RISK ASSESSMENT FOR AUSTRALIA – Red Deer (*Cervus elaphus*) (Linnaeus, 1758)

Class - Mammalia, Order - Artiodactyla, Family - Cervidae (Goldfuss, 1820), Genus - *Cervus* (Linnaeus, 1758); (Wilson and Reeder 1993, ITIS Integrated Taxonomic Information System 2007, Catalogue of Life 2008)

GOVERNMENT OF WESTERN AUSTRALIA

Department of Agriculture and Food

Score Sheet

SPECIES: Red Deer (*Cervus elaphus*) Other common names include Wapiti or Elk. **Synonyms:** There is no strong consensus regarding the relationship between *Cervus elaphus* and *Cervus canadensis*. In recent decades, most authors have included *Cervus canadensis* in *C. elaphus*; i.e., North American elk has been regarded as conspecific with Red Deer of western Eurasia (NatureServe 2008). One study addressed whether Red Deer represent only one species (*C. elaphus*) with numerous subspecies distributed all over the Holarctic, or whether there are two different species (*C. elaphus* and *C. canadensis*) consisting of an eastern and a western group, using DNA analysis. It was determined that there is a very high probability for the existence of two different species of Red Deer, with three subspecies in Asia and America (Eastern Red Deer) and four subspecies in Eurasia (Western Red Deer) and additional one or two primordial subspecies in Central Asia (Tarim group) (Ludt et al 2004). **Subspecies:** *C. e. affinis* *C. e. alashanicus* (Alaskan Wapiti) *C. e. bactrianus* (Bactrian Deer) *C. e. barbarus* (Barbary Deer, Atlas Deer) *C. e. corsicanus* (Corsican Red Deer) *C. e. elaphus* (Wapiti) *C. e. hanglu* (Kashmir Deer) *C. e. macneillii* (Sichuan Red Deer) *E. e. wallichi* (Tibetan Red Deer) *C. e. yarkandensis* (Tamrin Red Deer) (Wemmer and IUCN/SSC Deer Specialist Group 1998, CITES 2007, ITIS Integrated Taxonomic Information System 2007).		**Species Description** – The largest of the genus *Cervus*. Head and body length 165-265 cm, tail length 10-27 cm, shoulder height 75-150 cm, and weight 75-509 kg. Animals in the populations of North America and north-eastern Asia are usually larger than those of Europe and southern Asia, and males on average are larger than females. Upper parts are usually reddish-, yellowish- or greyish-brown, darker on the face, belly, neck and legs, and the underparts are paler. There is a prominent pale-coloured patch on the rump and buttocks. The pelage is coarse, and males have a long, dense mane. Males also have well-developed antlers measuring up to about 175 cm along the beam; they are usually six- to eight-tined, and are shed in spring. Females lack antlers. Newborn fawns have white spots on brown or reddish-brown coats (Nowak 1999, Long 2003, King 2005). **General information** – The species is highly gregarious. Discrete herds are formed, each usually occupying a definite area. For most of the year, the sexes stay in separate herds, of usually 4-7 members (not including the calves of females). Herds of as many as 1000 individuals may develop in some areas during certain parts of the year. Groups have a rank hierarchy maintained by threatening gestures, kicks, and chases (Corbet and Harris 1991, Mitchell-Jones et al 1999, Nowak 1999). **Longevity –** Few wild individuals survive more than about 12-15 years; males generally die earlier than females because of the intensity of their fighting (Nowak 1999). Maximum recorded longevity is 31.5 years (HAGR Human Ageing Genomic Resources 2006). **Status –** 1. Red List Category – Lower Risk Least Concern (LR/lc) Rationale: Listed as 'Lower risk least concern' on the IUCN Red List of Threatened Species. A taxon is Lower Risk when it has been evaluated and does not satisfy the criteria for any of the categories Critically Endangered, Endangered, or Vulnerable (Deer Specialist Group 1996). 2. CITES listed Protection Status – CITES Appendices I, II and III Rationale: The subspecies *Cervus elaphus hanglu* (the Kashmir Deer) is included on CITES Appendix I. Appendix I lists species that are the most endangered among CITES-listed animals and plants, and they are threatened with extinction. The subspecies *C. e. bactrianus* (the Bactrian Deer) is included on CITES Appendix II. Appendix II lists species that are not necessarily now threatened with extinction but that may become so unless trade is closely controlled. The subspecies *C. e. barbarus* (the Barbary Deer) Is included on CITES Appendix III. Appendix III is a list of species included at the request of a Party that already regulates trade in the species and that needs the cooperation of other countries to prevent unsustainable or illegal exploitation (CITES 2007).
DATE OF ASSESSMENT: 15/07/2008		**The Risk Assessment Model**

Bird and Mammal Model Used: (Bomford 2008) using PC CLIMATE (Brown et al 2006, Bureau of Rural Sciences 2006)		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 models are being used for the assessments:** Birds and mammals have been assessed using the Australian Bird and Mammal Model (Bomford 2008), pp 16-28, including both versions of stage B, models 1 (4 factors) and 2 (7 factors). All reptiles and amphibians were assessed using three models; the Australian Bird and Mammal Model (Bomford 2008), including Model A, using 3 factors from stage B (pp 54-55), and Model B, using 7 factors from stage B (pp 20), 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 06/05/2008		
FACTOR	**SCORE**	
STAGE A: RISKS POSED BY CAPTIVE OR RELEASED INDIVIDUALS		
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. Choose one:*	1	*Animal that is unlikely to make an unprovoked attack but which can cause serious injury (requiring hospitalisation) or fatality if cornered or handled* Large mammal and males have large antlers. Red Deer stags use their antlers to establish dominance during the rut. Opposing males will walk parallel for a while and then turn suddenly and lock antlers. They push and twist, attempting to throw each other off balance and seeking an opportunity to thrust with the antlers. The hides of old stags are covered with healed scars, and about 5% of males in a population may be expected to die annually from fighting (Nowak 1999). Antlers may be used also in attacks on humans: An employee of a Red Deer ranch was fatally gored by a large bull deer. The man was feeding the captive animal when he was charged at several times and killed. The man had been advised not to go inside the deer pen. The Red Deer had never attacked another worker in the 9 years it had been on the ranch, and it was apparently normally so gentle that children had been allowed to hand feed it (Johnson 2006, TheDenverChannel.com 2006). A man who kept exotic animals on his property was killed when a Red Deer gored him several times in the upper body with its antlers. The man was found in the deer's pen on his property. Deer kill about 150 people a year in the United States, however most of those deaths happen in deer-vehicle collisions (foxnews.com 2007).
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 TO A2 (0–4)**	**1**	
STAGE B: PROBABILITY ESCAPED OR RELEASED INDIVIDUALS WILL ESTABLISH FREE-LIVING POPULATION		
Model 1: Four-factor model for birds and mammals (BOMFORD 2008)		
B1. Degree of climate match between species overseas range and Australia (1–6)	5	*Climate Match Score = 2536 Very high climate match with Australia* [See above information on climate matching.] Climate data from 3762 locations (see species worldwide distribution map) were used to calculate the CMS; natural distribution Eurasia and North America, with introduced populations in Africa, North and South America, Europe, New Zealand, and Australasia (Long 2003) (see B2 and B3 for details).
B2. Exotic population established overseas (0–4)	4	*Exotic population established on an island larger than 50 000 km^2 or anywhere on a continent*

