RISK ASSESSMENTS FOR EXOTIC REPTILES AND AMPHIBIANS INTRODUCED TO AUSTRALIA – Boa Constrictor (*Boa Constrictor*) (Linnaeus, 1758)

Class – Reptilia, Order - Squamata (Oppel, 1811), Family - Boidae (Gray, 1825), Genus - *Boa* (Linnaeus, 1758); (McDiarmid et al 1999, ITIS Integrated Taxonomic Information System 2007, Catalogue of Life 2008)

GOVERNMENT OF WESTERN AUSTRALIA

Department of Agriculture and Food

Score Sheet

SPECIES: Boa Constrictor (*Boa constrictor*) Other common names include: Ampalagua, Bigoya, Masacuate. **Subspecies:** *B. c. amarali* (Stull, 1932) Brazil, Bolivia and Paraguay *B. c. constrictor* (Linnaeus, 1758) occurs throughout northern and central South America, including Trinidad and Tobago *B. c. imperator* (Daudin, 1803) central America (northern Mexico to northwestern South America) *B. c. longicauda* (Price and Russo, 1991) Tumbes Province, Peru (Price and Russo, 1991) *B. c. melanogaster* (Langhammer, 1983) east Ecuador *B. c. mexicana* (Jan, 1863) occurs in central and southern Mexico *B. c. nebulosa* (Lazell, 1964) Dominica Island, Lesser Antilles *B. c. occidentalis* (Philippi, 1873) confined to southeastern Bolivia, Paraguay and northwestern Argentina *B. c. orophias* (Linnaeus, 1758) Northwestern Peru *B. c. ortoni* (Cope, 1878) northwestern coastal Peru *B. c. sabogae* (Barbour, 1906) Taboga Island (Panama) (Mehrtens 1987, Obst et al 1988, Smith 1999, ITIS Integrated Taxonomic Information System 2007, The Reptile Database 2007, Catalogue of Life 2008)		**Species Description** – One of the world's largest snake species, reaching maximum total lengths of 4-5 m, and weight of more than 45 kg. Boas this size both in the wild and in captivity are rare; the average boa is considerably smaller, usually to 3 m. Growth generally stops by age 3 in males, and age 5 in females. Extensive morphological variation exists, both within and between subspecies. Boas on islands are dwarfed in size, averaging half the length and 1/5 of the mass of mainland boas, and exhibit different head shapes and patterns. Colour ranges from tan, green, red and yellow. Many Boa Constrictor populations exhibit reddish colouration of the tail and elsewhere on the body. They generally display distinctive, cryptic patterns on the body, of jagged lines, ovals, diamonds and circles. Most subspecies have a mid-dorsal head-stripe. The coloured patterns aid in camouflage under natural conditions, assisting the species with its sit-and-wait style of predation. The jaws are lined with small, hooked teeth, used for grabbing and holding prey while it is wrapped in the muscular body coils. The prey is squeezed and killed by suffocation (Mattison 1982, Mehrtens 1987, Obst et al 1988, Smith 1999, Ernst and Ernst 2003, Boback 2005, Quick et al 2005, Alves and Filho 2007, National Geographic 2008 , Woodland Park Zoo 2008). **General information –** Boas are very prolific breeders and give birth to numerous live young. Litters can be of several dozen young, up to 63 individuals (Mole 1924) as cited by (R.Reed 2008, pers. comm.), and possibly even up to 80 individuals. At birth, young are from 30 to 60 cm long, according to the size of the female parent (Mehrtens 1987, Smith 1999). **Longevity** – An old record from the Philadelphia Zoological Gardens lists the longevity record for a captive Boa Constrictor as 23 years (Conant and Hudson 1949), however the maximum longevity recorded in captivity is 40.4 years (Ernst and Ernst 2003, HAGR Human Ageing Genomic Resources 2006). **Status** – 1. Red List Category – Not Listed (IUCN 2008). 2. CITES listed Protection Status: CITES Appendix I and Appendix II. Rationale: All members of the Family Boidae are listed in CITES Appendix II, except for those species listed in Appendix I. Appendix II lists species that are not necessarily now threatened with extinction but that may become so unless trade is closely controlled. The Argentine subspecies (*B. c. occidentalis*) is included in CITES Appendix I. Appendix I lists species that are the most endangered among CITES-listed animals and plants (CITES 2007).
DATE OF ASSESSMENT: 05/02/2008 **Bird and Mammal Model Used: (Bomford 2008) using PC CLIMATE (Brown et al 2006, Bureau of Rural Sciences 2006)**		**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 of 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 was originally published in 'Risk Assessment for the Import and Keeping of Exotic Vertebrates in Australia' (Bomford 2003) available online

