN: "This species is endemic to the eastern and south-eastern United States. Its range extends from southern New Jersey, Maryland, and Kentucky southward to south-eastern Louisiana, southern Mississippi, southern Alabama, and southern Florida (Conant and Collins, 1991; Burbrink, 2002)".
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*	7	**MODERATE 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), resulting in the Assignment of species into one of two EIC Threat Categories: Extreme or Serious.	**EXTREME*** *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 world distribution map indicating where meteorological data was sourced for the climate analysis:



Figure 8 - World Distribution Map - IUCN Red List

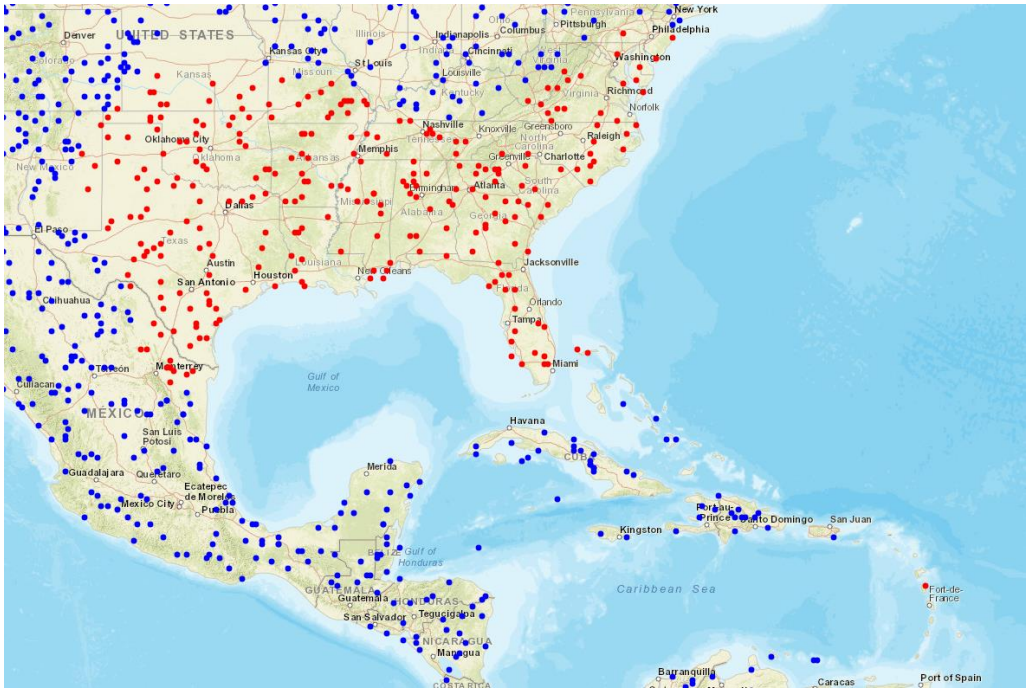


Figure 2 - World Distribution Map – Climatch



Figure 3 - World Georeferenced records (GBIF) – All referenced locations

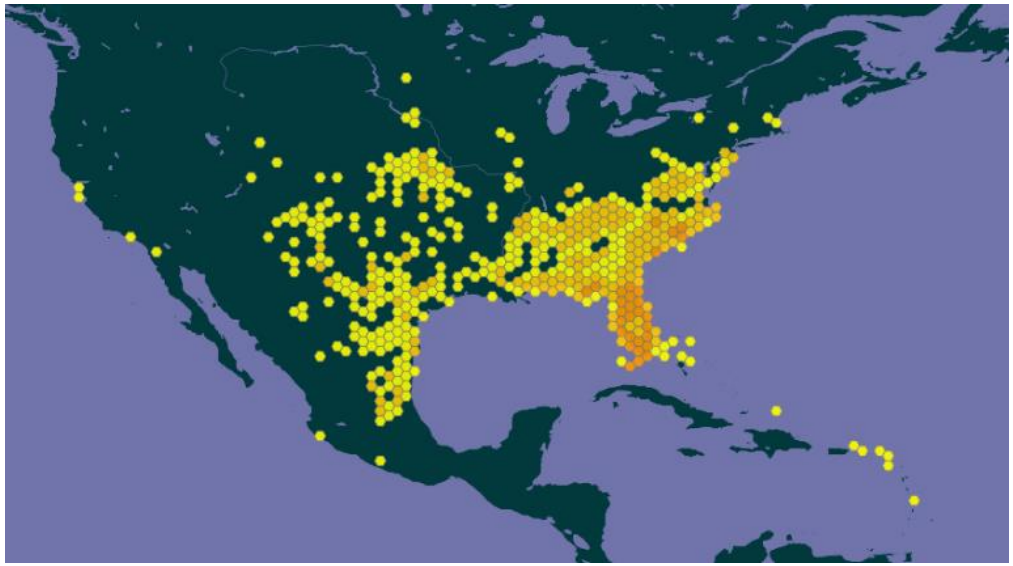
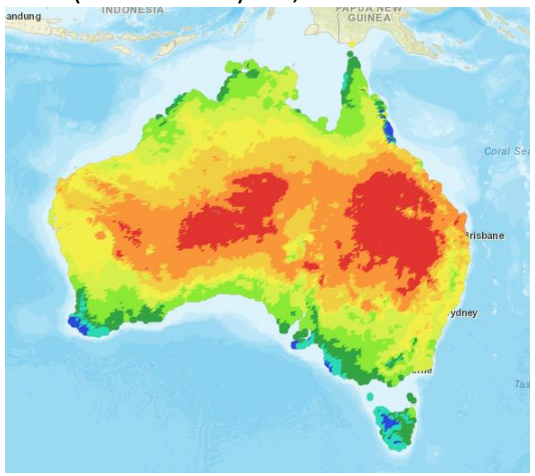