		Red Deer have been introduced to Africa, North America, South America, Europe, New Zealand and Australasia (Lever 1985, Mitchell-Jones et al 1999, Long 2003): **Africa:** • Bioko– Introduced to the island of Bioko (known formerly as Fernando Po) in the Gulf of Guinea in 1954, where Red Deer are still presumably established (Lever 1985, Long 2003). • Morocco – Red Deer were introduced to Morocco between Ceuta and Tangier in 1952. Five stags and 10 hinds were released on the north coast. A number were killed by poachers, but by 1969 two small herds were established (Lever 1985, Long 2003). • South Africa – Introduced in 1895 to an estate between Clocolan and Gum Tree, Orange Free State. In the mid-1930s there were at least 50 Red Deer present. In 1975 some escaped from a zoo or private collection near Vereeniging, Transvaal, and in 1981 5 strays were established there, and were known to be breeding (Lever 1985, Long 2003). **North America:** As a result of re-introductions throughout the United States during the 20th century, Red Deer now inhabit much of their former range (Long 2003), although they are mainly restricted to parts of western Canada and north-western United States (Lever 1985). • Mexico – In 1941, 18 Red Deer were liberated in northern Coahuila, but failed to established, as all had died or been killed by 1943. In 1952 and again in 1955, around 30 Red Deer were liberated at Coahuila, but the results of this attempt are not known. Some animals may have been released again in more recent years, but any success is not known (Long 2003). • Alaska – Since the 1920s there have been about nine translocations/introductions of Red Deer into Alaska. Some were released on Afognak Island in 1929, and by 1960 there were about 8 000 on the island. 8 were released on Kruzof Island 1926-1937; 3 in 1926-1937 and 24 in 1963-64 on Revillaegigedo Island; 8 in 1962 on Gravina Island. In 1928, 8 Red Deer were introduced to Kalsin Bay, Kodiak Island; these were kept in semi-domestication, but because of conflict with a local grazing enterprise, were transferred to Afognak Island in 1929, where they were thriving in 1936 (Long 2003). • Canada – Red Deer have been re-introduced in a number of areas in Canada with considerable success. Red Deer have been introduced with some success to islands off the Coast of Canada. 8 were placed on Graham Island in the Queen Charlotte Islands, where they became successfully established, but were exterminated by 1947. Red Deer were taken to Anticosti Island in 1903 and 1911, but did not establish (Long 2003). **South America:** • Argentina – Red Deer were introduced in Argentina in 1902. They first became established in the wild in 1922, in La Pampa Province, after escaping from a fenced estate. A few still existed in this area to at least the mid-1970s. 20 Red Deer brought in the 1920s to Neuquen Province became established, and were spreading widely and rapidly by the 1940s, they spread across the border into Chile, and south to Bariloche. They were throughout Lanin National Park and in the northern part of adjoining Nahuel Huapi National Park, where about 13 000-15 000 existed in 1965. By the late 1970s, Red Deer were established in the wild in considerable numbers in many widely scattered regions of Argentina (de Vos et al 1956, Lever 1985, Long 2003). • Chile – Red Deer were introduced to Chile during the 1920s for sporting and aesthetic purposes. In 1975 a herd of about 200 Red Deer inhabited an island in Lake Rupanco in

Osorno Province. Another herd established further north on an island in Lake Ranco in the province of Valdivia. Red Deer are also reportedly established in the wild in several localities between Temuco and Puerto Montt, where they are said to compete for grazing with domestic cattle (de Vos et al 1956, Lever 1985, Long 2003).

- Peru – In 1948, 30 Red Deer were translocated from Argentina to the Huacraruco Ranch in the district of San Juan, Cajamarca Province, northern Peru. From here, they were either released or escaped into the neighbouring basin of the Chicamo River, and in the 1970s numbered some 200-300 (Lever 1985, Long 2003).

Europe: In Europe, there have been many translocations and re-introductions of Red Deer within their natural range. Subspecies have also been introduced into the range of other subspecies (Lever 1985, Long 2003).

- Finland – The Province of Aland in Finland was reserved in 1537 as a royal hunting park to which Red Deer were introduced. They survived in this area until 1778, when the last was recorded (Long 2003).
- Switzerland – Red Deer have been naturally immigrating into Switzerland from surrounding areas for at least 75 years. Red Deer now inhabit about 50% of Swiss territory, and the expanding population was estimated about 20,500 in 1980 (Long 2003).

New Zealand:

- More than 250 Red Deer were imported into New Zealand between 1851 and 1919. About 1000 Red Deer had been liberated into the wild in New Zealand by 1923, including most of the imported animals, plus some translocated from earlier established wild herds or local game parks. Most releases were in or near forested and mountainous areas where the resulting herds had space to multiply and spread. Over 50 release sites are known, on all three main islands. Red Deer have now colonised most New Zealand habitats (de Vos et al 1956, King 2005)

Australasia:

- Papua New Guinea − Red Deer were probably introduced to Papua New Guinea at the same time as other deer species in the late 19th century, but now are not established anywhere in that country (Long 2003). [*Note: Because this is only a 'probable' introduction PNG has not been included in the climate analysis or on distribution map*.]
- Australia − Many Red Deer were imported into Australia during 1860-1888, however, the species has not flourished in Australia.
    - Queensland – 6 deer were released at Cressbrook station in 1873 near Toogoolawah in the Brisbane River Valley, Queensland, and again in this area in 1874. By 1878 these were reported to be increasing in numbers and spreading, and in the 1880s large numbers were said to be at Black Jack, Scrub and Waterfall creeks at the head of the Brisbane River. Releases of Red Deer were also made in the Conondale Range area in Queensland in the late 20th century, and also and Cunningham Gap at Maryvale, southern Queensland in 1903. 7 Red Deer were released at Warwick in 1903, and some in the Stanley Range in 1923. From these areas Red Deer spread and in 1978 they ranged from just north of Toowoomba north to Wide Bay Highway, west of Gympie. In the west they reached Gobonog, Nanango and Cooyar, and eastwards reached Northbrook, Conondale and Kandanga. They were also released on Hinchinbrook Island, first in 1900, then again in 1906 and 1915, but all had disappeared by 1918. Today, the only major population of Red Deer in Australia is

		located near the watersheds of the Brisbane and Mary Rivers, where the well-watered, largely ringbarked habitat provides improved pasture and ample cover. o New South Wales – A small and little-known Red Deer herd, the result of a liberation near Aston, NSW, around 1914, today lives around the headwaters of the Snowy River and appears to be expanding slightly southward. o Victoria – Red Deer were liberated in Linton Forest around 1914, and some may still survive there. They were established at Gembrook for some time, probably as a result of escapes or releases in the 1890s. These, however, had all disappeared by about 1946. In eastern Victoria some are established on the border with NSW and these may have originated from escapees and releases around 1918. A large population lived in the Grampians during the 1970s and early 1980s, and probably originated form escapees as early as 1859. A remnant herd, which lived in the softwood plantations and hardwood forest 30 km south-west of Ballarat, appears now to be extinct. o South Australia – Red Deer were released at Yallum Park, near Penola, around 1880, but the herd disappeared soon after. o In NSW, Victoria and SA there are now many smaller Red Deer herds in existence which are gradually increasing in size (A. Moriarty 2008, pers. comm.) o Western Australia – Red Deer were liberated at Cape Leeuwin in 1899, and two years later were said to be thriving. Their numbers began to decline 1924-1930 for unknown reasons. 4 Red Deer were released near Pinjarra in 1903, and by 1912 a herd of 30 were established. Red Deer were released at a second location in Pinjarra in 1915, and this herd numbered about 150 in 1920. This herd became so well established and successful that it was necessary to kill deer as they entered cultivated land. They were dispersed widely between the Dandalup and Murray rivers. A diminishing herd appears to have remained in the area until the last was shot in 1960. There were unconfirmed reports of herds of Red Deer reported at Menzies, north of Kalgoorlie, and in timber south of Coolgardie. (de Vos et al 1956, Strahan 1995, Long 2003, Moriarty 2004, Moriarty Unpublished). *[Note: In North America and Europe, subspecies of Red Deer have been introduced and translocated into the range of other subspecies, and in some instances, have replaced original populations. For this risk assessment, introductions have been considered at a <u>species</u> level; therefore introductions/translocations of subspecies have not been included. Further information on these introductions is provided in (Long 2003)].*
B3. Overseas range size (0–2) < 1 = 0; 1 – 70 = 1; >70 = 2	1	*Overseas range between 1-70 million km^2, estimated at 66.69 million km^2. Includes current and past 1000 years, natural and introduced range.* Red Deer have a wide natural distribution, however, fragmented populations now exist due to local extinction. The species was formerly widespread throughout much of North America, from southern Canada, through most of the conterminous United States, to northern Mexico (between about 56°N and 34°N). The species is now restricted to parts of western Canada and the north-western United States. Red Deer once occurred over most of Europe (including Britain, Corsica, and Sardinia) except for northern Scandinavia, Finland, and some Mediterranean islands; it is now extinct in Albania. The range expands east, through most of the mountain ranges in central Asia, southern Siberia, Mongolia, and the Far East to Manchuria, Korea, and northern western China, and south to the Himalayas and Yunnan. It is now extinct throughout much of Russia. The species also occurs in north-west Africa, in Tunisia and Algeria (Lever 1985, Wemmer and IUCN/SSC Deer

