Australian Government
Department of the Environment

2010 NOMINATION – *Canis lupus* ssp. *dingo*

Section 1 - Legal Status, Distribution, Biological, Ecological

Conservation Theme

1. The conservation themes for the assessment period commencing 1 October 2010 (for which nominations close 25 March 2010) are **'heathlands and mallee woodlands', and 'terrestrial, estuarine and near–shore environments of Australia's coast'.** *How does this nomination relate to the **conservation themes**?*	The dingo is found in both mallee woodlands and in terrestrial, estuarine and near-shore environments of Australia's coast, this nomination is therefore directly relevant to the themes for the current assessment period. The dingo was prevalent in mallee scrublands prior to European settlement and scientists argue strongly that the demise of the many small to medium Australian native animals is in part due to the influx of introduced mesopredators and constant planned eradication of the dingo (Glen & Dickman 2005, Glen et al 2007, Claridge & Hunt 2008, Johnson 2006, Johnson et al 2006, Johnson & VanDerWal 2009). Letnic et al (2009) found that abundance of the dusky hopping mouse (*Notomys fuscus)* was positively associated with the presence of the dingo, while Wallach et al (2009b) showed that dingoes coexisted with Malleefowl (*Leipoa ocellata)* (listed as vulnerable under the EPBC Act 1999), and with the Yellow-footed rock-wallaby (*Petrogale xanthopus xanthopus)* (listed as vulnerable under the EPBC Act 1999), providing further evidence that the presence of dingoes is associated with the survival of threatened species; in this case in semi arid, and arid scrublands. These projects show the importance of the dingo as a keystone species relevant to the preservation of flora and fauna in mallee woodlands ecosystems, therefore it is relevant to the theme of mallee woodlands.

Taxonomy

2. *What are the **currently accepted scientific and common name/s** for the species (please include Indigenous names, where known)?* *Note any other scientific names that have been used recently. Note the species authority and the Order and Family to which the species belongs (Family name alone is sufficient for plants, however, both Order and Family name are required for insects).*	Order: Carnivora Family: Canidae Scientific Name: *Canis lupus ssp. dingo* Common Name: Dingo Synonym: *Canis familiaris ssp. dingo* Aboriginal Names: Warrigal, Warang, Kua, Dingo, Maliki, Wantibirri, Mirigung, Boololomo, Noggum, Durda, Keli, Joogong, Papa-Inura, Dwer-da, Kurpany, Aringka, and Palangamwari. (Corbett 2004)
3. *Is this **species conventionally accepted**? If not, explain why. Is there any controversy about the taxonomy?*	The species is conventionally accepted. In the past the dingo has popularly been considered to be a separate species to that of the domestic dog and was officially named *Canis antarcticus* in 1792 and later *Canis dingo* (Barker & MacIntosh 1978), while more recently the names *Canis familiaris dingo* and *Canis lupus dingo* have been favoured. Using mitochondrial DNA Savolainen and colleagues concluded that the dingo and domestic dogs are derived from wolves (Savolainen *et al* 2004) and the dingo was referred to as sub-species of dog - *Canis familiaris dingo*, the domestic dog being *Canis familiaris familiaris*. However many scientific papers today refer to the dingo and domestic dog as a sub-species of the grey wolf *Canis lupus* and classify them as *Canis lupus dingo* and *Canis lupus familiaris* respectively. Some of the literature still refers to the dingo as *Canis familiaris dingo*.