Figure 4 - – World Georeferenced records (GBIF) – United States of America

Reptile model (2006): Climate match between world distribution of species and Australia:

Areas of Australia where the climate appears suitable for *Pantherophis guttatus*

CMS (Sum Level 7) = 7,276



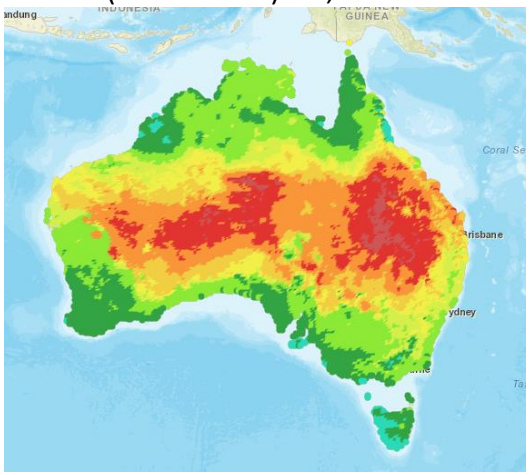
Score	Color	Count
0		76
1		216
2		650
3		2054
4		2759
5		2907
6		3298
7		4425
8		2840
9		11
10		0

Species: Pantherophis guttatus (Corn Snake)
Algorithm: Euclidean
278 source features selected
19236 target features selected
Approximate selected area: 2,638,924 km^2

Bird and Mammal model: Climate match between world distribution of species and Australia:

Areas of Australia where the climate appears suitable for *Pantherophis guttatus*

Value X (Sum Level 6) = 8,843



Score	Color	Count
0		0
1		177
2		2546
3		4340
4		1525
5		1805
6		2259
7		3628
8		2581
9		375
10		0

Species: Pantherophis guttatus (Corn Snake)
Algorithm: Closest Standard Score
278 source features selected
19236 target features selected
Approximate selected area: 2,638,924 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**		

Risk Assessor's details:

Risk Assessor's name:	Jodi Buchecker
Business address and contact details:	PIRSA jodi.buchecker@sa.gov.au
Date:	Feb 2024
Reviewers:	Catriona Dowd (DCCEEW) Victoria Greentree (NSW DPI)

Adapted from:	Dept of Agriculture and Fisheries Biosecurity Queensland, Invasive animal risk assessment for American corn snake (Csurhes and Fisher 2009, updated 2016) Corn Snake (*Elaphe guttata*) risk assessment for Australia. Amanda Page, Win Kirkpatrick and Marion Massam, March 2008, Department of Agriculture and Food, Western Australia.	**By:** Jodi Buchecker	**Date:** Feb 2024

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DRAFT National Risk Assessment: EXTREME

RISK ASSESSMENT FOR AUSTRALIA: Mainland leopard cat (*Prionailurus bengalensis*)

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

SPECIES: *Prionailurus bengalensis* (Kerr, 1792) **Synonyms:** *Felis bengalensis* (Kerr, 1792) *Felis euptilura* (Elliot, 1871) *Prionailurus bengalensis alleni* (Sody, 1949) *Prionailurus bengalensis horsfieldii* (Gray, 1842) *Prionailurus bengalensis chinensis* (Gray, 1837) *Prionailurus bengalensis trevelyani* (Pocock, 1939) *Prionailurus bengalensis iriomotensis* (Imaizumi, 1967) – Iriomote cat <u>Invalid Subspecies (Sunda)</u> *Prionailurus bengalensis borneoensis* (Brongersma, 1936)	**Species description:** The Mainland Mainland leopard cat has one of the widest global distributions of all smaller Southeast Asian cats (Coudrat et al. 2014; Rabinowitz 1990). Head to body length is between 39 to 75 centimetres, with a height of approximately 41 centimetres (ISEC Canada 2018; IUCN CatSG 2025; Sunquist and Sunquist 2014). Depending on regional locality, its weight ranges from 1.6 to 8 kilograms (IUCN CatSG 2025). Males tend to be larger and heavier than females. Tail length is about 40 to 50 percent as long as head and body measuring between 17 to 31 centimetres (IUCN CatSG 2025; Sunquist and Sunquist 2002). Roughly the size of a domestic cat, however, the Mainland leopard cat has longer legs and a shorter tail (Roberts 1977). Coat colouration, length and pattern are highly variable across its broad geographic range. Generally, northern populations (colder regions) tend to have paler (silvery grey), thicker fur and larger bodies, putting on weight before winter and becoming thinner by spring, whereas southern populations have shorter, darker fur (ochre-yellow or brownish) and are smaller in size (Sunquist and Sunquist 2002). The population on Iriomote Island in Japan generally have longer hair and a dusky brown coat with horizontal rows of spots forming subtle bands. Some Mainland leopard cats may be melanistic which “occurs as a common polymorphism and is a development of dark coloured pigment in skin” (Das et al. 2012). Black markings cover most of the body and limbs and vary considerably in shape and size between individuals and regional populations. These markings can appear as small solid spots, large rosettes, elongate splotches, or coalescing streaks. Often, these markings will converge into one or multiple stripes along the length of the body with one or two distinct longitudinal stripes on the shoulders and back of neck. The underparts are typically creamy-white and may have scattered or densely patterned black spots. The tail is heavily spotted and often features a few indistinct rings near its black tip (IUCN CatSG 2025; Sunquist and Sunquist 2002; Nowak 2005). It has a small head, short narrow muzzle and moderately long rounded ears (Seidensticker and Lumpkin 1991; Nowak 2005). The backs of the ears are black with a bright central white spot and there are four longitudinal bands running from the forehead to the neck. “The head is marked with two prominent dark stripes that extend from the inner corner of each eye to the base of the ear; two or three less distinct stripes also occur on the crow” (Sunquist and Sunquist

