Pest risk assessment

American corn snake (*Pantherophis guttatus* syn. *Elaphe guttatus*)

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This publication has been compiled by Steve Csurhes and Caitlin Davies of Biosecurity Queensland, The Department of Primary Industries.

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Summary

Pantherophis guttatus syn. *Elaphe guttata* (American corn snake, or red rat snake) is native to the south-eastern United States. It grows to about 180 cm long and its colour is highly variable. Diet is opportunistic and variable, including a wide range of insects, amphibians, lizards, small mammals and birds. Suitable habitat includes open grassland, forest, agricultural land and semi-urban areas.

P. guttatus is the most popular pet snake in the world, as it is easy to keep, comes in vivid colours and is easy to breed. Large numbers are kept both legally and illegally around the world. More than 30 illegal specimens have been seized to-date in Queensland.

P. guttatus is an opportunistic generalist and has naturalised on at least 16 islands in the Caribbean, after being transported with cargo from the United States. It is highly likely to naturalise in Queensland, and elsewhere outside its native range, if it is ever released in sufficient numbers into favourable habitat.

Factors that confer high pest-risk in Queensland include:

- a documented history as an invasive pest overseas

- large areas of Queensland offer suitable climate, habitat and food sources
- high fecundity (breeds freely and prolifically)

The brown tree snake, which ranks as one of the most destructive invasive animals in the world, has comparable biological attributes.

If *P. guttatus* successfully naturalised in Queensland, detection and eradication would be unlikely. As such, preventative legislation that avoids possession, escape/dumping and naturalisation is perhaps our only defence.

Identity and taxonomy

Family: Colubridae (Oppel, 1811)

Species: *Pantherophis guttatus* (Linnaeus, 1766)

Synonyms: *Elaphe guttatus* (Linnaeus, 1766), *E. guttata*

For a full list of synonyms refer to the Reptile Database.

Common names: Corn snake, Eastern corn snake, red corn snake, red rat snake, great plains rat snake, Emory's rat snake

Pantherophis guttatus (Linnaeus, 1766) is in the Colubridae family of snakes, a family that contains two-thirds of all snake species. The genus contains approximately 11 species, typically referred to as 'rat snakes'.

Pantherophis guttatus (Linnaeus, 1766) is part of the *Pantherophis guttatus* complex, and refers to the following species: *P. guttatus, Pantherophis emoryi, and Pantherophis slowinskii.* Correct diagnostics is challenging as the species' taxonomy is complex, with additional species in need of formal recognition (Myers *et al.* 2020).

Historically, Old and New World rat snakes were grouped together in the genus *Elaphe.* More recent molecular studies revealed that the genus *Pantherophis* should be resurrected for North American rat snakes north of Mexico (Krysko 2013; Utiger *et al.* 2002). As a result, the synonym *Elaphe guttatus* is widely used in the literature.

Description and biology

P. guttatus can be difficult to identify due to its highly variable colours and patterns (both in the wild and as a result of captive breeding and colour selection). Perhaps the most common form is orange or brownish-yellow, with large black-edged red blotches down the middle of its back. It typically has alternate black marks on its underside, giving a checker-board appearance. *Pantherophis emoryi* generally has similar coloration, being grey or tan with dark-grey, brown or green-grey blotching down its back. Both subspecies are relatively slender snakes 60–180 cm long. Specimens can live for up to 25 years.

In colder parts of its native range, *P. guttatus* hibernates over winter. However, in warmer climates along the south-eastern coast of the United States they shelter in rock crevices and logs during cold weather and come out on warm days to soak up the heat of the sun—a process known as brumation. During cold weather, snakes are less active and hunt less (NatureServe 2009).

Image 1. American corn snake.

Image 1. (A) Typical corn snake, *Pantherophis guttatus*, (B) Great plains rat snake, *Pantherophis emoryi* (Source: Vassil and LA Dawnson GNU Free Documentation Licence).