		Specialist Group 1998, Mitchell-Jones et al 1999, Nowak 1999, Long 2003). Introduced populations occur in Africa, North and South America, Europe, New Zealand, and Australasia (Long 2003) (see B2 for details).
B4. Taxonomic Class (0–1)	1	*Mammal* (Catalogue of Life 2008).
B. ESTABLISHMENT RISK SCORE **SUM OF B1-4 (1–13)**	**11**	
Model 2: Seven-factor model for birds and mammals (BOMFORD 2008)		
B5. Diet (0–1)	1	*Generalist with a broad diet of many food types* Diet includes a variety of fresh and dry grass, forbs, ferns, sedges, rushes, shrubs, conifers and woody plants (Corbet and Harris 1991, Latham et al 1999, Nowak 1999). The species can browse up to 180 cm by rearing up on its hind legs. They will eat the bark of some trees, especially rowans, willows, Norway spruce, and Lodgepole pine (Corbet and Harris 1991). The consumption of bark appears to be an important food for Red Deer in areas with severe winters. This is likely related to snow cover leading to winter food shortage, as Red Deer living in mild climates eat little bark, even in winter (Verheyden et al 2006). Red Deer will also consume twigs, seeds and forest fruits (Gebert and Verheyden-Tixier 2001), and also lichen and fungi (Latham et al 1999).
B6. Lives in disturbed habitat (0–1)	1	*Can live in disturbed habitats* Highly adaptable and associated with many climatic and vegetation types (Corbet and Harris 1991). The species is also known from agricultural areas. Population density can affect habitat use by red deer, and habitat use can shift from forest to agriculture lands, this occurs in Hungary where red deer utilize forest-agricultural complexes (Bíro et al 2006). Red Deer utilise a wide variety of habitats in both lowlands and mountains, including dense coniferous forests, open hardwood forests, mountain forests, chaparral, open moorland and grasslands (Mitchell-Jones et al 1999, Nowak 1999)
B7. Non-migratory behaviour (0–1)	1	*Facultative migrant in its native range* Red Deer are usually active during the early morning and late afternoon. In some areas it moves into higher country during the spring and returns to the lowlands in the autumn. Populations in eastern North America do not migrate, but those in the western mountains frequently do, the autumn movement generally being to lower elevations to avoid snow cover. Summer ranges cover a much larger area than winter ranges. In certain areas only a portion of a population migrates. About a fourth of the large Red Deer herd wintering at the Jackson Hole Refuge in Wyoming remains in the same range all year, while the other animals move out for distances as great as 97 km. Alternatively, a large number of the herds in northern Yellowstone remain in high mountains even during severe winters (Nowak 1999). Like most populations of Red Deer in western North America, the Jackson Red Deer herd of northwest Wyoming is migratory, travelling 10-100 km between seasonal ranges (Smith 2007). Home range sizes vary according to the habitat and season as well as the sex of the animal, and

		may extend to hundreds of hectares (Corbet and Harris 1991, Mitchell-Jones et al 1999). On a daily basis in Poland, male Red Deer use 3% of their annual home range, whereas females use 12% of their annual home range, indicating females use their home ranges more intensely than males (Kamler et al 2007).
B. ESTABLISHMENT RISK SCORE **SUM OF B1-7 (1–16)**	**14**	
STAGE C: PROBABILITY AN ESTABLISHED SPECIES WILL BECOME A PEST		
C1. Taxonomic group (0–4)	4	*Mammal in one of the orders that have been demonstrated to have detrimental effects on prey abundance and/or habitat degradation, AND mammal in one of the families that are particularly prone to cause agricultural damage.* Order Artiodactyla, Family Cervidae (Catalogue of Life 2008).
C2. Overseas range size including current and past 1000 years, natural and introduced range (0–2)	2	*Overseas range greater than 30 million km^2. Estimated at 66.69 million km^2.* Overseas distribution Eurasia and North America, with introduced populations in Africa, North and South America, Europe, New Zealand, and Australasia (Long 2003) (see B2 and B3 for details).
C3. Diet and feeding (0–3)	3	*Mammal that is primarily a grazer or browser* The diet of Red Deer varies and involves both grazing and browsing (Mitchell-Jones et al 1999, Nowak 1999). Diet includes a range or herbaceous material (Corbet and Harris 1991, Latham et al 1999, Nowak 1999) (see B5 for details).
C4. Competition with native fauna for tree hollows (0–2)	0	*Does not use tree hollows* After birth calves stand quickly, following the mother after 3 days (Nowak 1999). Bed sites are clear patches of slightly scraped ground, stripped of vegetation (Bíro et al 2006).
C5. Overseas environmental pest status (0–3) *Has the species been reported to cause declines in abundance of any native species of plant or animal or cause degradation to any natural communities in any country or region of the world?*	3	*Major environmental pest in any country or region* The Red Deer is listed on the IUCN's "100 of the World's Worst Invasive Alien Species" list (Global Invasive Species Database 2005). **<u>Browsing damage:</u>** • By browsing on tree seedlings, shrubs and climbers, deer tend to reduce stem densities, limit height growth and reduce foliage density, creating a more open understorey. Deer also tend to reduce the diversity of seedlings, and that effect is greater at higher deer densities (Gill and Beardall 2001). • In the United Kingdom recent studies have shown that the ground flora is being heavily affected by increased levels of grazing within British broadleaved woodland, particularly as a consequence of rising deer populations, including Red Deer. Long-term heavy grazing leads to a decline in relatively palatable species, and the spread of unpalatable ones, or those that are able to tolerate high grazing pressures, such as many grass species. Plant species may survive, but with reduced growth, reflected in shorter leaves/stems, or less dense thickets (Kirby 2001). • In lowland Britain, deer may suppress vegetation regeneration on woodland sites, by feeding on the seed source available for natural regeneration, browsing of seedlings or

planted saplings prior to establishment, browsing of either lateral branches or terminal buds of developing trees, bark-stripping of more mature specimens, or 'fraying' or bark from the main stem of small trees by rubbing them with the antlers. Heavy grazing pressure can result in dramatic changes in the composition and relative abundance of species of the woodland floor, which may be of serious consequence if that flora itself contains rare or valuable species. Browsing may also have a damaging effect upon field and shrub layers, causing changes to woodland architecture and the microclimate offered to other species (Putman and Moore 1998), and browsing and bark-stripping could affect the structure and composition of forest vegetation, as well as of the associated fauna, such as invertebrates and birds (Verheyden et al 2006).

- Red Deer are widespread and abundant on New Zealand, and are common to all forest types. While no studies have demonstrated that Red Deer alone have eliminated the beech forest cover from any extensive area in New Zealand, it may be argued that Red Deer have reduced the extent of beech forest by impeding tree regeneration along forest margins and at other open sites. Although there is abundant evidence that heavy browsing by Red Deer in beech forests can result in marked shifts in understory species composition (including, in some cases, reduction in beech seedling numbers), the long-term effects on the forest regeneration potential are still undetermined (Veblen and Stewart 1982)
- In New Zealand in the early 1900s, Red Deer were modifying native vegetation, and causing increased erosion of water catchments, threatening downstream values. However, the effect of deer browsing on erosion is hard to distinguish from natural erosion, so is therefore no longer seen as a justification for Red Deer control. The worst damage done by Red Deer has been their selective removal of preferred food species, causing major changes in the composition of native vegetation in many areas. The density and complexity of the understorey has been greatly reduced by the loss of palatable herbs, shrubs, understorey woody species, and seedlings. Some sub-canopy trees have been killed by bark-stripping. Average reductions of 50-60% in the densities of woody stems, and of nearly 90% in the densities of seedlings and saplings of shrub-hardwood species, has been attributed to Red Deer browsing. Deer continue to adversely affect regeneration patterns in many forests, although the long-term consequences are still debatable (King 2005).
- In New Mexico, one trial indicated that, at high densities, Red Deer can reduce "growing season" non-woody biomass, forb richness, and aspen regeneration. It seems, however, that Red Deer have little or no impact on summer vegetation in other areas (Kleintjes Neff et al 2007).
- Deer (including Red Deer) browsing on Isla Victoria, South America, has nearly eliminated the subcanopy tree, *Aristotelia chilensis*, which otherwise forms dense understoreys and has significantly reduced the abundance of numerous other woody and herbaceous species (Veblen et al 1989).

Trampling damage:

- In the United Kingdom recent studies have shown that the ground flora is being heavily affected by rising deer populations, including Red Deer. Plants are damaged by trampling, so that their abundance is reduced along deer paths or in areas where deer congregate (Kirby 2001).