Prionailurus bengalensis heaneyi (Groves, 1997) *Prionailurus bengalensis javanensis* (Desmarest, 1816) *Prionailurus bengalensis rabori* (Groves, 1997) *Prionailurus bengalensis sumatranus* (Horsfield, 1821) **Subspecies:** *Prionailurus bengalensis bengalensis* (Kerr, 1792) *Prionailurus bengalensis euptilurus* (Elliot, 1871) **Common Names:** Mainland leopard cat Common mainland leopard cat Asian Mainland leopard cat Mainland leopard cat *Prionailurus bengalensis bengalensis* (Kerr, 1792) Bengal Mainland leopard cat	2002). There are also white streaks from the eyes to the nose, and white cheek patches bordered by black lines. A black bar across the throat is occasionally present. Eye colouration varies from deep golden-brown or grey, and the eyes are often surrounded by dark patches or streaks. The naked rhinarium (nose pad) is typically reddish-brown, and the vibrissae (whiskers) are long and white (Francis 2001, 2008; IUCN CatSG 2025; Nowak 2005; Roberts 1977; Sunquist and Sunquist 2002, 2014; Thai National Parks n.d.). Males may have a larger skull and longer hind foot compared to females (Sicuro and Oliveira 2015). An excellent swimmer, there is well-defined webbing between their toes (Sunquist 2014) enabling Mainland leopard cats to successfully colonise offshore islands (Francis 2008; IUCN CatSG 2025). Due to its small foot size, Mainland leopard cats will avoid areas with dense amounts of snow (particularly above 10 centimetres) (Sunquist and Sunquist 2014). Previously consisting of 12 distinct subspecies, morphological and genetic research by Patel et al. (2017), with further analysis by Kitchener et al. (2017) resulted in the split of *Prionailurus bengalensis* into two distinct species: *Prionailurus bengalensis* (Mainland leopard cat) and *Prionailurus javanensis* (Sunda Mainland leopard cat). From numerous previously described subspecies on the mainland, only two are tentatively recognised based on genetic studies. The 2 recognised subspecies of Mainland leopard cat (*P. bengalensis*) are (IUCN CatSG 2025; Kitchener et al. 2017; Patel et al. 2017): ***P. b. bengalensis*** and ***P. b. euptilurus*** Agile and arboreal (Rabinowitz 1990; Roberts 1977; Sunquist and Sunquist 2014), the Mainland leopard cat is primarily nocturnal with crepuscular (also known as twilight), and some daytime activity recorded (Gumal et al. 2014; McCann and Pawlowski 2020; Zaw et al. 2014). During periods of inactivity, Mainland leopard cats will rest in dense vegetation or undergrowth (Rabinowitz 1990). **General information:** Distribution: The Mainland leopard cat has an extensive distribution ranging from the Russian Far East in the north to Singapore in the south. Its native range includes Afghanistan, Bangladesh, Bhutan, Cambodia, China, Hong Kong, India, Japan (islands of Tshushima and Iriomote), Democratic People's Republic of Korea, Republic of Korea, Lao People's Democratic Republic, Myanmar, Nepal, Pakistan, Russian Federation, Singapore, Taiwan (Republic of China), Thailand and Vietnam (CITES 2025; Ghimirey et al. 2023; Species+ 2025). Its presence is uncertain in Macao, SAR (Ghimirey et al. 2023; Species+ 2025) and it became extinct on Jeju Island between 1930 and 1940 (Jo et al. 2012). The 2 subspecies have different distributions:

	P. b. bengalensis: in South and Southeast Asia occurring from Pakistan to China and probably inhabiting the Malay Peninsula (Kitchener et al. 2017). Localities including Afghanistan, Bangladesh, Cambodia, southern China, India, Lao People's Democratic Republic, Myanmar, Pakistan, Nepal, Bhutan, Thailand, Singapore, and Vietnam (CITES 2025; Patel et al. 2017). ***P. b. euptilurus:*** existing in northeast China (Patel et al. 2017), Russian Far East, Taiwan, Iriomote Island, Tsushima Island (Kitchener et al. 2017) and the Korean Peninsula (Kim et al. 2021). Habitat: A habitat generalist, the Mainland leopard cat is known to be versatile and easily adaptable to a diverse spectrum of habitats and partially human-modified areas, so long as there is an abundance of food (Gray et al. 2014; Shanida et al. 2023; Tenzin et al. 2019). It is commonly found throughout the warmer tropical forests of Southeast Asia all the way to China and Korea (IUCN CatSG 2025). With a preference for evergreen and semi-evergreen forests (Ghimirey et al. 2014; McCann and Pawlowski 2020), the Mainland leopard cat is recorded from sea level to a maximum recorded elevation of 4,474 metres (Thapa et al. 2013). The Mainland leopard cat also inhabits deciduous forests (McCann and Pawlowski 2020), secondary and degraded habitats including agricultural landscapes and plantations (Willcox et al. 2014), shrubland, successional grassland (Ghimirey et al. 2023; IUCN CatSG 2025; Poudyal et al. 2019), mountainous areas (Kim et al. 2021) and lowland riparian habitats (Lee et al. 2015). It prefers low to medium tree canopies and low tree density whilst also requiring plant and shrub coverage for shelter, breeding and to assist with hunting (Shanida et al. 2023; Wu et al. 2020). The Mainland leopard cat is positively influenced by annual precipitation with a preference to be near wetlands and agricultural wetlands (Choi et al. 2012 cited in Kim et al. 2021; Ghimirey et al. 2023; Poudyal et al. 2019; Shanida et al. 2023; Srivathsa et al. 2015). Diet: The Mainland leopard cat is carnivorous. Diet includes small mammals (especially rodents), birds, amphibians, insects and fish (Chua et al. 2016; Poudyal et al. 2019; Seryodkin, and Burkovskiy 2019). It will also feed on snakes, crabs and carrion with plant matter also recorded in scat analysis (Shanida et al. 2023; Lee et al. 2014). A terrestrial ambush predator (Chau et al. 2016; Shandia et al. 2023), they rely on the underbrush and vegetation for the abundance of prey (Giseburt 2023). However, they will also hunt in trees (ISEC Canada 2018). Reproduction: Reproduction varies across the distribution. In its northern range, breeding is reported to take place once a year between February and March whereas in the tropics breeding can occur year-round (IUCN CatSG 2025). Sexual maturity is reached at 18 months but can be as young as 8 months in captivity (IUCN CatSG 2025). After a gestation period between 56–70 days, females give birth to 1 to 4 kittens per litter (usually 2 to 3) (IUCN CatSG 2025; Roberts 1977). Using shrubs for breeding and shelter (Shanida et al. 2023), young are often born in a hollow tree, rocky crevice or

	burrow (ISEC Canada 2018). The father may participate in rearing the young (Frese 1980; Nowak 2005) and the cubs will open their eyes at 10 to 15 days (Acharjyo and Mishra 1980). Mainland leopard cats are primarily solitary but have been observed in pairs or with dependent young. They can be aggressive to breeding partners in captivity (Giseburt 2023). The Bengal cat is a cross between a male domestic cat (*Felis catus*) and female Mainland leopard cat and is a popular pet across the world (Thai National Parks n.d.; Sunquist and Sunquist 2014). **Longevity:** The maximum recorded longevity for this species in captivity is 17 years (AnAge 2023). The IUCN reports that the generation length for the Mainland leopard cat is 6.44 years (Ghimirey et al. 2023). **Conservation status:** **IUCN:** Least Concern **CITES:** Appendix I - ***P. b. bengalensis:*** Only the populations of Bangladesh, India and Thailand; all other populations are included in Appendix II. Appendix II - ***P. b. bengalensis:*** All other populations, except the populations of Bangladesh, India and Thailand, which are included in Appendix I.
DATE OF ORIGINAL ASSESSMENT: September 2025 Aimee Carter, PIRSA **Reviewer:** Win Kirkpatrick, DPIRD **Risk assessment model used for the assessment:**	**The risk assessment model:** Models for assessing the risk that exotic vertebrates could establish in Australia have been developed for mammals, birds (Bomford 2003, 2006, 2008), reptiles and amphibians (Bomford et al 2005, Bomford 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.

Bomford 2008, Bird and Mammal Model	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/.