	It is not uncommon to still see the dingo referred to as a species. The International Wolf Center in the US lists the dingo on their species list as *Canis dingo* and the domestic dog as *Canis familiaris* rather than including both on their sub-species listings (International Wolf Center 2007).
4. *If* ***the species*** *is* ***NOT conventionally accepted****, please provide:* *(i) a taxonomic description of the species in a form suitable for publication in conventional scientific literature;* ***OR*** *(ii) evidence that a scientific institution has a specimen of the species and a written statement signed by a person who has relevant taxonomic expertise (has worked, or is a published author, on the class of species nominated)****,*** *that the person thinks the species is a new species.*	**Not applicable**
5. *Is this species* ***taxonomically distinct*** *(Taxonomic distinctiveness – a measure of how unique a species is relative to other species)?*	This species is taxonomically distinct. The dingo is a primitive dog that is thought to have evolved from a small Asian wolf (*Canis lupus pallipes/ Canis lupus arabs*) 6,000 to 10,000 years ago and which became widespread throughout southern Asia. It is deduced that Asian seafarers subsequently introduced dingoes into Australia (Corbett 2001a). Studying mitochondrial DNA Savolainen and colleagues suggest dingoes arrived on the continent around 5,000 years ago and possibly up to 10,800 years ago (Savolainen *et al* 2004). Fossil and DNA evidence suggest that this occurred 4,000 to 5,000 years ago (Salavolainen et al 2004). The term *pure dingo* refers to the dingo type first described at the time of European settlement of Australia, which may also represent the *ancestral* dog type. Savolianen et al (2004) state: *After >3,000 years of isolation the dingoes represent a unique isolate of early undifferentiated dogs.* Because dingoes were established in Australia for thousands of years prior to first white settlement they qualify as a native species under the EPBC Act. Salvolainen et al (2004) note that: *the dingo is similar in general morphology to South Asian domestic dogs ..., and in skeletal morphology it especially resembles Indian pariah dogs and wolves... In measures of skull morphology, values for dingoes are between those of dogs and wolves, overlapping with both...* A recent study of genetic polymorphism in a variety of feral and wild-type dogs from Indonesia (Bali street dog), New Guinea (indigenous New Guinea singing dog) and Australia (dingo) found that the dingo and New Guinea singing dog possessed alleles that were not found in the Bali street dog and that are relatively uncommon in conventional purebreds. Although further research is acknowledged as needed, the authors suggest that the findings indicate the dingo was closely related to the indigenous singing dog from New Guinea (Runstadler *et al* 2006). Recent genetic research has shown that the Australian dingo population is descended from a very small number of animals (hypothetically a single pregnant female), and most likely from a single introduction event. This means that Australian dingoes are the product of a genetic bottleneck and are genetically and phenotypically distinct from Asian dingo populations (Savolainen et at 2004) Dingoes can be distinguished with a high degree of confidence from domestic dogs and dingo-like hybrids on the basis of skull morphology, body size and coat and colour. Recent advances in DNA identification

have also been made by geneticist, Dr Alan Wilton, of the University of New South Wales. Wilton's method can identify hybridization with a high degree of confidence and is now routinely used by dingo conservationists (Wilton 2001)

In a talk given to Victoria Naturally on 2 July 2007 Michael Soulé was categorical in his assertion that the dingo is a native animal, as it has been present in the environment for about 5000 years, and as such is a vital part of the ecosystem. This position is supported by Breckwoldt (1988).