Colour morphs

Highly variable colour morphs are generated via alteration to skin pigmentation, including loss of one or more pigments. Within the species' native range, specific colour morphs tend to be associated with certain regions. Many of these colour morphs are rare in the wild.

However, after extensive captive-breeding, many are now common in the pet trade. New colour morphs can be developed via cross-breeding. Descriptions of the commonest morphs are presented in Table 1. This table uses information from Wikipedia contributors, 'Corn Snake', *Wikipedia, The Free Encyclopedia,* 26 August 2009, 14:25 UTC, <http://en.wikipedia.org/w/index.php?title=Corn_Snake&oldid=310169262> accessed 8 September 2009.)

Table 1. Wild type and selectively-bred colour morphs of *Pantherophis guttatus*

Name of colour morph	Common name of morph	Description
Wild type	Normal	Orange with black lines around red-coloured saddle markings going down the back, with black and white checkered bellies
Wild type (regional)	Miami/Florida	Often smaller snake with some specimens having high contrasting light-silver to grey ground colour, with orange saddle markings surrounded by black
Wild type (regional)	Carolina/okeetee	Deep-red dorsal saddle marks surrounded by very black borders; the ground colour varies, with bright orange being popular among breeders
Amelanistic *Selectively bred*	Candy cane	Red saddle marks on a white background, often the background is orange/yellow
Amelanistic (okeetee) *Selectively bred*	Reverse okeetee	An amelanistic okeetee snake that has the normal black rings around the saddle marks replaced with wide white rings

Anerythristic	Black albino	Lacking erythrin (red, yellow and orange) pigments; produces a snake that is mostly black, grey and brown.
Hybrid *(Elaphe guttata x Lampropeltis getula californiae)*	Jungle	These show extreme pattern variations, taking markings from both parents

Diet

Diet is broad and opportunistic. However, adults typically feed on rodents and other small animals including bats and birds. They hunt on the ground and in trees (arboreal). Juveniles feed on smaller prey such as insects, frogs and lizards. Prey is killed by constriction since the species is not venomous.

Reproduction

Mating occurs shortly after winter, with eggs laid about one month after mating. Clutch size varies from 10–12 eggs, but can be up to 24. The eggs are usually laid in warm areas with high humidity (e.g. near rotting logs, decaying vegetation). Once laid, the adult snake abandons the eggs and does not return. Eggs hatch in approximately 65 days. Newly hatched snakes are about 25 cm long. Sexual maturity occurs after 600 days. Longevity can exceed 20 years in the wild (de Magalhaes & Costa 2009).

P. guttata can hybridise with related species, including the Californian king snake (*Lampropeltis getula californiae).* Despite belonging to different genera, offspring are sexually viable.

Predators and diseases

P. guttatus is often consumed by large birds and other reptiles (including snakes).

Like all non-native reptiles, *P. guttatus* is a potential host for a range of foreign pests and diseases, which could threaten native Australian and domestic animals. For example, some reptiles can carry ticks that spread the bacterium *Cowdria ruminantium* that, although not lethal to reptiles, can kill grazing animals. *P. guttatus* is a vector of cryptosporosis (Xioa *et al.* 2004).

Origin and distribution

P. guttatus is native to the eastern and southern United States including the states of Arkansas, Mississippi, Alabama, South Carolina, North Carolina, Kentucky, Virginia, Maryland, Delaware, New Jersey, Florida, Texas, Louisiana and Georgia (Reptile Database, J Craig Venter Institute <http://www.jcvi.org/reptiles/search.php>). Some sources suggest that its range in the United States is more extensive and includes central states and Mexico (Lever 2003). Whether this is a result of natural range-extension or human-assisted translocation is unknown. Refer to Nature Serve Explorer for a map of native range.