Damage to fauna:

		• The effects of deer in woodlands are known to result in habitat changes which can be detrimental to songbirds. The principal mechanism by which deer may affect habitat quality is through the reduction of low woody vegetation by browsing, which forms a key element to the preferred habitat of several species of birds – this may be associated with loss of nest sites, increased exposure to predators, and reduction of food (Gill and Fuller 2007). • In New Mexico, the response of butterflies to Red Deer herbivory was monitored. The results of the trial indicated that, at high densities, Red Deer can reduce aspen growth regeneration and, therefore, potentially alter adult butterfly species community composition in aspen-mixed conifer forests (Kleintjes Neff et al 2007). • Deer grazing and browsing may impact fauna indirectly. The majority of herbivorous insects feed almost entirely on one or a very limited number of plant species. As a result, their diversity is likely to be directly related to the richness of the plant community. In contrast, predators do not need to be so specific, but instead rely on strategies such as camouflage to obtain prey. The diversity of predators may therefore depend as much on vegetation structure as plant species composition (Gill 2000). • In Scotland, the effect of grazing by Red Deer was assessed – lepidopterous (butterfly and moth) larvae formed 60% of all invertebrates observed, and the number of larvae was higher in ungrazed areas than grazed areas. Deer may act as competitors with the larvae for fresh, easily digestible leaves and new tips, or they may indirectly predate moth eggs or larvae laid near growing tips. Reductions in larval abundance associated with Red Deer grazing may also have knock-on effects for other animals species feeding on larvae, such as insectivorous forest birds (Baines et al 1994). • In some regions in Switzerland it is thought that Red Deer compete with food and habitat with the Alpine Chamois (*Rupicapra rupicapra*) (Long 2003). • In Argentina, South America, Red Deer have invaded several National parks. Of particular concern is the possible competition with the Patagonian Huemul (*Hippocamelus bisulcus*), an endangered Deer endemic to the southern parts of Chile and Argentina – there is now evidence of extensive dietary overlap with this endangered native cervid, and is also likely with Guanaco (*Lama guanicoe*), another native ungulate (Global Invasive Species Database 2005). **Spread of weeds:** • Red Deer can act as agents for seed dispersal and have the potential to spread seeds of pest plants. Fruits and seeds are readily eaten by deer, and may form a substantial part of their diet, particularly in autumn when many species are fruiting. Seeds may also be eaten inadvertently, when other plant parts are being ingested. Ungulates are known to act as dispersal agents for a number of plant species by passing seeds through their gut, carrying them on their coats, or between their hooves, or simply spitting out seeds after mastication or rumination (Gill and Beardall 2001). **General damage:** • The four species of feral deer in Queensland Australia, including Red Deer, all feed on a combination of shrub, understorey and grass species. Reports indicate that two deer species have caused significant environmental damage where deer numbers are high, but that all the species could have some impact on their environments. However, without

		comparative studies of the area before deer established it is not possible to assess the environmental changes that may have occurred over the last 100 years. (Jesser 2005). **Positive impacts:** • Invertebrate groups that benefit from deer include dung beetles, both external and internal parasites, and species dependent on carrion. Three species of Dung Beetle (*Aphodius* spp.) with a limited range are known to occur in British woodlands and use deer faecal pellets. There are also 13 rare species of carrion feeding beetles (mostly Sexton and Rove Beetles, *Nicriphorus* spp., *Silpha* spp., *Sphaerites* spp., *Aleochora* spp., *Omalium* spp.), that are known to occur in these woodlands. With the decline in extensive grazing, especially in woodland habitats, both dung and carrion feeders are now likely to be very dependent on deer (Gill 2000). • In England and Wales, deer impact on heathlands, grasslands and wetlands is generally welcomed, as it assists in reducing the invasion of scrub (Putman and Moore 1998).
C6. Climate match to areas with susceptible native species or communities (0–5) *Identify any native Australian animal or plant species or communities that could be susceptible to harm by the exotic species if it were to establish a wild population here.*	5	*One or more susceptible native species or ecological communities that are listed as vulnerable or endangered under the Australian Government* Environment Protection and Biodiversity Conservation Act 1999 *has a restricted geographical range that lies within the mapped area of the highest six climate match classes for the exotic species being assessed.* Reference for all vulnerable or endangered species and communities (status noted in bold) (Dept of the Environment Water Heritage and the Arts 2007, 2008). Susceptible Australian native species or natural communities that could be threatened include ground nesting birds, which may have their nests and/or eggs trampled; and plants and communities which may be damaged due to Red Deer grazing and/or trampling: **Birds: Critically endangered** – Spotted Quail-thrush (Mt Lofty Ranges) (*Cinclosoma punctatum anachoreta*); **Endangered** – Chestnut-rumped Heathwren (Mt Lofty Ranges) (*Hylacola pyrrhopygia parkeri*), Western Ground Parrot (*Pezoporus wallicus flaviventris*), Buff-breasted Button-quail (*Turnix olivii*); **Vulnerable –** Western Bristlebird (*Dasyornis longirostris*), Partridge Pigeon (*Geophaps smithii*), Mallee Emu-wren (*Stipiturus mallee*) (Pizzey and Knight 1997, Barrett et al 2003). **Mammals: Critically endangered** – Gilbert's Potoroo (*Potorous gilbertii*); **Endangered** – Northern Hairy-nosed Wombat (*Lasiorhinus krefftii*), Bridled nail-tail Wallaby (*Onychogalea fraenata*), Prosperine Rock-wallaby (*Petrogale Persephone*), Long-footed Potoroo (*Potorous longipes*); **Vulnerable** – Quokka (*Setonix brachyurus*) (Strahan 1995). **Invertebrates: Critically endangered** – Golden Sun Moth (*Synemon plana*); **Endangered** – Gove Crow Butterfly (*Euploea alcathoe*), a moth (*Phyllodes imperialis*); **Vulnerable** –– Bathurst Copper Butterfly (*Paralucia spinifera*). **Plants: Critically endangered –** Canberra Spider-orchid (*Arachnorchis actensis*), Black-tipped Spider-orchid (*A. anthracina*), Windswept Spider-orchid (*A. dienema*), Lindley's Spider-orchid (*A. lindleyana*), Rosy Spider-orchid (*A. pallida*), Sagg Spider-orchid (*A. saggicola*), Myrtle elbow orchid (*Thynninorchis nothofagicola*), Native Wintercress (*Barbarea australis*), Thick-stem Caladenia (*Petalochilus campbellii*), Robust Fingers (*P. tonellii*), Forest Fingers (*P. sylvicola*), Kilsyth South Spider-orchid (*Caladenia sp.*), Blue Tinsel Lily (Calectasia cyanea), Brindabella Midge-orchid (*Corunastylis ectopa*), Firth's Midge-orchid (*C. firthii*), Maroon-flowered Daviesia (*Daviesia glossosema*), Bearded Heath (*Epacris barbata*), Border Heath (*E. limbata*), Stuart's Heath (*E. stuartii*), a herb (*Euphrasia gibbsiae subsp. psilantherea*), Davies' Waxflower (*Phebalium daviesii*),