		http://www.daff.gov.au/brs/land/feral-animals/management/risk . This model used the Apple Mac application CLIMATE (Pheloung 1996) for climate matching. The risk assessment model was revised and recalibrated 'Risk Assessment for the Establishment of Exotic Vertebrates in Australia: Recalibrated and Refinement of Models'(Bomford 2006) and the climate application changed to PC CLIMATE software (Bureau of Rural Sciences 2006), available online at http://affashop.gov.au/product.asp?prodid=13506. The most recent publication (Bomford 2008) includes updated instructions for using the exotic vertebrate risk assessment models and an additional model for freshwater fish. A bird and mammal model for New Zealand has also been included. **Which model is being used for the assessments:** Birds and mammals have been assessed using the Australian bird and mammal risk assessment model (Bomford 2008), pp 16-28. All reptiles and amphibians were assessed using three models; the 7 factor Australian bird and mammal model (Bomford 2008), p 21, the 4 factor Australian bird and mammal model used for reptiles and amphibians (Bomford 2008), p 54-55, and the Australian reptile and amphibian model (Bomford 2008), p 51-53. The rational for using additional models for reptiles and amphibians is to compare establishment risk ranks of the three models for a precautionary approach. If the models produce different outcomes for the establishment potential of any reptile or amphibian, the highest ranked outcome should be used (Bomford 2008). **Climate Matching Using PC CLIMATE** Sixteen climate parameters (variables) of temperature and rainfall are used to estimate the extent of similarity between data from meteorological stations located in the species' world distribution and in Australia. Worldwide, data (source; worlddata_all.txt CLIMATE database) from approximately 8000 locations are available for analysis. The number of locations used in an analysis will vary according to the size of the species' distribution. Data from approximately 762 Australian locations is used for analysis. To represent the climate match visually, the map of Australia has been divided into 2875 grid squares, each measured in 0.5 degrees in both longitude and latitude. CLIMATE calculates a match for each Australian grid by comparing it with all of the 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. These levels of climate match are used in the risk assessment for questions B1 (scores are summed to give a cumulative score), C6, and C8. For a grid square on the Australian map to score highly, it must match closely all 16 climatic variables of at least one meteorological station in the species' distribution for each level of climate match. [The score for each grid is based on the minimum Euclidian distance in the 16- dimensional variable space between it and all stations in the species' distribution. Each variable is normalized by dividing it by its worldwide standard deviation.]
LITERATURE SEARCH TYPE AND DATE: NCBI, CAB Direct, MEDLINE, Science Direct, Web of Knowledge (Zoological Records, Biological Abstracts), SCIRUS, Google Search and Google Scholar 29/10/2007		
FACTOR	**SCORE**	
PROBABILITY ESCAPED OR RELEASED INDIVIDUALS WILL ESTABLISH FREE-LIVING POPULATION		
Model A: Using the first three factors/questions from stage B of the Australian Bird and Mammal Model (Bomford 2008) pp 54-55)		
B1. Degree of climate match between species overseas range and Australia (1–6)	5	*Climate Match Score = 1730 Very high climate match with Australia* Climate data from 402 locations (see species worldwide distribution map) were used to calculate the CMS.
B2. Exotic population established overseas (0–4)	4	*Exotic population established on a continent and on small islands less than 50 000 km^2*

		▪ In the United States, a breeding population has established in Dade County, Florida, as a result of released or escaped pet snakes (Ernst and Ernst 2003, Lever 2006). ▪ Introduced onto Cozumel Island, Mexico, in 1971. The species is now established and has a wide distribution on the island. The population may have originated from 2 to 6 large boas that were released following a film production on the island. All evidence strongly indicates that humans were responsible for the introduction of the boa on to Cozumel and that the species is established and its range expanding. However, it is possible that the species dispersed naturally onto the island or that it was overlooked before 1971 (Martinez-Morales and Cuaron 1999, Lever 2006, Romero-Najera et al 2007). ▪ 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. By December 2003, 273 various sized boas had been captured. 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 (Quick et al 2005). ▪ From 1923, Boa Constrictors were reported to occur frequently in bananas shipped to local grocery stores in Iowa. However, these animals did not establish in the wild, being unable to survive Iowa's winters (Christiansen 2001).
B3. Overseas range size score (0–2) < 1 = 0; 1 – 70 = 1; >70 = 2	1	*Overseas range between 1-70 million km^2, estimated at 15.02 million km^2. Includes current and past 1000 years, natural and introduced range.* ▪ The Boa Constrictor has an extensive natural geographic distribution, ranging from northern Mexico, through Central America (Belize, Guatemala, Honduras, El Salvador, Nicaragua, Costa Rica, Panama), to South America (Colombia, Ecuador, Peru, Venezuela, Guyana, Surinam, French Guiana, Brazil, Bolivia, Uruguay, northwestern Argentina) (Davis and Smith 1953, Mehrtens 1987, Greene 1997, McDiarmid et al 1999, Quick et al 2005, The Reptile Database 2007). Boas are probably the most common, and most widely ranging snake in the world (Smith 1999). ▪ It has successfully naturally colonised at least 43 marine islands throughout its range, including Dominica and St Lucia islands in the Lesser Antilles; San Andres and Providencia Islands (Colombia), Taboga Island (Panama), Trinidad and Tobago, plus many other continental islands along the Atlantic and Pacific coasts of Mexico, Central and South America (McDiarmid et al 1999, Henderson 2004, Boback 2005, Powell and Henderson 2005). Although the Boa Constrictor can swim, it doesn't spend significant time in the water (Woodland Park Zoo 2008). ▪ The species occurs at an elevations up to 780-940 m and is rarely found above 1000 m (Duellman 1966, Chiaraviglio et al 2003, The Reptile Database 2007, Woodland Park Zoo 2008). The Boa Constrictor does exceed 1000 m in several locations, such as the Honduras – 1370 m (McCranie et al 2006), Costa Rica – 1360 m (Savage 2002), and El Salvador – 1200 m (Kohler et al 2006) [all as cited by R.Reed 2008, pers. comm.). ▪ The different subspecies occupy restricted ranges (Mehrtens 1987, Obst et al 1988, Smith 1999); see listed subspecies above. ▪ Exotic populations have established on Cozumel Island, Mexico, Aruba Island, Lesser Antilles, and in Florida, US (see B2 for details).
ESTABLISHMENT RISK SCORE **SUM OF SCORE A (B1) + SCORE B (B2) + SCORE C (B3) (1-12)**	**10**	
Model B: Using the seven factors/questions from stage B of the Australian Bird and Mammal Model (Bomford 2008) pp 20)		