P. guttatus has naturalised on 16 Caribbean islands, including the Cayman Islands, United States Virgin Islands, Anguilla, Antigua and St Bartélmy (Powell & Henderson 2003, Perry *et al.* 2003). Its introduction to the Cayman Islands is thought to have originated from a single newly hatched clutch of eggs transported within an ornamental plant destined for a golf course on the island (Lever 2003). Accidental transportation of live specimens probably happens regularly, since the species is frequently found within cargo (mainly from Florida and south-eastern United States). For example, small numbers have been sighted in South America (Lever 2003), Sao Paulo City, Brazil (Eterovic & Duarte 2002) and Taiwan (Shiau *et al.* 2006), as well as the Caribbean generally. However, in many cases it is too early to tell if self-sustaining wild populations have established.

Figure 1. Global distribution of *Pantherophis guttatus* (Source: GBIF 2025).

Status in Australia and Queensland

P. guttatus has not yet naturalised in Australia or Queensland. However, it is kept illegally as a pet and there have been numerous sightings of escaped or dumped animals, particularly around Sydney, where the number of detections has been increasing steadily, a situation described as a "ticking timebomb" by McFadden *et al*. (2017). More than 30 specimens have been seized to-date in Queensland, and some have resulted in successful prosecutions.

It is an offence to keep *P. guttatus* as a pet in Australia and only a small number are kept under permits in zoos and reptile parks.

P. guttatus is the most commonly kept pet snake in the world. This is not surprising since it is easy to keep, comes in a variety of colours and can be easily bred. Accordingly, demand is high. Illegal specimens can sell for $500 - $1000 in Australia, with selectively bred colour morphs fetching higher prices (Keith Larner 2009, pers. comm.). As such, there is a commercial incentive for people to keep and breed this species, and smuggle it into the country. A study by Toomes *et al.* (2019) found that this species was among the 'top 5' most frequently intercepted non-native vertebrates in Australia (both at the national border and post-border). Since the likelihood of naturalisation is very high, effective compliance is essential.

Preferred habitat

P. guttatus can survive in a range of habitats, including open forests/forest openings, pine woodland, grassland (and overgrown fields), shrub lands, rock hillsides, cultivated or agricultural land, urban areas, mangrove thickets, barnyards, abandoned buildings, areas near springs and old rubbish dumps (Ernst & Ernst 2003).

History as a pest elsewhere

While *P. guttatus* has naturalised on at least 16 islands in the Caribbean—including the Cayman Islands, United States Virgin Islands, Anguilla, Antigua and St Bartélmy (Powell & Henderson 2003, Perry *et al*. 2003)—its impact on the local environment is poorly documented. This is probably due to the snake's recent arrival and, therefore, small population size (Platenberg & Boulon 2006). Nonetheless, they are considered to pose a significant long-term threat (Platenberg & Boulon 2006). As has occurred in places such as Micronesia, invasive snakes can have devastating impacts on local wildlife. On the island of Guam, introduced brown tree snakes (*Boiga irregularis*) have significantly reduced populations of several locally native bird species (Rodda *et al.* 1999). Hence, it seems reasonable to be concerned at the potential impact of other generalist predators such as *P. guttatus*. Of particular concern, is a study by Hayes *et al*. (2004) that listed *P. guttatus* as a significant threat to the endangered brown-headed nuthatch on Grand Bahama.

Pest potential in Queensland

P. guttatus has several attributes that suggest it has the potential to become a significant invasive pest in Queensland:

- It is climatically well-suited to humid subtropical areas of south-east Queensland, possibly extending into drier areas further west and north-west.
- It is a generalist predator and would have little difficulty finding sufficient food items if naturalised in Queensland.
- It tolerates a diversity of habitats that exist in Queensland.
- It breeds freely and prolifically.
- It has successfully naturalised elsewhere.

The brown tree snake, which ranks as one of the most destructive invasive animals in the world due to its irreversible impacts on native bird species in Micronesia, has comparable biological attributes.