		Freycinet Waxflower (*Philotheca freyciana*), Chestnut Leek-orchid (*Prasophyllum castaneum*), Western Leek-orchid (*P. favonium*), Milford Leek-orchid (*P. milfordense*), Fleurieu Leek Orchid (*P. murfetii*), Pungent Leek-orchid (*P. olidum*), Knocklofty Leek-orchid (*P. perangustum*), Pretty Leek-orchid (*P. pulchellum*), Robust Leek-orchid (*P. robustum*), Ben Lomond Leek-orchid (*P. stellatum*), Sky-blue Sun-orchid *(Thelymitra jonesii*). **Endangered –** Fitzgerald Woollybush (*Adenanthos dobagii*), Velvet Woollybush (*A. velutinus*), Roadside Wallaby Grass (*Austrodanthonia popinensis*), a shrub (*Baeckea kandos*), a shrub (*Bertya granitica*), Scott River Boronia (*Boronia exilis*), Granite Boronia (*B. granitica*), Repand Boronia (*B. repanda*), Ironcap Boronia (*B. revoluta*), Charming Spider-orchid (*Arachnorchis amoena*) plus many other orchid species, Drummond's Grass (*Deyeuxia drummondii*), Apsley Heath (*Epacris apsleyensis*), Funnel Heath (*E. glabella*), Grand Heath (*E. grandis*). **Vulnerable** – Desert Flannel-flower (*Actinotus schwarzii*), Yass Daisy (*Ammobium craspedioides*), River Swamp Wallaby-grass (*Amphibromus fluitans*), Slender Tailflower (*Anthocercis gracilis*), Hairy-joint Grass (*Arthraxon hispidus*), Water Tassel-fern (*Huperzia marsupiiformis*), Square Tassel-fern (*H. prolifera*), a fern (*Lastreopsis walleri*), Marble Daisy-bush (*Olearia astroloba*), Budawangs Wallaby-grass (*Plinthanthesis rodwayi*), Salt-lake Tussock-grass (*Poa sallacustris*), Lilac Leek-orchid (*Prasophyllum colemaniae*), Tawny Leek-orchid (*P. fuscum*), Pale Leek-orchid (*P. pallidum*), Dense Leek-orchid (*P. spicatum*), Sturdy Leek-orchid (*P. validum*). **<u>Communities</u>: Endangered** – Eastern Stirling Range Montane Heath and Thicket, Natural Temperate Grassland of the Southern Tablelands of NSW and the Australian Capital Territory, Shrublands on southern Swan Coastal Plain ironstones.
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* • Throughout their range, Red Deer compete with livestock and forestry. They are considered as having a major impact on commercial forestry and the conservation of some native plants and woodland. In Britain they are reared intensively on more than 200 deer farms, mainly for meat (Corbet and Harris 1991). In most of Europe, Red Deer are an important game animal (Mitchell-Jones et al 1999). Agricultural fields can satisfy the ecological requirements of Red Deer during the vegetation growth period of their natural browse from the forest shrub layer (Bíro et al 2006). • Deer in Britain affect not just farmers and foresters, but also horticulture, fruit production, domestic gardening, allotments, suburbs and city centres as well as the countryside and remote parts of Scotland (Blake 2007). • In England and Wales, the majority of agricultural damage reported was due to Fallow, Red and Roe Deer. Most reports were of damage to pasture or cereals, with oilseed rape, market gardens, nursery and orchard crops also frequently damaged. In commercial forestry, Red Deer may cause damage by browsing on young or established trees, stripping bark from established trees or causing damage to stems with antlers. Red Deer are regularly observed grazing out in arable crops; grazing is particularly heavy during the period of vegetative growth in winter and spring, although Red Deer may return to cereal crops just as the ears are ripening and feed directly on the ripening ears. The species may also cause some damage to ripening crops by crushing stems in bedding sites or by rolling in the crop. Further costs are incurred in relation to measures aimed at reducing damage, such as fencing, or employment of hunters to reduce Red Deer numbers. However, despite the apparent severity of damage caused to agriculture or forestry, the actual economic significance of such damage would appear in many cases to be negligible or small. Field crops frequently recover completely from such damage, and

		although woodland crops may be first checked and quality of the timber may be reduced as a consequence of earlier browsing damage, losses may be far less than they first appear (Putman and Moore 1998). • Red Deer populations are currently increasing in density and expanding their range in many Scottish forests. These populations are responsible for damage to commercial tree crops. The economic significance of damage caused to commercial tree crops is difficult to quantify, owing to the uncertainty surrounding the potential for the tree to recover following injury. But, in some circumstances browsing can reduce early height increment thereby increasing establishment costs. Bark stripping injuries can result in downgrading of timber from high quality structural grades to pulp or fire wood (Ratcliffe 1989). In 1990 the British Forestry Commission estimated that fencing costs and direct culling costs together amounted to around £1.5 million throughout Scotland. For plantations in the Scottish uplands, damage due to deer browsing and bark-stripping can amount to as much as 40% of the crop (Putman and Moore 1998). • Studies of Red Deer in Hungary indicate that as many as 89.2% of poplar trees may be damaged. High and moderate damage did not affect the commercial value of the timber produced, however, severe damage did. Damage to agricultural crops and forestry is reported to be considerable (Long 2003). • In Germany, Red Deer cause damage to forest trees and feed on crops planted adjacent to forests. Damage to agricultural crops can be extensive (Long 2003). Red Deer sometimes cause damage in forest nurseries in Russia, but supplementary feeding prevents deer damage, except when Red Deer feed exclusively on trees (Long 2003). • Conflict in North America occurs with ranging interests when Red Deer descend onto private land in winter or spring and use forage needed for livestock. Competition with sheep occurs when both deer and sheep graze summer weedy patches or in winter when they both graze and browse the same areas. In some areas of Montana, competition with both cattle and sheep is indicated in areas used by deer in winter (Long 2003). • In New Zealand in the early 1900s, Red Deer were seen as competing with livestock and damaging crops. This concern is no longer prominent, as Deer are mainly restricted to unfarmed areas by hunting, so direct competition with stock is minimal (although wild Red Deer infected with Bovine tuberculosis continue to pose an indirect threat to the beef, dairy and deer farming industries) (King 2005). • In south-east Queensland, damage to forestry seedlings, agricultural crops, commercial flower crops, and orchards has been observed. Red Deer also reportedly compete for forage with cattle (Jesser 2005). Most damage is caused to crops and pastures during severe winters, and numbers of Deer are occasionally destroyed (Long 2003).
C8. Climate match to susceptible primary production (0–5) *Assess Potential Commodity Impact Scores for each primary production commodity listed in Table 9, based on species' attributes (diet, behaviour, ecology), excluding risk of spreading disease which is addressed in Question C9.*	5	*Score = 570 (Bomford 2008)* See Commodity Scores Table – species has attributes making it capable of damaging sheep, cattle, timber, cereal grain, oilseed, grain legume, fruit, vegetable, other livestock, and other horticultural commodities.
C9. Spread disease (1–2)	2	*All birds and mammals (likely or unknown effect on native species and on livestock and other domestic animals).*
C10. Harm to property (0–3)	1	*$1.00-10 million*