B4. Taxonomic Class (0–1)	1	*Reptile* (McDiarmid et al 1999, ITIS Integrated Taxonomic Information System 2007, Catalogue of Life 2008).
B5. Diet score (0–1)	1	*Generalist with a broad diet of many food types* Boa Constrictors feed on a wide variety of vertebrates including small mammals, birds and their eggs, small lizards, and occasionally amphibians. Larger sized boas may also feed on medium sized mammals such as monkeys, wild pigs, the Central American agouti, the Cozumel raccoon and coati, or the white-tailed deer (Mehrtens 1987, Obst et al 1988, Greene 1997, Martinez-Morales and Cuaron 1999, Ernst and Ernst 2003, Henderson 2004, Boback 2005, Alves and Filho 2007, National Geographic 2008). Boa Constrictors have been observed preying and feeding on bats on Providencia Island (Thomas 1974). Examination of stomach contents of boas on Aruba Island showed that birds comprised 40% of prey taken, lizards 35 % and mammals 25.0 %; 52 separate prey items were identified (Quick et al 2005). Boa Constrictors have also been observed preying on bats in western Brazil (Esberad and Vrcibradic 2007). In captivity, the main food is rodents, but larger boas may also take rabbits or chickens (Mattison 1982). The Boa Constrictor is an ambush predator (Montgomery and Rand 1978, Smith 1999, Ernst and Ernst 2003).
B6. Habitat score - undisturbed or disturbed habitat (0–1)	1	*Can live in human-disturbed habitats* Boa Constrictors are very adaptable and occur in a wide range of habitats (Mehrtens 1987, Quick et al 2005), primarily inhabiting lowland, tropical rainforest but also occurring in arid pampas grasslands and scrub, mountainous tropical rainforest, coastal scrubs and marshes, and in second-growth forests (Smith 1999). It is frequently found close to human habitation (Obst et al 1988), and has been observed in urban areas (Romero-Najera et al 2007). In agricultural areas in South America it uses cultivated fields, especially those supporting sugar cane. It seems to thrive in disturbed settings (Ernst and Ernst 2003).
B7. Non-migratory behaviour (0–1)	1	*Non-migratory or facultative migrant in its native range* The different subspecies occupy distinct and restricted ranges (Mehrtens 1987, Obst et al 1988, Smith 1999). The species is active all year round in its native range (Chiaraviglio et al 2003). Long distance movements are probably seldom made, provided food and shelter are locally available. One individual tagged with a radio transmitter moved a total of only 135 m in 12 days, spending much of its time underground in mammal burrows (Ernst and Ernst 2003).
ESTABLISHMENT RISK SCORE **SUM OF B1-7 (1–16)**	**14**	

Australian Reptile and Amphibian Model (Bomford 2008, pp 51-53)		
Score A. *Climate Match Risk Score Degree (Sum of species 4 scores for Euclidian match classes 7 – 10)*	47	*CMRS = 100(1318/2785)* Natural distribution is Central and South America, and numerous marine islands, with introduced populations occurring on Cozumel Island, Mexico, on Aruba Island, Lesser Antilles, and in Florida, US (The Reptile Database 2007) (see B2 and B3).
Score B. *Has the species established an exotic population in another country? (0–30)*	30	*Species has established a breeding self-sustaining exotic population in another country* Dade County, Florida, by released or escaped snakes form the pet trade (Ernst and Ernst 2003, Lever 2006).
Score C. *Taxonomic Family risk score (0–30)*	5	*Low risk family (Bomford 2006)* Boidae (Integrated Taxonomic Information System (ITIS) 2007).
ESTABLISHMENT RISK SCORE	**82**	

SUM OF SCORE A + SCORE B + SCORE C (0 – ≥116)		
PUBLIC SAFETY RISK RANK		
Risks to public safety posed by captive or released individuals (using the questions from stage A of the Australian Bird and Mammal Model (Bomford 2008, pp 17)		
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.* Boa Constrictors tend to be calm snakes however, disposition varies among individuals, with age and in response to handling. Boas that are handled often become more familiar with people and are less likely to bite (Smith 1999). Many young boas are placid, whereas some adults hiss and strike readily. When annoyed, the head and neck are usually thrown back in an S-curve and the animal may hiss long and very loudly. Individuals may also bite. The jaws are lined with small, hooked teeth designed for grabbing and holding. After biting the snake may let go immediately, or it may clamp down with its jaws and coil tightly around anything available, including peoples' arms and legs. Bites from boas less than 1.5 m in length generally have the severity of a cat scratch, but those from larger specimens can require a stitches if the skin tears when the person or snake pulls back. Most individuals become calmer after being in captivity for some time, and those born in captivity usually grow up docile (Greene 1997, Smith 1999, Ernst and Ernst 2003, National Geographic 2008 , Woodland Park Zoo 2008). In the United States, approximately 50,000 people per year are bitten by snakes, most of which are non-venomous (Kleinman et al 1998). Attacks by pet boas have been documented. Examples include: an 18-year-old man was bathing his pet boa when it attacked him and bit him on the right eye. When the snake struck, the victim partially blocked the attack with his hand, however the snake was able to engage the victims' right eye with its lower teeth. It would not release its bite and tried to wrap itself around the victim's neck. The snake also had infectious stomatis, a bacterial infection of the mouth, however no infection of the eye occurred (Kleinman et al 1998). A similar attack occurred on a 30-year-old man, who received a corneal perforation in the left eye after being attacked by his pet Boa Constrictor (Korn and Korn 2005). There are no known human fatalities by wild of captive Boa Constrictors. A report that a man was choked to death by his pet Boa Constrictor at his home in Cincinnati, US (BBC News 2006) was found to be incorrect – the man was in fact killed by an underweight Burmese Python (R.Reed 2008, pers comm.).
A2. Risk to public safety from individual captive animals (0–2) *Assess the risk that irresponsible use of products obtained from captive individuals of the species (such as toxins) pose a public safety risk (excluding the safety of anyone entering the animals' cage/enclosure or otherwise coming within reach of the captive animals)*	0	*Nil or low risk (highly unlikely or not possible)* The species is non-venomous (Greene 1997).
PUBLIC SAFETY RISK SCORE **SUM OF A1 + A2 (0-4)**	**1**	