Legal Status

6. *What is the species' **current conservation status** under Australian and State/Territory Government legislation?*	The dingo is not listed under any federal legislation. Following a nomination in 2008 by Dr Ernest Healy of the Dingo CARE Network Inc., the Scientific Advisory Committee of the Department of Sustainability and Environment (DSE) in Victoria made a preliminary recommendation to list the dingo (*Canis lupus subsp. dingo*) as a threatened native species under the Victorian Flora and Fauna Guarantee Act 1988 (FFG 1988). This nomination was subsequently confirmed by the Minister in October 2008 (Victorian Government Gazette No G 45 2009) In 2008 Humane Society International nominated 11 populations of dingo for inclusion on the National Heritage list. These populations reside in the Arafura Swamp, Bradshaw Training Area and Kapalga in the Northern Territory; five Kimberley Islands in Western Australia; Fraser Island in Queensland, Kosciusko in New South Wales and the Simpson Desert in central Australia (HSI 2005). The nominations were generally rejected as it was determined that they did not meet the necessary heritage criteria, but those populations that exist within World Heritage areas would be assessed as a part of a long-process that aims to review all World Heritage listed places for additional values. In 2002 a nomination by the Colong Foundation to have populations of dingoes in NSW listed as endangered was submitted. A copy of this nomination can be viewed at http://www.colongwilderness.org.au/Dingo/Dingo_nom_text.pdf A major problem for those charged with protecting Australian wildlife and particularly the dingo is that there are Acts of Parliament that both protect dingoes and call for their eradication! For example in New South Wales the Companion Animal Act 1998 assigns no special status to the dingo, under this Act the dingo is a dog and can be kept as a pet in most of the State. However the Rural Lands Protection Act 1998 and the Wild Dog Destruction Act 1921 assigns the dingo to the status of wild dog, a pest species and therefore requires land owners to destroy the animals. On the other hand the National Parks and Wildlife Act 1974, the Forest Act of 1916 and the Threatened Species Conservation Act 1995 protects native fauna and "native" is defined as a species being present in Australia prior to 1788 which the dingo was (Davis 2001)! Dingoes are regarded under Northern Territory legislation as native wildlife and "this status affords the dingo full legal protection, making it an offence to possess, interfere with, or kill dingoes unless authorised to do so under the *Territory Parks and Wildlife Conservation Act (2000)* (PWS NT, n.d.). Some various State Acts and the dingo's status within them are briefly given below (there are many more regulations and Acts that come under other programs, for example relating to wild dog/dingo baiting controls): Northern Territory: Territory Parks and Wildlife Conservation Act (2000). Status: native and protected. Dingoes in the Northern Territory are regarded as having an important conservational value since interbreeding of dingoes and other domestic dogs is low in the area. However dingoes can be legally killed when they are a danger for the livestock industry. Western Australia

Agriculture and Related Resources Protection Act 1976. Status: controls to stocked land. Populations have to be controlled and can be kept as pets under certain conditions. Control measures are strictly confined to livestock areas and other domestic dogs are controlled in general.
Western Australian Wildlife Conservation Act (1950). Status: unprotected fauna.
Although not protected, dingoes are normally not hunted without permission in conservation areas.

South Australia
Animal and Plant Control Board (Agricultural Protection and Other Purpose) Act (1986). Status: declared pests in the sheep zone south of the DBF; unprotected wildlife north of the DBF however the South Australian Dingo Policy restricts dingo control beyond a 35km baited buffer zone north of the DBF.
Dingos have to be controlled and can only be kept in captivity of authorized zoos and wildlife parks.

Queensland
Rural Lands Protection Act (1985). Status: declared pests. All landowners are legally committed to reduce the number of all wild dogs on their lands.
Nature Conservation Act (1992). Status: native wildlife in Protected Areas, unprotected outside protected areas. Dingo regarded as a natural resource (therefore protected) in conservation areas such as Fraser Island; however a management strategy exists which allows for the culling of any dingo considered dangerous (Corbett 2009a). Outside of these areas dingoes are not regarded as native Australian and are not protected. Dingoes and their hybrids can only be kept in wildlife parks and zoos with ministerial agreement.

New South Wales
Rural Lands Protection Act (1998). Status: noxious animals. This Act allocates wild dogs the status of pests and demands from landowners, that they shall be decimated or eradicated.
National Parks and Wildlife Act (1974). Status: unprotected under the Act but offered protection in protected areas.
Threatened Species Conservation Act (1995). Status: native species, since these dogs had established populations before the European colonization.
Wild Dog Destruction Act (1921). Status: Western Division of NSW mandatory control. This law only affects the western part of the state, where landowners are committed to control wild dogs. The law forbids the ownership of dingoes in that region, except when you have legal permission.
Companion Animal Act (1998). Status: can be kept as pets except in the western division.

ACT
Nature Conservation Act (1980). Status: protected, control subject to permit. On private land killing of wild dogs is allowed when you have permission from the state.