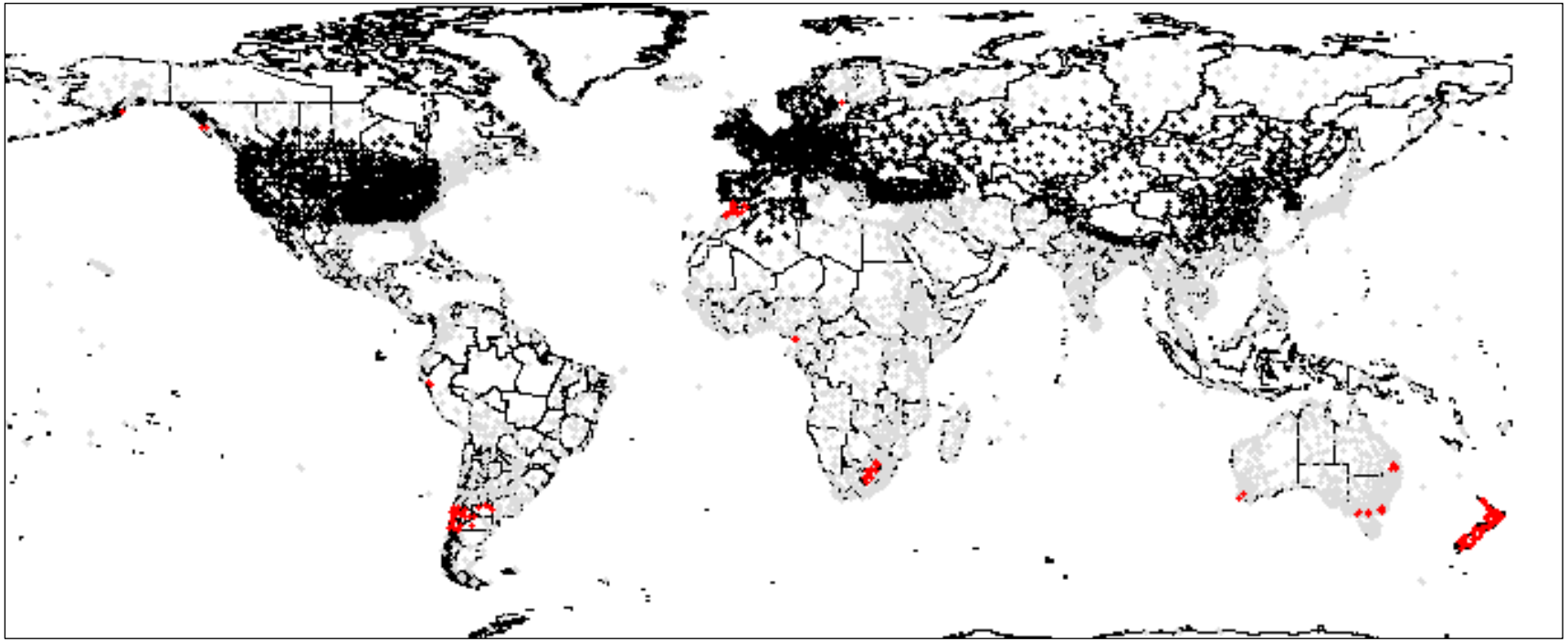
		Significant damage may be caused to cars in deer-vehicle collisions (Animal Attack Files 2000, 2001a). In Britain, collisions between vehicles and Deer run at a rate of 74,000 a year, and the cost to motorists is massive (Blake 2007). The annual number of vehicle collisions with ungulates (including Red Deer) in Europe is estimated to cause material damage amounting to $1 billion (US) (Groot Bruinderink and Hazebroek 1996). Deer may also cause physical damage to fences and walls (Putman and Moore 1998). One report of a deer smashing through a window of an elderly couple's home, breaking a table, stove and microwave oven (Animal Attack Files 2001b). This type of damage by Red Deer is unlikely to be a regular occurrence. Red Deer may cause damage to ornamental home gardens, by browsing and trampling. Deer in Britain are affecting domestic gardening, allotments, suburbs and city centres as well as the countryside and remote parts of Scotland. Red Deer have been known to make golf courses unplayable due to their hoof prints in the greens (Blake 2007)
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	*Moderate risk – injuries or harm moderate but unlikely to be fatal and few people at risk* Red Deer stags have large antlers used for establishing dominance during the rutting season (Nowak 1999); antlers have been used by deer to cause harm to humans. • During a hunting trip, a man was kicked to death by a Red Deer (The Onion 1998). • An elderly woman was trampled in her backyard, by a female Red Deer protecting her newborn calf. The woman suffered severe abdominal injuries. Dangerous encounters between Red Deer and residents of Estes Park, Colorado, are not uncommon, especially during the calving season (Ragan 2002). • An elderly couple had to be treated for minor injuries from broken glass after a large Red Deer smashed through a kitchen window and landed on their breakfast table. It is thought the Deer was searching for its newly born calf (Animal Attack Files 2001b). • While deer kill about 150 people a year in the United States, most of these deaths happen in deer-vehicle collisions (foxnews.com 2007). A man was killed when a deer hit by a car travelling in the opposite direction crashed through his windshield and hit him in the head; another two people were killed and one injured when their vehicle hit a deer (Animal Attack Files 2000). In a similar case, a deer went through the windshield of a vehicle, killing the passenger (Animal Attack Files 2001a). (N. B. In all these deer-vehicle collision examples, the deer species is not specified.) • In Europe between 2000-2005, 20 people died, 134 were seriously injured, and 600 suffered minor injuries as a result of deer-vehicle collisions (Blake 2007); Red Deer account for only a small percentage of ungulate-traffic collisions (Groot Bruinderink and Hazebroek 1996). **Zoonoses:** Free-ranging Deer are thought to be relatively free of major diseases (Corbet and Harris 1991). No specific reports found of Red Deer carrying zoonotic diseases. Red Deer can act as hosts for disease carrying ticks, such as Lyme Disease - transmission of spirochaete through tick bite; symptoms include malaise, fatigue, chills, pyrexia, headache, episodic polyarthritis, cardiac and neurological abnormalities; If diagnosed in the early stages, Lyme Disease can be cured with antibiotics without treatment, complications involving joints, the heart, and the nervous system can occur. (Stevenson and Hughes 1988, Duffy et al 1994). Wild deer may also be a source of zoonoses such as Leptospirosis. Infection from either of these diseases is more likely in

		those coming into close contact with wild deer, such as hunters and agricultural workers. However, the potential for disease transmission becomes an increasing public health issue as wild deer intrude more into outer urban areas (Jesser 2005).
C. PEST RISK SCORE **SUM C 1 TO 11 (1–37)**	**30**	
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	**11**	**EXTREME ESTABLISHMENT RISK**
STAGE B. ESTABLISHMENT RISK RANK – RISK OF ESTABLISHING A WILD POPULATION **MODEL 2: SEVEN-FACTOR MODEL FOR BIRDS AND MAMMALS (BOMFORD 2008)** ≤ 6 = low establishment risk; 7-11 = moderate establishment risk; 12-13 = serious establishment risk; ≥14 = extreme establishment risk	**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	**30**	**EXTREME PEST RISK**
VERTEBRATE PESTS COMMITTEE THREAT CATEGORY		**EXTREME - ENDORSED BY VPC**
Median number of references per mammal, for all mammals assessed by (Massam et al 2010) (n=17) Total number of references for this species *(median number for references for Public Safety Risk, Establishment Risk and Overseas Environmental and Agricultural Adverse Impacts)*		37 39 – more than the median number of mammal references were used for this assessment, indicating a decreased level of uncertainty.

World Distribution – Red Deer (*Cervus elaphus*), includes current and past 1000 years; including natural populations (black) and introduced populations (red).

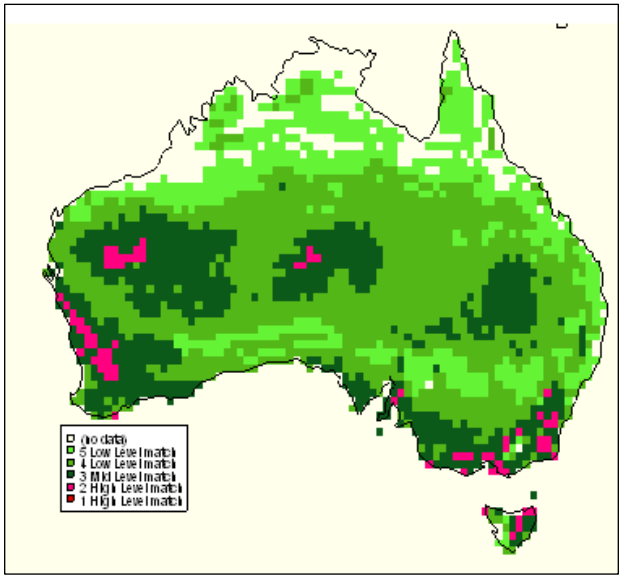
Each black or red dot is a location where meteorological data was sourced for the climate analysis (see B1), faint grey dots are locations available for CLIMATE analysis but are not within the species' distribution therefore not used.

[Note: The Australian distribution indicated, was not included in the climate analysis for this assessment. However, to assist predictions of further spread within Australia, an analysis with Australian distribution has also been included on page 17 for comparison.]



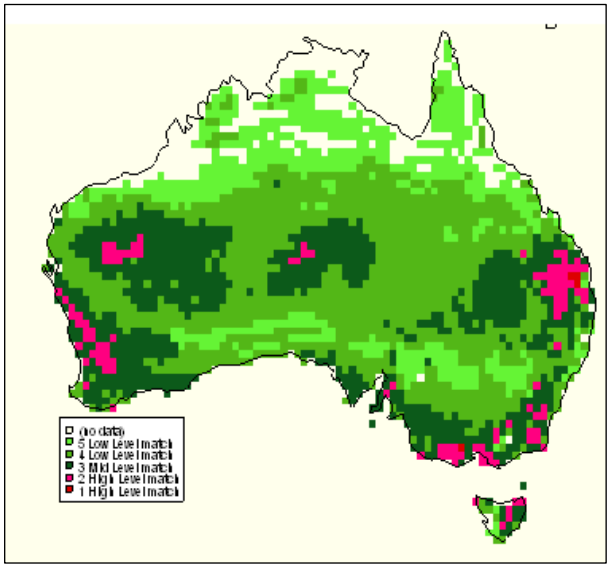
Map 1. Climate match between the world distribution of Red Deer (*Cervus elaphus*) and Australia for five match classes.