OTHER INFORMATION TO ASSESS PEST RISKS		
Checklist of factors associated with increased risks of adverse impacts of established species (Bomford 2008, pp 90-91) NB – an asterisk (*) denotes factors that have not been researched to the same degree as other factors, and were generally addressed using standard textbooks only		
FACTOR	**TICK IF YES**	
1. Has adverse impacts elsewhere *Impacts can be economic, environmental or social; impacts can be significant or subtle.*	✓	*Reported to be a moderate environmental pest in natural communities in at least one country or region of the world [score = 2, using scoring from Australian Bird and Mammal Model Q C5 (0-3)].* The species is reported as a pest where it was introduced on Cozumel Island, Mexico. Boas have become very abundant and widespread on the island, and severely affect the fauna. Since there are no major predators, the

		Boa Constrictor has become a formidable keystone predator on Cozumel, inducing top-down effects, interfering with the whole insular, system dynamics and causing the decline of Cozumel native species. Examples of endemic Cozumel species threatened by predation include the Cozumel Thrasher (*Toxostoma guttatum*) (a bird), rodents *(Reinthrodontomys spectabilis, Oryzomys couesi cozumelae* and *Peromyscus leucopus cozumelae*) and the Cozumel whiptail (*Cnemidophorus cozumela*) (a lizard) (Martinez-Morales and Cuaron 1999, Romero-Najera et al 2007). An ecological risk assessment of non-native boas and pythons in the US found that the Boa Constrictor may pose a particularly high risk as a potentially invasive species. Factors considered for the assessment included body size, fecundity, climatic profiles of native ranges, the number of snakes imported, and the average value of snakes sold. The Boa Constrictor was calculated to be the highest-risk snake in the US, based on ecological variables, and the third highest-risk snake based on trade variables (i.e. the number of snakes imported, and the value of imported individuals). A list of vertebrates native to the US and listed as threatened or endangered under the US Endangered Species Act, that are most likely to be impacted by establishment of feral populations of boas or pythons is provided. Examples of species listed include the Silver Rice Rat (*Oryzomys palustris natator*), Key Deer (*Odocoileus virginianus clavium*), and the Florida Scrub Jay (*Aphelocoma coerulescens coerulescens*) (Reed 2005). *Can nest or shelter in tree hollows [score = 2, using scoring from Australian Bird and Mammal Model Q C4 (0, 2)].* Boas seek shelter and nest in hollow logs and stumps, tree holes, rock crevices, abandoned mammal burrows, and similar retreats (Montgomery and Rand 1978, Mehrtens 1987, Greene 1997, Ernst and Ernst 2003, National Geographic 2008). *No reports of damage to crops or other primary production in any country or region [score = 0, using scoring from Australian Bird and Mammal Model Q C7 (0-3)].* *Moderate risk of harm or annoyance to the public posed by a wild population – Injuries Or Harm moderate but unlikely to be fatal and few people at risk [score = 3, using scoring from Australian Bird and Mammal Model Q C11 (0-5)].* Boa Constrictors kill their prey by constriction. The Intense Pressure Prevents Both The Heart And Lungs From Functioning, Causing Almost Instantaneous Unconsciousness And Death. Although Often Mild-Mannered, When Disturbed Some Wild Boa Constrictors Are Aggressive. They Hiss Loudly, Shake Their Tales, And Release A Pungent Musk. Biting May Occur, But Is Often Used As A Last Resort (Mehrtens 1987, Ernst and Ernst 2003). Serious Injuries As A Result Of Attacks By Captive Boas Have Been Known To Occur (See A1). In The Wild, Boas Are Usually Docile Animals, And Do Not Usually Predate On Large Animals (Ingestion Of Large-Sized Meals Would Render The Boa Helpless And Unable To Defend Itself Or Escape Predators During The Digestive Process) (Mehrtens 1987). There Are No Known Human Fatalities Caused By Attacks From Wild Boa Constrictors (R.Reed 2008, Pers Comm.). The Species Has Been Observed Displaying Aggressive Behaviour When Protecting Young: At La Selva, A Pregnant Boa Constrictor Was Removed From Within A Tree Buttress For Observation, And A Few Days Later Was Returned With Several Dozen Newborn Young To The Same Site. All The Young Retreated Into The Hollow Trunk Immediately After Release, The Mother Backed Against The Entrance Hole, Hissing And Lunging At Her Captors (Greene 1997). Zoonoses: Many Reptiles Carry *Salmonella* Bacteria In Their Intestinal Tract That Are Easily Spread To Humans However Transmission From Reptiles To Humans Occurs Through Ingestion Of The Bacteria; Simply Touching Or Handling An Infected Animal Will Not Result In Transmission. Overall, Reptile And Amphibian Contacts Are Estimated To Account For Around 74,000 (6%) Of The Approximately 1.2 Million *Salmonella* Infections That Occur Each Year In The United States (Mermin et al 2004). Risk Of Disease Transmission From Populations Of The Boa Constrictor Established In The Wild Is Very Low.