Victoria
Catchment and Land Protection Act (1994). Status: established pest animal and landowners (except from the Commonwealth) have the legal duty to hinder the spreading of wild dogs on their lands and to eradicate them as much as possible. The term wild dog includes here all dingoes, feral domestic dogs, dogs who became wild and crossbreeds (except for recognized breeds like the Australian Cattle Dog).
Domestic (Feral and Nuisance) Animal Act (1994). Status: commits every dog owner to have their dogs under control at all times.
National Parks Act (1975). Status: protected in protected areas subject to

	management policy. Since 1998 it is possible to own dingoes as pets. Victorian Flora and Fauna Guarantee Act 1988. Status: listed as a Threatened species <u>Tasmania</u> National Parks and Wildlife Act (1970). Status: never colonised, import ban. The control of dogs that attack livestock is managed under the *Dog Control Act (1987)*. (Sources: 1. *A Management Program for the dingo (Canis lupus dingo) in the Northern Territory of Australia 2006 – 2011 Department of Natural Resources Environment and the Arts, Palmerston, NT;* 2. *Davis E, and Leys A, (2001) Reconciling wild dog control and dingo conservation under New South Wales legislation. In: A symposium on the dingo (eds. C.R. Dickman & D Lunney) pp 108-119. Royal Zoological Society of New South Wales, Sydney.)*
7. *Does the species **have specific protection** (e.g. listed on an annex or appendix) under other legislation or intergovernmental arrangements, e.g. Convention on International Trade in Endangered Fauna and Flora (CITES), Convention on Migratory Species (CMS).*	The dingo is listed in the category 'Vulnerable A2e' in the IUCN Red List. The population trend is one of decreasing numbers. The dingo is not afforded protection under any other international conventions. The Grey wolf (*Canis lupus*) is listed under both Appendices I and II of CITES (due to the status of different populations). At the forthcoming CITES Conference of Parties (CoP15) due to take place at the end of March 2010 a specific amendment has been put forward by Switzerland to clarify the Appendix I and II ruling for the Grey Wolf as follows: *'Excludes the domesticated form and the dingo which are referenced as Canis lupus familiaris and Canis lupus dingo'*. (CITES, 2010) HSI does not dispute this and considers this proposal to be a clarification that neither the domesticated forms of the dog nor the dingo have ever been treated as being covered by the listing of *Canis lupus* in the CITES Appendices.

Description

8. *Give a brief description of the species' **appearance**, including size and/or weight, and sex and age variation if appropriate; social structure and dispersion (e.g. solitary/clumped/flocks).*	The average adult dingo in Australia stands 570 mm at the shoulder, is 1230 mm long from nose to tail-tip and weighs 15 kg. The coat colour is typically ginger but varies from sandy-yellow to red-ginger and is occasionally black-and-tan, white or black. Most dingoes have white markings on the feet, tail tip and chest, some have black muzzles and all have pricked ears and bushy tails. 'Pure' dingoes are distinct from similar looking domestic dogs and hybrids because they breed once a year, and have skulls with narrower snouts, larger auditory bullae (ear sounding box) and larger canine (holding) and carnassial (cutting) teeth. (Corbett 2001) Australian dingos are bigger than their Asian counterparts possibly due to their protein rich diet (Hintze 2002). Dingoes can be distinguished from hybrid dogs by their DNA (Wilton 2001) and once dead the dogs' phenotypes can be differentiated by their skull morphology (Corbett 2001). There is difficulty however in visual assessment as dingoes have been crossed with domestic dogs purposefully during the days of early European settlement. The highly valued Australian cattle dogs were originally bred by purposefully crossing various domestic breeds including Dalmatian with dingo in order to breed in 'positive dingo traits' such as courage. Most female dingoes become sexually mature at two years and have only one oestrus period each year, although some do not breed in droughts. *Eastern Highlands and Central Australian dingoes housed in Canberra do not have a testicular cycle. They are spermatogenically active and capable of mating with oestrous females and fathering young all year. They do exhibit a breeding season (April-June) but this is entirely governed by the female. During the breeding season testosterone levels rise; this is thought to be influenced by the presence of an oestrous female and copulation. There are indications that captive dingoes in Central Australia may have a testicular cycle. Colony dingoes showed little interest in and do not mate with an oestrous domestic female at times other than January-July. They also become almost aspermous outside the breeding season. In contrast, Central Australian dingoes housed in Canberra are spermatogenically active and capable of successful matings all year.* Catling (1979) Males in arid Australia also have a seasonal breeding cycle of about six months where the inability to breed successfully at other times is more probably due to a lack of seminal fluid than to a lack of sperm. Gestation takes about 63 days and litters of 1-10 pups (the average is 5) are whelped during the winter months usually in an underground den. Pups usually become independent at 3-4 months or, if in a pack, when the next breeding season begins (HSI 2005). Pups remain with their parents for up to two years, during their second year they assist with the rearing of the next litter of pups (Corbett 2001). Even in captivity mature bitches that have not been mated will alloparent pups if the opportunity occurs ([redacted] pers obs). Although dingoes are often seen alone, many such individuals belong to socially integrated packs whose members meet every few days or coalesce during the breeding season to mate and rear pups. At such times scent marking and howling is most pronounced. Dingoes use scent-posts to indicate currently shared hunting-grounds, to mark territorial boundaries, and possibly to synchronise reproduction between pairs (HSI 2005). Vocalisations include three basic howl types: moans, bark-howls and