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	75
Dark Green	8 MOD MATCH	659
Mid Green	7 MOD MATCH	1190
Lime Green	6 LOW MATCH	612
		CMS = 2536



Map 2. Climate match between the world distribution (including Australian distribution) of Red Deer (*Cervus elaphus*) 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	4
Pink	9 HIGH MATCH	115
Dark Green	8 MOD MATCH	713
Mid Green	7 MOD MATCH	1155
Lime Green	6 LOW MATCH	556
		CMS = 2543



Red Deer *(Cervus elaphus)* Susceptible Australian Primary Production – Calculating Total Commodity Damage Score

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

Industry	Commodity Value Index 1 (CVI based on 2005- 06 data)	Potential Commodity Impact Score (PCIS 0-3)	Climate Match to Commodity Score (CMCS 0–5)	Commodity Damage Score (CDS columns 2 X 3 X 4)
Cattle (includes dairy and beef) consumption of stock fodder consumption of stock fodder only therefore commodity value adjusted down by 1/3	**11**	**3**	**4**	**132**
Timber (includes native and plantation forests)	**10**	**3**	**4**	**120**
Cereal grain (includes wheat, barley sorghum etc) no reports of damage to this commodity	**8**	**3**	**4**	**96**
Sheep (includes wool and sheep meat) consumption of stock fodder only therefore commodity value adjusted down by 1/3	**5**	**3**	**5**	**75**
Fruit (includes wine grapes)	**4**	**3**	**5**	**60**
Vegetables	**3**	**3**	**5**	**45**
Poultry and eggs	2	0	0	0
Aquaculture(includes coastal mariculture)	2	0	0	0
Oilseeds (includes canola, sunflower etc) no reports of damage to this commodity	**1**	**3**	**5**	**15**
Grain legumes (includes soybeans) no reports of damage to this commodity	**1**	**3**	**5**	**15**
Sugarcane	1	0	0	0
Cotton	1	0	0	0
Other crops and horticulture (includes nuts tobacco and flowers etc)	**1**	**2**	**4**	**8**
Pigs	1	0	0	0
Other livestock (includes goats, deer, camels, rabbits)	**0.5**	**2**	**4**	**4**
Bees (included honey, beeswax and pollination)	0.5	0	0	0
Total Commodity Damage Score (TCDS)				**570**

[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:

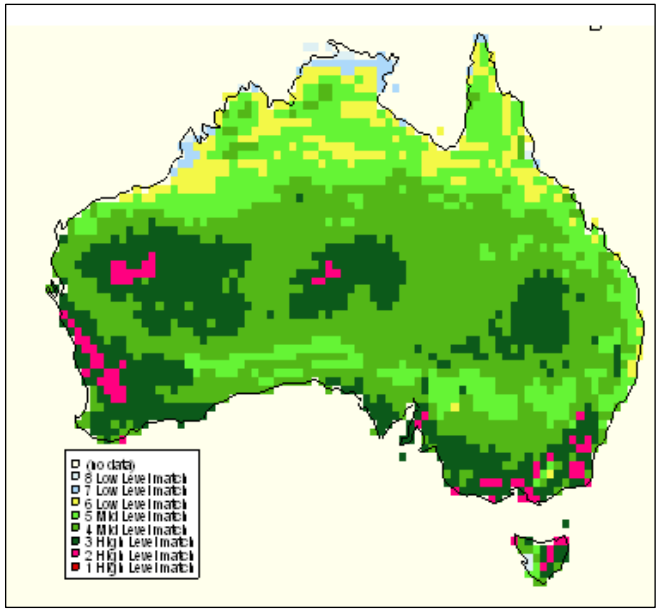
0. Nil (species does not have attributes to make it capable of damaging this commodity)
1. Low (species has attributes making it capable of damaging this or similar commodities and has had the opportunity but no reports or other evidence that it has caused damage in any country or region
2. Moderate–serious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

Map 3. Climate match between the world distribution of Red Deer *(Cervus elaphus)* 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	75
Dark Green	8 HIGH MATCH	659
Mid Green	7 MOD MATCH	1190
Lime Green	6 MOD MATCH	612
Yellow	5 MOD MATCH	199
Blue	4 LOW MATCH	35
Light blue	3 LOW MATCH	14



References

Animal Attack Files (2000). Man killed by deer sent airborne by another car. http://www.igorilla.com/gorilla/animal/2000/deer_hits_driver.html [Access date:28/05/2008].

(2001a). Deer crashes into Florida woman's car; passenger dies. http://www.igorilla.com/gorilla/animal/2001/deer_crashes.html [Access date:28/05/2008].

(2001b). Elk wrecks house in breakfast rampage. http://www.igorilla.com/gorilla/animal/2001/elk_wreaks_house.html [Access date:17/07/2008].

Baines D, Sage RB and Baines MM (1994). The implications of Red Deer grazing to ground vegetation and invertebrate communities of Scottish native pinewoods *Journal of Applied Ecology,* 31(4):776-783.

Barrett G, Silcocks A, Barry S, Cunningham R and Poulter R (2003). *The New Atlas of Australian Birds*. Royal Australasian Ornithologists Union/Birds Australia.

Bíro Z, Szemethy L, Katona K, Heltai M and Peto Z (2006). Seasonal distribution of red deer (*Cervus elaphus*) in a forest-agriculture habitat in Hungary. *Mammalia,* 70(1-2):70-75.

Blake D (2007). Deer in Britain: the challenges for nature conservation *Ecos - British Association of Nature Conservationists,* 28(2):41-49.

Bomford M (2003). Risk Assessment for the Import and Keeping of Exotic Vertebrates in Australia. Bureau of Rural Sciences, Canberra.

(2006). Risk assessment for the establishment of exotic vertebrates in Australia: recalibration and refinement of models - A report produced for the Department of Environment and Heritage. Bureau of Rural Sciences, Canberra.

(2008). Risk assessment models for establishment of exotic vertebrates in Australia and New Zealand - A report produced for the Invasive Animals Cooperative Research Centre. Bureau of Rural Sciences, Canberra.

Bomford M, Kraus F, Braysher M, Walter L and Brown L (2005). Risk Assessment Model for the Import and Keeping of Exotic Reptiles and Amphibians. A report produced for the Department of Environment and Heritage. Bureau of Rural Sciences, Canberra.

Brown L, Barry S, Cunningham D and Bomford M (2006). Current practice in applying CLIMATE for weed risk assessment in Australia. In: Proceedings of the 15th Australian Weeds Conference, Adelaide, South Australia, pp.703-706.

Bureau of Rural Sciences (2006). CLIMATE software. Bureau of Rural Sciences, Department of Agriculture, Fisheries and Forestry, Canberra. http://adl.brs.gov.au/anrdl/metadata_files/pe_brs90000003434.xml [Access date:09/04/2010].

Catalogue of Life (2008). Catalogue of Life: 2008 Annual Checklist. http://www.usa.species2000.org [Access date:09/04/2010].

CITES (2007). Appendices I, II and III. CITES (the Convention on International Trade in Endangered Species of Wild Fauna and Flora). http://www.cites.org [Access date:01/02/2008].

Corbet GB and Harris S (1991). *The Handbook of British Mammals*. Blackwell Science, Oxford.

de Vos A, Manville RH and Van Gelder RG (1956). Introduced mammals and their influece on native biota. *Zoologica (New York),* 41(4):163-194.

Deer Specialist Group (1996). *Cervus elaphus*. IUCN Red List of Threatened Species. www.iucnredlist.org [Access date:08/02/2008].

Dept of the Environment Water Heritage and the Arts (2007). Threatened species and threatened ecological communities. http://www.environment.gov.au/biodiversity/threatened/species.html [Access date:09/04/2010].

(2008). EPBC Act List of Threatened Ecological Communities. Australian Government. http://www.environment.gov.au/cgi-bin/sprat/public/publiclookupcommunities.pl [Date accessed:15/01/2008].

Duffy DC, Campbell SR, Clark D, Domova C and Gurney S (1994). *Ixodes scapularis* (Acari: Ixodidae) Deer Tick Mesoscale Populations in Natural Areas: Effects of Deer, Area, and Location. *Journal of Medical Entomology,* 31(1).

foxnews.com (2007). Ga. Man Killed in Apparent Deer Attack. The Associated Press. http://www.foxnews.com/wires/2007Oct08/0,4670,DeerAttack,00.html [Access date:16/07/2008].

Gebert C and Verheyden-Tixier H (2001). Variations of diet composition of Red Deer (*Cervus elaphus* L.) in Europe. *Mammal Review,* 31(3-4):189-201.

Gill R (2000). The Impact of Deer on Woodland Biodiversity. Forestry Commission Information Note 36. http://www.forestry.gov.uk [Access date:07/05/2008].

Gill RMA and Beardall V (2001). The impact of deer on woodlands: the effects of browsing and seed dispersal on vegetation structure and composition. *Forestry,* 73(3):209-218.

Gill RMA and Fuller RJ (2007). The effects of deer browsing on woodland structure and songbirds in lowland Britain. *Ibis,* 149:119-127.

Global Invasive Species Database (2005). *Cervus elaphus* (mammal). Invasive Species Specialist Group http://www.issg.org/database/species/ecology.asp?si=119&fr=1&sts= [Access date:08/02/2008].