*2. Has close relatives with similar behavioural and ecological strategies that have had adverse impacts elsewhere **		No reports found (Lever 2006).
3. Is dietary generalist	✓	Boa Constrictors feed on a wide variety of vertebrates including small mammals, birds and their eggs, small lizards, and occasionally amphibians. Larger sized boas may also feed on medium sized mammals such as monkeys, wild pigs, the Central American agouti, the Cozumel raccoon and coati, or the white-tailed deer (Mehrtens 1987, Obst et al 1988, Greene 1997, Martinez-Morales and Cuaron 1999, Ernst and Ernst 2003, Henderson 2004, Boback 2005, Alves and Filho 2007, National Geographic 2008).
*4. Stirs up sediments to increase turbidity in aquatic habitats **		No information found (Lever 2006).
*5. Occurs in high densities in their native or introduced range **		The introduced population of boas on Cozumel Island had an encounter rate of 1.8 boas/100 km. The authors state that this value is clearly a minimum, because observations of snakes were not the objective of the transects (Martinez-Morales and Cuaron 1999). (Boback 2005) studied boa populations inhabiting islands off the coast of Belize. He found that density ranged from 0.5-4.3 boas/ha, with the highest density on West Snake Cay, with a density of 16.4 boas/ha.
*6. Harbours or transmits diseases or parasites that are present in Australia **	✓	Exotic snakes can harbour diseases that could harm native snake species, such as Inclusion Body Disease or Ophidian Paramyxo Virus (Schumacher 2006).
7. Has close relatives among Australia's endemic reptiles and amphibians		No Australian species in the family Boidae or genus *Boa* (Catalogue of Life 2008; Cogger 2000).
*8. Is known to have spread rapidly following their release into new environments **	✓	25 years following its release, the boa is now widespread on Cozumel Island. It is thought the population originated from 2-6 released individuals in the 1970s (Martinez-Morales and Cuaron 1999).
9. Is predatory	✓	Boa Constrictors feed on a wide variety of vertebrates including small mammals, birds and their eggs, small lizards, and occasionally amphibians. Larger sized boas may also feed on medium sized mammals such as monkeys, wild pigs, the Central American agouti, the Cozumel raccoon and coati, or the white-tailed deer (Mehrtens 1987, Obst et al 1988, Greene 1997, Martinez-Morales and Cuaron 1999, Ernst and Ernst 2003, Henderson 2004, Boback 2005, Alves and Filho 2007, National Geographic 2008). Boa Constrictors have been observed preying and feeding on bats on Providencia Island (Thomas 1974). Examination of stomach contents of boas on Aruba Island showed that birds comprised 40% of prey taken, lizards 35 % and mammals 25.0 %; 52 separate prey items were identified (Quick et al 2005). Boa Constrictors have also been observed preying on bats in western Brazil (Esberad and Vrcibradic 2007). In captivity, the main food is rodents, but larger boas may also take rabbits or chickens (Mattison 1982). The Boa Constrictor is an ambush predator (Montgomery and Rand 1978, Smith 1999, Ernst and Ernst 2003).
Factors	**1**,3,6,8,9	
Susceptible native Australian species (using question C6 from the Australian Bird and Mammal Model, Bomford 2008, pp 22-23)		
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**	*[Boa Constrictors are generalist predators, feeding on a wide range of vertebrates, including small mammals, birds, lizards and snakes. Larger boas will also take medium-sized mammals (see B5 for details on diet).]* *One or more susceptible native species or ecological communities that are listed as vulnerable or endangered under the Australian Government* Environment Protection and Biodiversity Conservation Act 1999 *(Department of the Environment Water Heritage and the Arts 2007, 2008)has a restricted geographical range that lies with the*