The Australian Bird and Mammal Model:

FACTOR	SCORE	DETAIL
STAGE A: RISKS POSED BY CAPTIVE OR RELEASED ANIMALS		
A1. Risk to people from individual escapees (0–2) *Assess the risk that individuals of the species could harm people. (NB, this question only relates to aggressive behaviour shown by escaped or released individual animals. Question C11 addresses the risk of harm from aggressive behaviour if the species establishes a wild population).* *Aggressive behaviour, size, plus the possession of organs capable of inflicting harm, such as sharp teeth, claws, spines, a sharp bill, or toxin-delivering apparatus may enable individual animals to harm people. Any known history of the species attacking, injuring or killing people should also be taken into account. Assume the individual is not protecting nest or young.*	1	*Animal that is unlikely to make an unprovoked attack, but which can cause serious injury (requiring hospitalisation) or fatality if cornered or handled.* Mainland leopard cats are shy and elusive, typically fleeing humans (Miller 2011) and avoiding areas of dense human populations for habitation (Shanida et al. 2023). However, due to their sharp teeth and claws, any close contact, handling, or cornering could result in serious injury.
A2. Risk to public safety from individual captive animals (0–2) *Assess the risk that irresponsible use of products obtained from captive individuals of the species (such as toxins) pose a public safety risk (excluding the safety of anyone entering the animals' cage/enclosure or otherwise coming within reach of the captive animals)*	0	*Nil or low risk (highly unlikely or not possible).*

STAGE A PUBLIC SAFETY RISK SCORE **SUM A1 - A2 (0-4)**	1	**MODERATELY 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 = 10,565 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.*
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.* Approximately 9,586,078 km^2. Note: The species has many GBIF (Figure 3) georeferenced occurrences which are not included in the IUCN map (Figure 1). The populations established throughout Java, Bali, Borneo, Sumatra, Palawan, Panay, Philippines and possibly Malay Peninsula (IUCN CatSG 2025) are presumed to be the Sunda Mainland leopard cat (*Prionailurus javanensis*) and have therefore not been included in the Climatch statistics.
B4. Taxonomic Class (0–1) *Bird = 0; mammal = 1*	1	*Mammal*

B. ESTABLISHMENT RISK SCORE **SUM OF B1- B4 (1–13)**	6	**MODERATE establishment risk**
Model 2: SEVEN-FACTOR MODEL FOR BIRDS AND MAMMALS (Bomford 2008)		
B5. Diet score (0–1) *Specialist = 0; generalist = 1*	1	*Generalist with a broad diet of many food types.*
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.* Tolerant of human modified landscapes, such as plantations or areas adjoining agriculture and can survive in fragmented habitats (Willcox et al. 2014; WU et al. 2020). Repeatedly seen through camera trap analysis along roads (Srivathsa et al. 2015; Selvan et al. 2014), through scat analysis (Chua et al. 2016) and road kills. Found within and outside protected areas (Tenzin et al. 2019). Due to the high presence of murids, Mainland leopard cats are often seen transversing through tea, oil palm (Chua et al. 2016), coffee (Jathanna et al. 2020; Srivathsa et al. 2015) and cardamom (Ghimirey et al. 2012) plantations as well as rice fields (Shanida et al. 2023). They have been reported to encroach close to human residences (Willcox et al. 2017), however their preference is for undisturbed habitats due to their elusive nature.
B7. Migratory score (0–1) *Always migratory = 0; non-migratory = 1*	1	*Non-migratory.* The Mainland leopard cat is not a migrant (Ghimirey et al. 2023).
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 (Carnivora) = 2.*
C2. Overseas range size including current and past 1000 years, natural and introduced range (0–2) *Estimate the species overseas range size (including current and past 1000 years, natural and introduced range) in millions of square kilometres*	0	*Overseas geographic range less than 10 million square kilometres.* Approximately 9,586,078 km^2. Note: The species has many GBIF (Figure 3) georeferenced occurrences which are not included in the IUCN map (Figure 1). The populations established throughout Java, Bali, Borneo, Sumatra, Palawan, Negros, Cebu, Panay, Philippines and possibly Malay Peninsula (IUCN CatSG 2025) are presumed to be the Sunda Mainland leopard cat (*Prionailurus javanensis*) and have therefore not been included in the Climatch statistics.
C3. Diet and feeding (0–3)	3	*Mammal that is a strict carnivore (eats only animal matter) and arboreal (climbs trees for any reason).* Scat analysis found 14 prey species including larger animals (*Sus scrofa*, wild boar) that may have been through scavenging (Rabinowtiz 1990).
C4. Competition with native fauna for tree hollows (0–2)	2	*Can nest or shelter in tree hollows.* Mainland leopard cats are reported to use tree hollows, small caves, crevices and rocks to take shelter, den and breed in (Nowak 2005; Rabinowtiz 1990; Roberts 1977).
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.* Lives in sympatry with multiple species. No degradation reported with the Mainland leopard cat living within the giant panda (*Ailuropoda melanoleuca*) range (Li et al. 2010). Degree of overlap with the marbled cat (*Pardofelis marmorata*) was low and coexisting (Mukherjee et al. 2019).
C6. Climate match to areas with susceptible native species or communities (0–5)	5	*The species has more than 692 grid squares within the highest four climate match classes, that overlap the distribution of any susceptible native species or*