The risk to human safety is considered small, since this species is non-venomous and generally reluctant to bite. However, like all non-native reptiles, it might transmit various exotic diseases and may pose a threat to agriculture, if it transmits invasive insects such as ticks.

Climate match

Using the Climatch software, version 1.0 (Bureau of Rural Sciences), the area of Australia where the climate appears suitable for survival of *P. guttatus* was predicted (Figure 4). Substantial areas of Queensland and Australia, highlighted in red and orange, appear to have climate types that are similar to climates experienced within the species' native range. Tropical savannas and the coastal wet tropics of north Queensland appear less suitable. Tasmania appears least suitable.

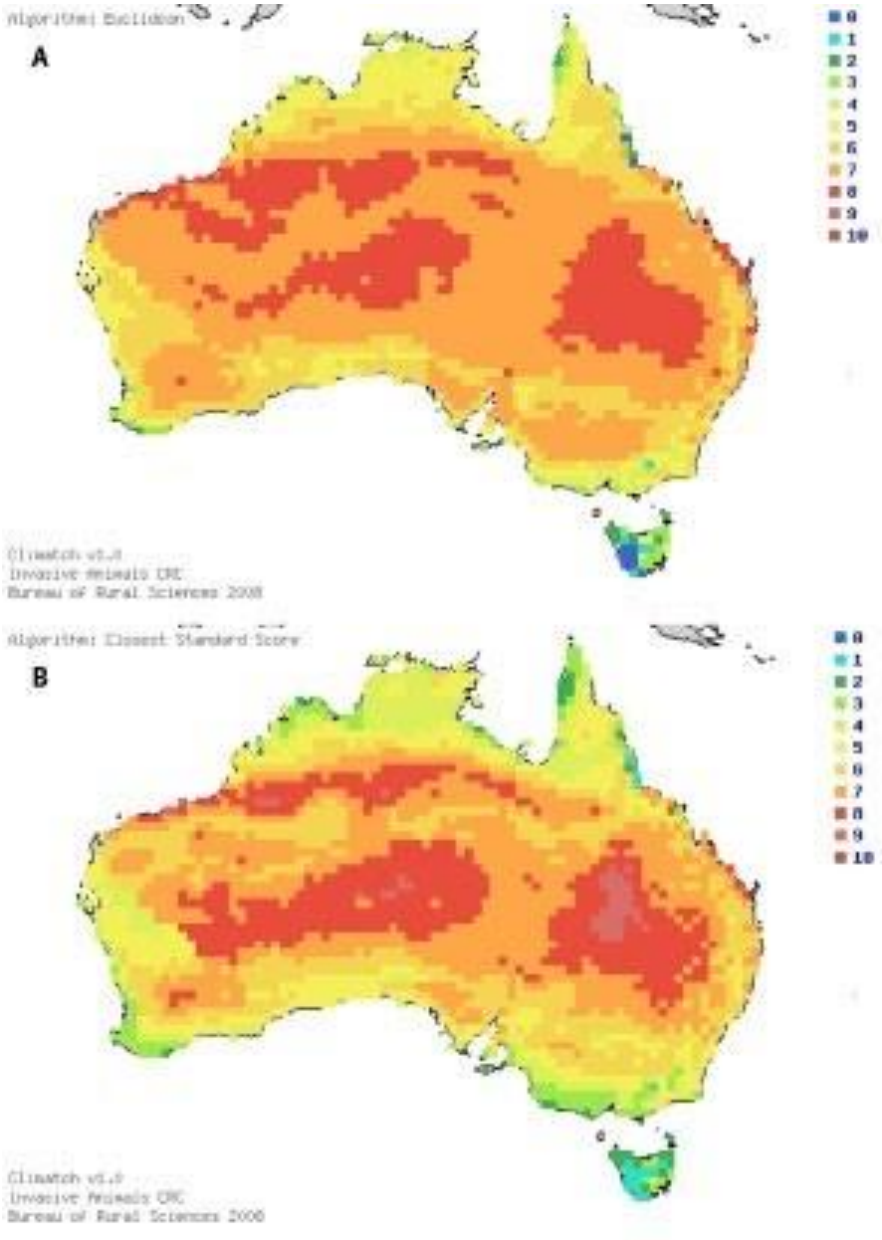

Figure 2. Climatch results for *Elaphe guttatus* in Australia, using two distinct algorithms: (A) euclidean and (B) closest standard score (the scale indicates the degree of climate-match, with 10 being the highest or most suitable climate). Red and orange indicate areas where climate is most suitable.

Habitat match

P. guttatus is an ecological generalist that can survive in a diverse range of habitats from grassland, forest and agricultural land to semi-urban areas. Consequently, it is likely to find favourable habitat types in Queensland.

Generalist diet

P. guttatus has a varied and opportunistic diet, including amphibians, lizards, small mammals and birds. Suitable prey items exist in Queensland and the species is predicted to have little difficulty finding sufficient food for survival and reproduction in the wild. *P. guttatus* would compete for food with a range of other generalist (native) reptilian predators.

High fecundity

P. guttatus can lay up to 24 eggs per clutch (usually 10–12) and is likely to reproduce freely and quickly if naturalised in suitable habitat types in Queensland. A wild population could develop from the escape or release of a small number of individuals, as is believed to have occurred on the Cayman Islands, where a wild population appears to have developed from a single clutch of eggs.

Risk of introduction and release