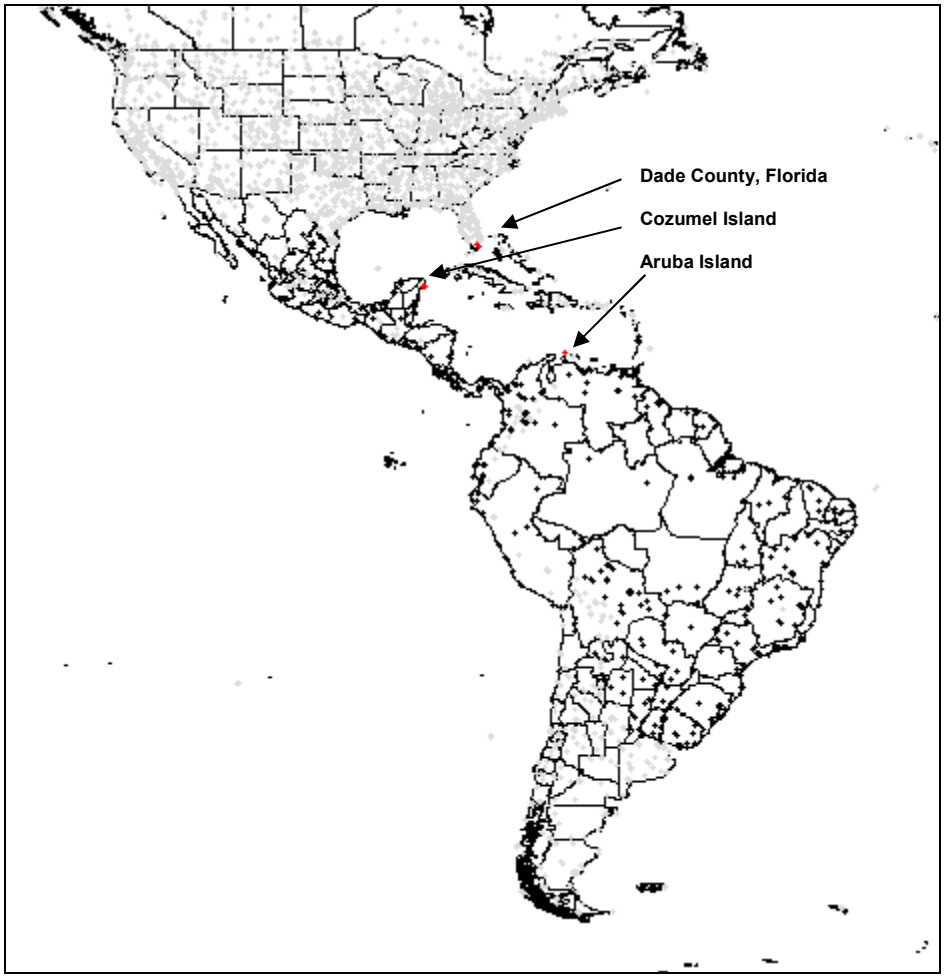
		mapped area of the highest six climate match classes for the exotic species being assessed. [score = 5, using scoring from Australian Bird and Mammal Model Q C6 (0-5)]. Vulnerable or endangered Australian native species or natural communities that could be threatened include: **Mammals:** **Vulnerable –** Large-eared Pied Bat (*Chalinolobus dwyeri*), Kowari (*Dasycercus byrnei*), Mulgara (*D. cristicauda*), Golden Bandicoot (*Isoodon auratus auratus*), Greater Bilby (*Macrotis lagotis*)**,** Golden-backed Tree-rat (*Mesembriomys macrurus*), Northern Hopping-mouse (*Notomys aquilo*), Eastern Long-eared Bat (*Nyctophilus timoriensis*), Black-footed Rock-wallaby (*Petrogale lateralis*)**,** Black-flanked Rock-wallaby (*P. lateralis lateralis*), Brush-tailed Rock-wallaby (*P. penicillata*), Fluffy Glider (*Petaurus australis*), Carpentarian Antechinus (*Pseudantechinus mimulus*), Plains Rat (*Pseudomys australis*), Djoongari (*P. fieldi*), Pilliga Mouse (*P. pilligaensis*), Spectacled Flying-fox (*Pteropus conspicillatus*), Grey-headed Flying-fox (*P.* poliocephalus), Pilbara Leaf-nosed Bat (*Rhinonicteris aurantius*), Butler's Dunnart (*Sminthopsis butleri*), Arnhem Rock-rat (*Zyzomys maini*) **Endangered –** Northern Bettong (*Bettongia tropica*), Ampurta (*Dasycercus hillieri*), Northern Quoll (*Dasyurus hallucatus*), Spotted-tailed Quoll (*D. maculatus*), Semon's Leaf-nosed Bat (*Hipposideros semoni*), Mala (*Lagorchestes hirsutus*), Northern Hairy-nosed Wombat (*Lasiorhinus krefftii*), Bridled Nail-tail Wallaby (*Onychogalea fraenata*), Mahogany Glider (*Petaurus gracilis*), Proserpine Rock-wallaby (*Petrogale persephone*), Hastings River Mouse (*Pseudomys oralis*), Greater Large-eared Horseshoe Bat (*Rhinolophus philippinensis*), Julia Creek Dunnart (*Sminthopsis douglasi*), Carpentarian Rock-rat (*Zyzomys palatalis*), Central Rock-rat (*Z. pedunculatus*) (Strahan 1995). **Birds:** **Vulnerable –** Grey Grasswren (*Amytornis barbatus barbatus*), Thick-billed Grasswren (*A. textilis modestus*), Red Goshawk (*Erythrotriorchis radiatus*), Crested Shrike-tit (*Falcunculus frontatus whitei*), Partridge Pigeon (*Geophaps smithii*), Malleefowl (*Leipoa ocellata*), Purple-crowned Fairy-wren (*Malurus coronatus coronatus*), Crimson Finch (*Neochmia phaeton evangelinae*), Plains-wanderer (*Pedionomus torquatus*), Princess Parrot (*Polytelis alexandrae*), Superb Parrot (*P. swainsonii*), Black-breasted Button-quail (*Turnix melanogaster*), Masked Owl (*Tyto novaehollandiae kimberli*). **Endangered –** Coxen's Fig-Parrot (*Cyclopsitta diophthalma*), Eastern Bristlebird (*Dasyornis brachypterus*), Gouldian Finch (*Erythrura gouldiae*), Swift Parrot (*Lathamus discolor*), Star Finch (*Neochmia ruficauda ruficauda*), Night Parrot (*Pezoporus occidentalis*), Golden-shouldered Parrot (*Psephotus chrysopterygius*), Buff-breasted Button-quail (*Turnix olivii*), Regent Honeyeater (*Anthochaera phrygia*) (Barrett et al 2003, Christidis and Boles 2008). **Reptiles:** **Vulnerable –** Five-clawed Worm-skink (*Anomalopus mackayi*), Three-toed Snake-tooth Skink (*Coeranoscincus reticulatus*) Yinnietharra Rock-Dragon (*Ctenophorus yinnietharra*), Airlie Island Ctenotus (*Ctenotus angusticeps*), Hamelin Ctenotus (*C. zastictus*), Striped-tailed Delma (*Delma labialis*), Atherton Delma (*D. mitella*), Collared Delma (*D. torquata*), Great Desert Skink (*Egernia kintorei*), Yakka Skink (*E. rugosa*), Baudin Island Spiny-tailed Skink (*E. stokesii aethiops*), Mount Cooper Striped Lerista (*Lerista vittata*), Brigalow Scaly-foot (*Paradelma orientalis*), Border Thick-tailed Gecko (*Underwoodisaurus sphyrurus*). **Endangered –** Yellow-snouted Gecko (*Diplodactylus occultus*), Arhem Land Egernia (*Egernia obiri*), Slater's Skink (*Egernia slateri slateri*), Western Spiny-tailed Skink (*Egernia stokesii badia*), Allan's Lerista (*Lerista allanae*), Grassland Earless Dragon (*Tympanocryptis pinguicolla*) (Cogger 2000).
Susceptible Australian primary production (using question C8 from the Australian Bird and Mammal model; Bomford 2008 pp 23-25)		
C8. Climate match to susceptible primary production (0–5) *Assess Potential Commodity Impact Scores for each primary production*	**2**	***Score = 20 (Bomford 2003, 2006). [score = 2, using scoring from Australian Bird and Mammal Model Q C8 (0-5)].***