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.		*ecological communities.* Examples of susceptible native species or ecological communities (DCCEEW Protected Matters Search Tool) include: *Pezoporus occidentalis* (Night Parrot) – Critically Endangered *Lathamus discolor* (Swift Parrot) – Critically Endangered *Rostratula australis* (Australian Painted Snipe) – Critically Endangered *Dasyurus hallucatus* (Northern Quoll) – Endangered *Mesembriomys gouldii gouldii* (Black-footed tree-rat) – Endangered *Zyzomys palatalis* (Carpentarian rock-rat) – Endangered These species will be affected through predation, habitat threats and competition for resources.
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 Mainland leopard cat is regularly reported as causing livestock degradation and being a livestock pest (Amin et al. 2018; Himalayan Nature 2018). As a poultry thief, the species is often poisoned (Giseburt 2023; Mowbray 2023; Wang 1998 & Wange and Xie 2004 cited in Lau et al. 2010).
C8. Climate match to susceptible primary production (0–5) *Assess Potential Commodity Impact Scores for each primary production commodity listed in Table 9, based on species' attributes (diet, behaviour, ecology), excluding risk of spreading disease which is addressed in Question C9.* *0 = 0; 1-19 = 1; 20-49 = 2; 50-99 = 3; 100-149 = 4; ≥150 = 5*	2	Total Commodity Damage Score = 35 (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).* In the wild, Mainland leopard cats were reported to have unidentified parasitic round worms about 35 millimetres (Roberts 1977), canine distemper (IFAW 2023),

		as well as contracting feline immunodeficiency virus (FIV) infection from domestic cats (Hayama et al. 2010). Both FIV and round worms are found in Australia. 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 - $10 million.* Although they tend to avoid human habitations, Mainland leopard cats are often involved in vehicle collisions potentially causing vehicle damage (Mugerwa et al. 2020). Mainland leopard cats will also mark their territory with faeces polluting the areas they inhabit (Chung and Lee 2022).
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.* Mainland leopard cats are shy and elusive, typically fleeing humans (Miller 2011) and avoiding areas of dense human populations for habitation (Shanida et al. 2023). However, due to their sharp teeth and claws, any close contact, handling, or cornering could result in serious injury.
C. PEST RISK SCORE SUM C 1 TO C 11 (1–37)	20	**EXTREME pest risk**
STAGE A. PUBLIC SAFETY RISK RANK – RISK TO PUBLIC SAFETY POSED BY CAPTIVE OR RELEASED INDIVIDUALS *0 = Not dangerous; 1 = Moderately dangerous; ≥ 2 = Highly dangerous*	1	MODERATELY dangerous

STAGE B. ESTABLISHMENT RISK RANK – RISK OF ESTABLISHING A WILD POPULATION **MODEL 1: FOUR-FACTOR MODEL FOR BIRDS AND MAMMALS (BOMFORD 2008)** *≤ 5 = low establishment risk; 6-8 = moderate establishment risk; 9-10 = serious establishment risk; ≥ 11-13 = extreme establishment risk*	6	MODERATE establishment risk
STAGE B. ESTABLISHMENT RISK RANK – RISK OF ESTABLISHING A WILD POPULATION **MODEL 2: SEVEN-FACTOR MODEL FOR BIRDS AND MAMMALS (BOMFORD 2008)** *≤ 6 = low establishment risk; 7-11 = moderate establishment risk; 12-13 = serious establishment risk; ≥14 = extreme establishment risk*	9	MODERATE establishment risk
STAGE C. PEST RISK RANK - RISK OF BECOMING A PEST FOLLOWING ESTABLISHMENT *< 9 = low pest risk; 9-14 = moderate pest risk; 15-19 = serious pest risk; > 19 = extreme pest risk*	20	EXTREME pest risk

ENVIRONMENT AND INVASIVES COMMITTEE THREAT CATEGORY	**EXTREME**

Figure 1: World distribution map (IUCN Red List), Figure 3: GBIF reporting map and Figure 4: Climatch world distribution map indicating where meteorological data was sourced for the climate analysis (see B1):