The species' most likely invasion pathway is via the illegal pet trade. Experienced reptile keepers admit that *P. guttatus* can readily escape from enclosures, due to its small size and general agility. In addition, there is a risk that people will dump unwanted breeding stock into the wild in the mis-guided belief that they are providing a 'good home' for the animals, a problem common to all domestic pets.

A less likely avenue of introduction is via live specimens (or eggs) hitching a ride within cargo from the south-eastern United States. For example, corn snakes on St Thomas (in the United States Virgin Islands) entered on uninspected construction cargo from the south-eastern United States.

Numerical risk analysis

Two separate numerical models developed by Bomford (2008) were applied to further assess the pest and establishment risk of *P. guttatus* in Australia. Both models generated 'serious risk' scores (see the Appendix).

Appendix

Risk assessment using the Australian reptile and amphibian model

Using the Australian reptile and amphibian model (Bomford 2008), *P. guttatus* was scored as a serious establishment risk.

Table 3. Australian reptile and amphibian model for *P. guttatus.*

Criteria	Number	Comment
Species		*Elaphe guttatus* (corn snake)
Date of assessment		10 September 2008
Literature search type and date		See references
A. Climate match	67	High climate match in Australia = 63 (Bureau of Rural Sciences 2006) (Figure 4)
B. Exotic population established overseas (0–4)	30	Species has been introduced into another country (United States Virgin Islands)
C. Taxonomic family risk score	10	Colubridae = 10
Establishment risk score	**107**	**Serious establishment risk**

Risk assessment using the bird and mammal model (adapted for reptiles)

Using the bird and mammal model, adapted for reptiles (Bomford 2008), *P. guttatus* was ranked as having a serious establishment risk.

Table 4. Australian bird and mammal model for *P. guttatus.*

Criteria	Number	Comment
Species		*Elaphe guttatus* (corn snake)
Date of assessment		10 September 2008
Literature search type and date		See references
A. Climate match	5	Very high climate match in Australia = 2083 (Bureau of Rural Sciences 2006) (Figure 4)
B. Exotic population established overseas (0–4)	2	Species has been introduced into mostly small islands = 2 (United States Virgin Islands)
C. Taxonomic family risk score	1	Global range—200 000–2 500 000 km^2 (NatureServe 2009) = 1
Establishment risk score	**8**	**Serious establishment risk**

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