commodity listed in Table 9, based on species' attributes (diet, behaviour, ecology), excluding risk of spreading disease which is addressed elsewhere.		See Commodity Scores Table – species has attributes making it capable of damaging sheep, pig, poultry, and other livestock industries. There are no reports of damage to crops or other primary production in any country or region for this species.
SUMMARY OF RESULTS		
ESTABLISHMENT RISK RANKS – RISK OF ESTABLISHING A WILD POPULATION		
MODEL A: USING THE FIRST THREE FACTORS/QUESTIONS FROM STAGE B OF THE AUSTRALIAN BIRD AND MAMMAL MODEL (BOMFORD 2008) PP 54-55) ≤ 4 = LOW ESTABLISHMENT RISK; 5-7 = MODERATE ESTABLISHMENT RISK; 8-9 = SERIOUS ESTABLISHMENT RISK; 10-12 = EXTREME ESTABLISHMENT RISK	**10**	**EXTREME**
MODEL B: USING THE SEVEN FACTORS/QUESTIONS FROM STAGE B OF THE AUSTRALIAN BIRD AND MAMMAL MODEL (BOMFORD 2008) PP 20) ≤ 6 = LOW ESTABLISHMENT RISK; 7-11 = MODERATE ESTABLISHMENT RISK; 12-13 = SERIOUS ESTABLISHMENT RISK; ≥ 14 = EXTREME ESTABLISHMENT RISK	**14**	**EXTREME**
AUSTRALIAN REPTILE AND AMPHIBIAN MODEL (BOMFORD 2008, PP 51-53) ≤ 22 = LOW ESTABLISHMENT RISK; 23-60 = MODERATE ESTABLISHMENT RISK; 61-115 = SERIOUS ESTABLISHMENT RISK; ≥116 = EXTREME ESTABLISHMENT RISK	**82**	**SERIOUS**
HIGHEST ESTABLISHMENT RISK RANK (When establishment risk ranks differ between the models, the highest ranked outcome is used, (Bomford 2008).	**-**	**EXTREME – ENDORSED BY VPC**
PUBLIC SAFETY RISK RANK AUSTRALIAN BIRD & MAMMAL MODEL, STAGE A (BOMFORD 2008, PP 17) A = 0 = NOT DANGEROUS; A = 1 = MODERATELY DANGEROUS; A ≥ 2 = HIGHLY DANGEROUS	**1**	**MODERATELY DANGEROUS**
Median number of references for Establishment Risk and Public Safety Risk, for all reptiles assessed by (Massam et al 2010) (n=11)		15, 2

Total number of references for this species		29 – more than the median number of reptile references were used for this aspect of the assessment, indicating a decreased level of uncertainty. 7 - more than the median number of reptile references were used for this aspect of the assessment, indicating a decreased level of uncertainty
DAFWA THREAT CATEGORY - assigned for this study **(Public Safety + ERR) + use of the precautionary approach (when Prelim. Threat Ranking Low or Moderate)**		**EXTREME – NOT ENDORSED BY VPC**
OTHER INFORMATION TO ASSESS PEST RISKS		
CHECKLIST OF FACTORS ASSOCIATED WITH INCREASED RISKS OF ADVERSE IMPACTS OF ESTABLISHED SPECIES (BOMFORD 2008, PP 90-91) (0-9)	**1**,3,6,8,9	
AUSTRALIAN SPECIES POTENTIALLY AT RISK AUSTRALIAN BIRD & MAMMAL MODEL, Q. C6 (BOMFORD 2008, PP 22-23) (0-5)	**5**	
AUSTRALIAN PRIMARY PRODUCTION POTENTIALLY AT RISK AUSTRALIAN BIRD & MAMMAL MODEL, Q. C8 (BOMFORD 2008, PP 23-25) (0-5)	**2**	
ALTERNATIVE THREAT CATEGORY - assigned for this study **(Public Safety + ERR) + arbitrary increase of one rank (based on presence of adverse impact factors 1 or 5, or maximum scoring for predicted effects on Australian species or primary production)**		**EXTREME – NOT ENDORSED BY VPC**
Median number of references for Establishment Risk, Public Safety Risk and Overseas Environmental and Agricultural Adverse Impacts, for all reptiles assessed by (Massam et al 2010) (n=11) Total number of references for this species		20 38 – more than the median number of reptile references were used for this assessment, indicating a decreased level of uncertainty.

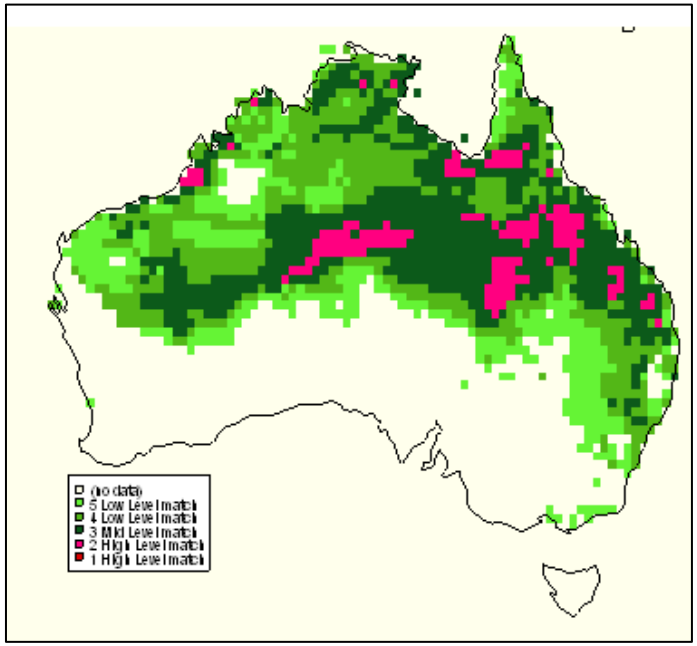
WORLDWIDE DISTRIBUTION - Boa Constrictor (*Boa Constrictor*) including natural populations (black) and introduced populations (red), includes current and past 1000 years