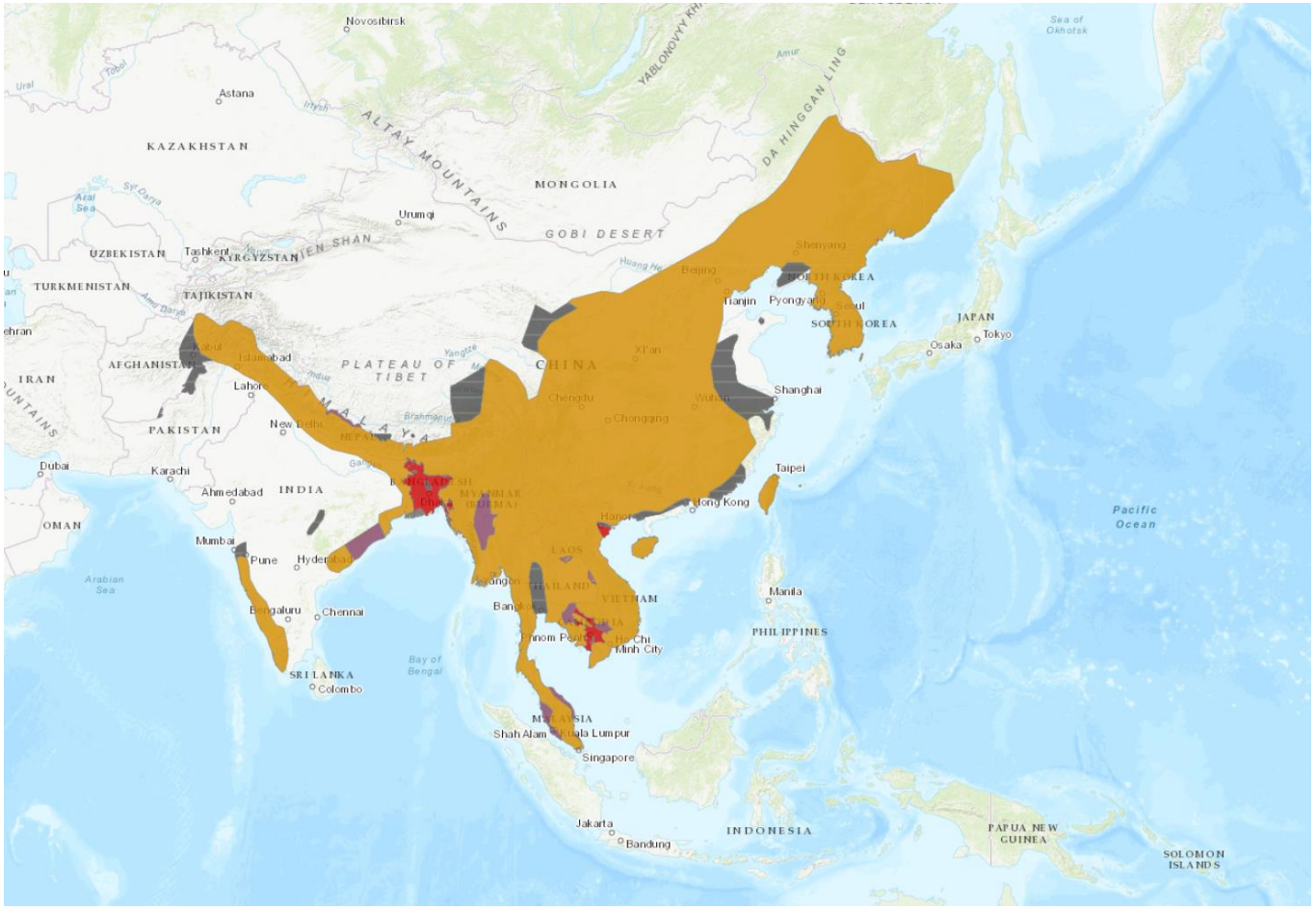


Figure 9- World Distribution Map - IUCN Red List

Figure 2 – IUCN Red List Map Key

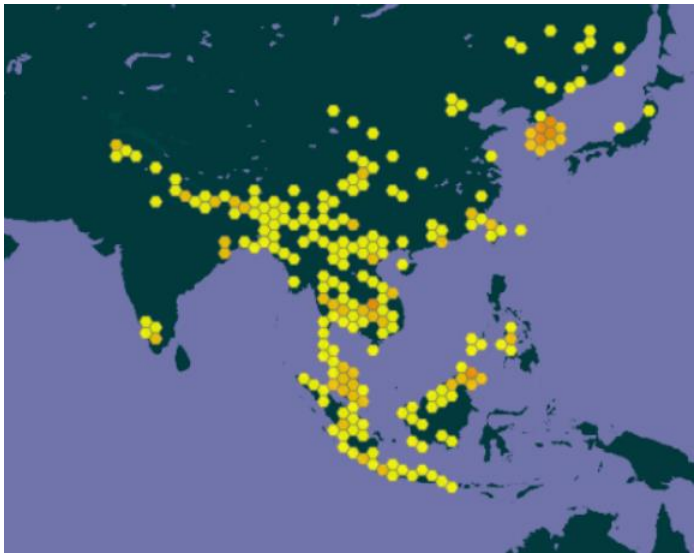


Figure 3 - World Georeferenced records (GBIF)