Groot Bruinderink G and Hazebroek E (1996). Ungulate traffic collisions in Europe. *Conservation Biology,* 10(4):1059-1067.
HAGR Human Ageing Genomic Resources (2006). AnAge Database. Human Ageing Genomic Resources http://genomics.senescence.info/ [Access date:09/04/2010].
ITIS Integrated Taxonomic Information System (2007). Integrated Taxonomic Information. www.itis.gov [Access date:31/01/2008].
Jesser P (2005). *Deer in Queensland - Pest Status Review*. State of Queensland (Department of Natural Resources and Mines) Brisbane. www.dpi.qld.gov.au/cps/rde/xbcr/dpi/IPA-Deer-PSA.pdf.
Johnson B (2006). Captive elk's fate uncertain after attack. Craig Daily Press. http://www.craigdailypress.com/news/2006/feb/10/captive_elks_fate/ [Access date:17/07/2008].
Kamler JF, Jedrzejewska B and Jedrzejewski W (2007). Factors affecting daily ranges of red deer *Cervus elaphus* in Bialowieża Primeval Forest, Poland *Acta Theriologica,* 52(2):113-118
King CM (2005). *The Handbook of New Zealand Mammals*. Oxford University Press, Auckland, pp.600.
Kirby KJ (2001). The impact of deer on the ground flora of British broadleaved woodland *Forestry,* 74(3):219-229.
Kleintjes Neff PK, Fettig SM and VanOverbeke DR (2007). Variable response of butterflies and vegetation to elk herbivory: an exclosure experiment in ponderosa pine and aspen-mixed conifer forests. *Southwestern Naturalist,* 52(1):1-14.
Latham J, Staines BW and Gorman ML (1999). Comparative feeding ecology of red (*Cervus elaphus*) and roe deer (*Capreolus capreolus*) in Scottish plantation forests. *Journal of Zoology,* 247(3):409-418.
Lever C (1985). *Naturalised Mammals of the World*. Longman, London.
Long JL (2003). *Introduced Mammals of the World: Their History, Distribution and Influence*. CSIRO Publishing, Collingwood, Australia.
Ludt CJ, Schroeder W, Rottmann O and Kuehn R (2004). Mitochondrial DNA phylogeography of red deer (*Cervus elaphus*). *Molecular Phylogenetics and Evolution,* 31:1064-1083.
Massam M, Kirkpatrick W and Page A (2010). Assessment and prioritisation of risk for 40 exotic animal species Department of Agriculture and Food, Western Australia. Invasive Animals Cooperative Research Centre, Canberra.
Mitchell-Jones AJ, Amori G, Bogdanowicz W, Krystufek B, Reijnders PJH, Spitzenberger F, Stubbe M, Thissen JBM, Vohralik V and Zima J (1999). *The Atlas of European Mammals*. Academic Press, London.
Moriarty A (2004). The liberation, distribution, abundance and management of wild deer in Australia. *Wildlife Research,* 31:291-299.
Moriarty AJ (Unpublished). *A review of the ecology of wild deer species in Australia*. Department of Environment and Climate Change, Albury, NSW.
Natural Resource Management Standing Committee (2004). Guidelines for the Import, Movement and Keeping of Exotic Vertebrates in Australia. Developed by the Vertebrate Pests Committee http://www.feral.org.au/feral_documents/VPCGuidelinesApril05.pdf [Access date:09/04/2010].
NatureServe (2008). *Cervus canadensis* (Linnaeus, 1758) NatureServe Explorer, Virginia, USA. http://www.natureserve.org/explorer/servlet/NatureServe?searchName=Cervus+canadensis [Access date:21/07/2008].
Nowak RM (1999). *Walker's Mammals of the World Vol II*. The Johns Hopkins University Press, Baltimore.
Pheloung PC (1996). *CLIMATE: a system to predict the distribution of an organism based on climate preferences*. Agriculture Western Australia, Perth.
Pizzey G and Knight F (1997). *The Graham Pizzey and Frank Knight Field Guide to the Birds of Australia*. Angus and Robertson.
Putman RJ and Moore NP (1998). Impact of deer in lowland Britain on agriculture, forestry and conservation habitats. *Mammal Review,* 28(4):141-164.
Ragan T (2002). Woman injured in elk attack/DOW says mother was protecting calf; no. The Gazette (Colorado Springs). http://findarticles.com/p/articles/mi_qn4191/is_20020606/ai_n10005769 [Access date:16/07/2008].
Ratcliffe PR (1989). The control of red and sika deer populations in commercial forests. In: Mammals as Pests (ed by Putman RJ). Chapman and Hall, London, pp.98-115.
Smith BL (2007). Migratory behavior of hunted elk. *Northwest Science,* 81(4):251-264.
Stevenson WJ and Hughes KL (1988). *Synopsis of zoonoses in Australia*. Australian Government Publishing Service, Canberra.
Strahan R (1995). *The Mammals of Australia*. Reed New Holland, Sydney, Auckland, London, Cape Town.
The Onion (1998). Wife Too Busy Videotaping Elk Attack To Save Husband's Life. http://www.theonion.com/content/node/31916 [Access date:17/07/2008].
TheDenverChannel.com (2006). Man Killed By Bull Elk In Moffat County: Ranch Employee was Feeding Captive Elk. http://www.thedenverchannel.com/news/6880866/detail.html [Access date:17/07/2008].

Veblen TT, Mermoz M, Martin C and Ramilo E (1989). Effects of Exotic Deer on Forest Regeneration and Composition in Northern Patagonia *Journal of Applied Ecology,* 26(2):711-724.
Veblen TT and Stewart GH (1982). The effects of introduced wild animals on New Zealand forests. *Annals of the Association of American Geographers,* 72(3):372-397.
Verheyden H, Ballon P, Bernard V and Saint-Andrieux C (2006). Variations in bark-stripping by red deer *Cervus elaphus* across Europe *Mammal Review,* 36(3):217-234.
Wemmer C and IUCN/SSC Deer Specialist Group (1998). *Deer: Status Survey and Conservation Action Plan*. IUCN/SSC, Gland, Switzerland.
Wilson DE and Reeder DM (1993). *Mammal Species of the World. A Taxonomic and Geographic Reference*. Smithsonian Institution Press, Washington.

Vertebrate Pests Committee Threat Categories (Natural Resource Management Standing Committee 2004)

VPC Threat Category

A species' VPC Threat Category is determined from the various combinations of its three risk ranks; (A) Public safety risk rank, (B) Establishment risk rank, (C) Pest risk rank.

B. Establishment Risk Rank[1]	C. Pest Risk Rank[1]	A. Public Safety Risk Rank	Threat Category
Extreme	Extreme	Highly Dangerous, Moderately Dangerous or Not Dangerous	**Extreme**
Extreme	High	Highly Dangerous, Moderately Dangerous or Not Dangerous	**Extreme**
Extreme	Moderate	Highly Dangerous, Moderately Dangerous or Not Dangerous	**Extreme**
Extreme	Low	Highly Dangerous, Moderately Dangerous or Not Dangerous	**Extreme**
High	Extreme	Highly Dangerous, Moderately Dangerous or Not Dangerous	**Extreme**
High	High	Highly Dangerous, Moderately Dangerous or Not Dangerous	**Extreme**
High	Moderate	Highly Dangerous, Moderately Dangerous or Not Dangerous	**Serious**
High	Low	Highly Dangerous, Moderately Dangerous or Not Dangerous	**Serious**
Moderate	Extreme	Highly Dangerous, Moderately Dangerous or Not Dangerous	**Extreme**
Moderate	High	Highly Dangerous, Moderately Dangerous or Not Dangerous	**Serious**
Moderate	Moderate	Highly Dangerous	**Serious**
Moderate	Moderate	Moderately Dangerous or Not Dangerous	**Moderate**
Moderate	Low	Highly Dangerous	**Serious**
Moderate	Low	Moderately Dangerous or Not Dangerous	**Moderate**
Low	Extreme	Highly Dangerous, Moderately Dangerous or Not Dangerous	**Serious**
Low	High	Highly Dangerous, Moderately Dangerous or Not Dangerous	**Serious**
Low	Moderate	Highly Dangerous	**Serious**
Low	Moderate	Moderately Dangerous or Not Dangerous	**Moderate**
Low	Low	Highly Dangerous	**Serious**
Low	Low	Moderately Dangerous	**Moderate**
Low	Low	Not Dangerous	**Low**

[1] 'Establishment Risk' is referred to as the 'Establishment Likelihood' and 'Pest Risk' is referred to as the 'Establishment Consequences' by the Natural Resource Management Standing Committee (2004).