Each black or red dot is a location where meteorological data was sourced for the climate analysis (see B1); faint grey dots are locations available for CLIMATE analysis but are not within the species distribution therefore not used.



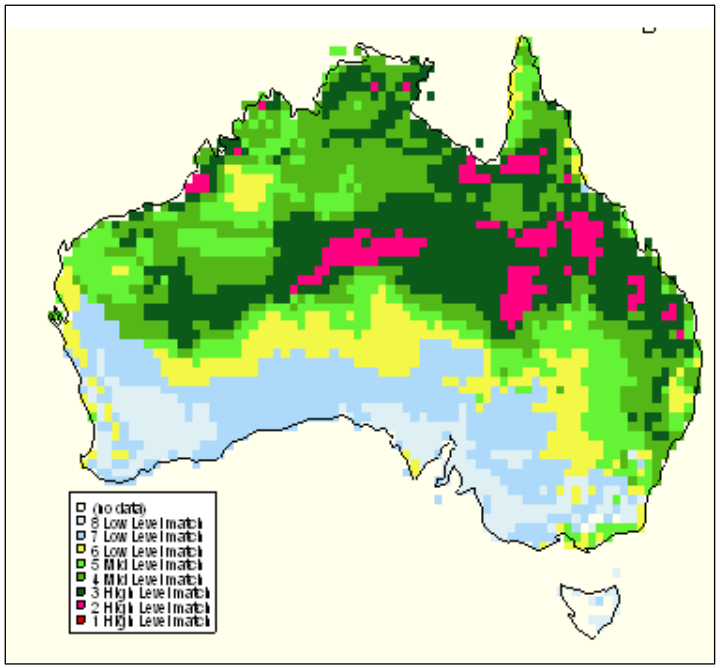
Map 1. Climate match between the world distribution of Boa Constrictor (*Boa Constrictor*) and Australia for five match classes.

Colour on Map	Level of Match from Highest (10) to Lowest (6)	No. Grid Squares on Map
Red	10 HIGH MATCH	0
Pink	9 HIGH MATCH	137
Dark Green	8 MOD MATCH	617
Mid Green	7 MOD MATCH	564
Lime Green	6 LOW MATCH	412
		CMS= 1730



Map 2. Climate match between the world distribution of Boa Constrictor *(Boa Constrictor)* and Australia for eight match classes.

Colour on Map	Level of Match from Highest (10) to Lowest (3)	No. Grid Squares on Map
Red	10 HIGH MATCH	0
Pink	9 HIGH MATCH	137
Dark Green	8 HIGH MATCH	617
Mid Green	7 MOD MATCH	564
Lime Green	6 MOD MATCH	412
Yellow	5 MOD MATCH	329
Blue	4 LOW MATCH	470
Light blue	3 LOW MATCH	235



Boa Constrictor *(Boa Constrictor)* Susceptible Australian Primary Production – Calculating Total Commodity Damage Score

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

Industry	Commodity Value Index (based on 2005-2006 data)	Potential Commodity Impact Score (0-3)	Climate Match to Commodity Score (0–5)	Commodity Damage Score (columns 2 X 3 X 4)
Sheep (includes wool and sheep meat)	**5**	**1**	**2**	**10**
Cattle (includes dairy and beef)	11	0	0	0
Timber (includes native and plantation forests)	10	0	0	0
Cereal grain (includes wheat, barley sorghum etc)	8	0	0	0
Pigs	**1**	**1**	**3**	**3**
Poultry and eggs	**2**	**1**	**3**	**6**
Aquaculture(includes coastal mariculture)	2	0	0	0
Cotton	1	0	0	0
Oilseeds (includes canola, sunflower etc)	1	0	0	0
Grain legumes (includes soybeans)	1	0	0	0
Sugarcane	1	0	0	0
Grapes	0	0	0	0
Other fruit	4	0	0	0
Vegetables	3	0	0	0
Nuts	1	1	0	0
Other livestock (includes goats (McGregor 1997)**, deer, camels, rabbits)**	**0.5**	**1**	**2**	**1**
Honey and beeswax	0.5	0	0	0
Other horticulture (includes flowers etc)	1	0	0	0
Total Commodity Damage Score (TCDS)				**20**

[Table 9 Rational

Potential Commodity Impact Score (0-3)

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

0. Nil (species does not have attributes to make it capable of damaging this commodity)
1. Low (species has attributes making it capable of damaging this or similar commodities and has had the opportunity but no reports or other evidence that it has caused damage in any country or region
2. Moderate–serious (reports of damage to this or similar commodities exist but damage levels have never been high in any country or region and no major control programs against the species have ever been conducted OR the species has attributes making it capable of damaging this or similar commodities but has not had the opportunity)
3. Extreme (damage occurs at high levels to this or similar commodities and/or major control programs have been conducted against the species in any country or region and the listed commodity would be vulnerable to the type of harm this species can cause).

Climate Match to Commodity Score (0–5)

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

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