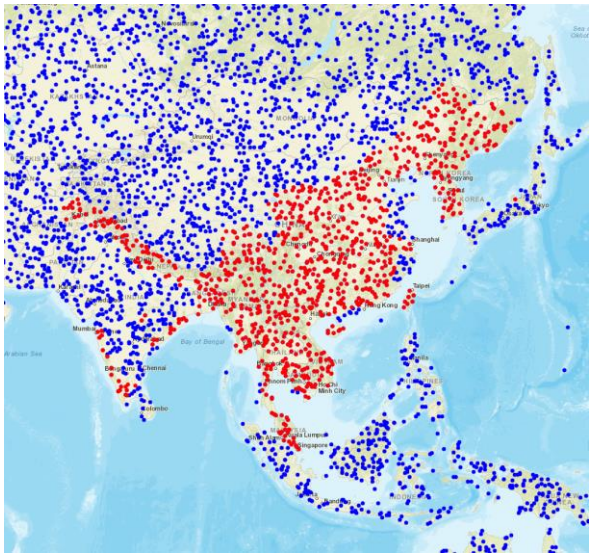
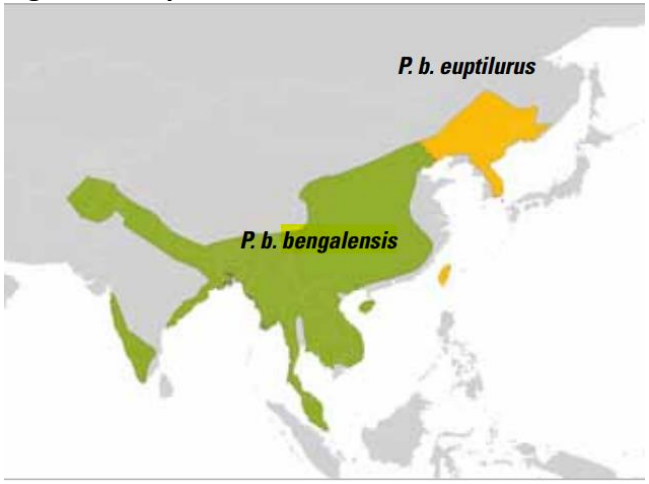


Figure 4 – World Distribution map – Climatch

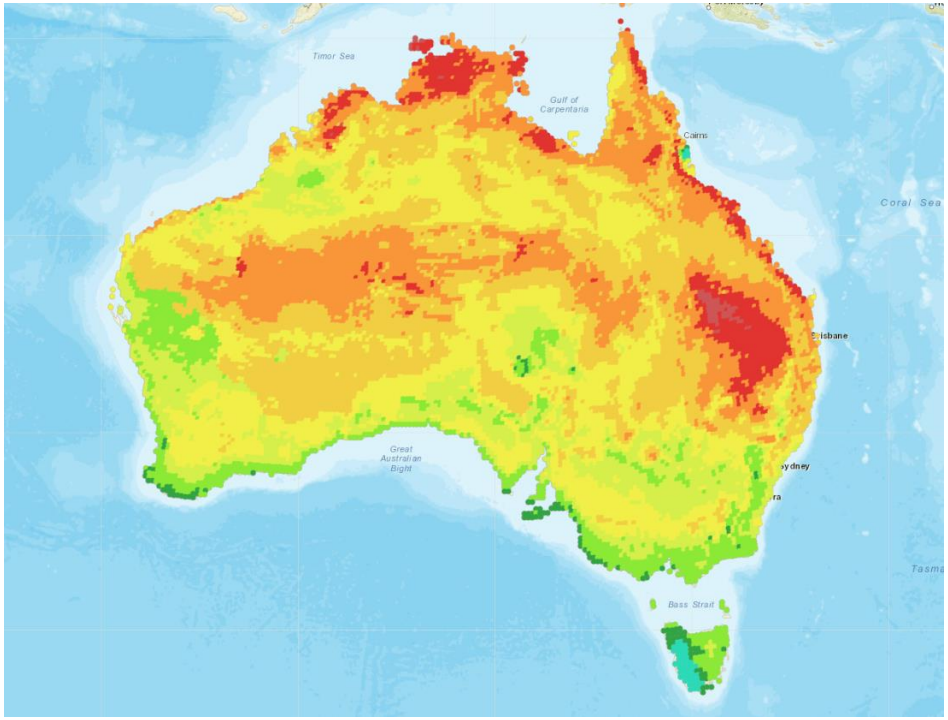
Figure 5: As per Kitchener et al. 2017, distribution of the 2 subspecies of Mainland leopard cat within the species distribution.



Distribution of tentative subspecies of the mainland leopard cat
Borders between subspecies are speculative.

Figure 5 – Mainland leopard cat distribution (Kitchener et al. 2017)

Figure 6: Climate match between world distribution of species and Australia:
Areas of Australia where the climate appears suitable for *Prionailurus bengalensis*
Value X = 10,565



Score	Color	Count
0		0
1		51
2		130
3		1215
4		2306
5		4969
6		5932
7		3566
8		991
9		76
10		0

Species: Prionailurus bengalensis (Mainland Leopard Cat)
Algorithm: Closest Standard Score
1000 source features selected
19236 target features selected
Approximate selected area: 9,586,078 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			
Sheep (includes wool and sheep meat)	5			
Fruit and nuts (includes wine grapes)	5			
Vegetables	3			
Poultry and eggs	3	2	5	30
Fisheries products	2	1	2	4
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			
Other livestock (includes goats, deer, camels, rabbits)	0.1	2	5	1
Bees (includes honey and beeswax)	0.1			
Total Commodity Damage Score (TCDS)				35

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:

8. *Nil (species does not have attributes to make it capable of damaging this commodity)*
9. *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*
10. *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)*
11. *Extreme (damage occurs at high levels to this or similar commodities and/or major control programs have been conducted against the species in any country or region and the listed commodity would be vulnerable to the type of harm this species can cause).*

Climate Match to Commodity Score (0–5)

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

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

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

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