	coughing/snuffs. Howling is used for long distance communication and has two purposes - attracting pack members and repelling rivals. Dingoes distinguish these purposes by means of howl responses, sight, physical location, and pheromones (chemical messages) to confirm the identity and perhaps the social status of both the initiating and responding howlers. Basic howl types provide information about the location itself, about the howler, and about group size. Overall, howling is mostly used by members of stable territorial packs (or subunits) especially when packs are using or defending essential resources, particularly oestrus and pregnant females, food and water (HSI, 2005). Coughing/snuffs are used as a warning signal, and used by the bitch in the wild to warn pups of danger. In remote areas where dingoes are not disturbed by human control operations, discrete and stable packs of 3-12 dingoes occupy territories throughout the year. Such packs have distinct male and female hierarchies where rank order is largely determined and maintained by aggressive behaviour, especially within male ranks. The dominant pair may be the only successful breeders but other pack members assist in rearing the pups (HSI, 2005, Corbett 2001). The size of a dingo pack's territory varies with prey resources and terrain but is not correlated with pack size. For individuals, home range size also varies with age. The largest recorded territories (45-113 km^2) and home ranges (mean 77 km^2) occur in the Fortescue River area of north-west Australia. Mean home ranges recorded elsewhere are 25-67 km^2 for arid central Australia, 39 km^2 for tropical northern Australia, and 10-21 km^2 for forested regions of eastern Australia. Most dingoes remain in their birth area, but some, especially young males, disperse and the longest recorded distance for a tagged dingo is 250 km over 10 months in central Australia (Corbett 2001).

9. *Give a brief description of the species' **ecological role** (for example, is it a 'keystone' or 'foundation' species, does it play a role in processes such as seed dispersal or pollination).*	The dingo performs the role of an apex predator in ecosystems. A recent account of the ecological role of the dingo within Australia states:...*in the transition from Aboriginal to European Australia the dingo emerged as perhaps the most ecological significant mammal species on the continent.* (Johnson 2006). The significance of this ecological role is reflected in the management objective on many conservation agencies, which seek to conserve the dingo as part of Australia's natural heritage (For example see ACF 1984, HSI 2009, Corbett 2008 & Corbett 2009). Removing an apex predator from a system can have profound effects at lower trophic levels affecting species richness and abundance (Corbett 1995a in HSI 2005, Fleming 2001, Glen and Dickman 2005, Glen *et al.* 2007, Harden 2001, Johnson 2006, Letnic in de Blas 2009, Soulé 2007). Secondary extinction can then occur in small native animals "the top-predator hypothesis predicts that threatened species will not survive where dingoes are rare or absent" (Wallach *et al* 2009a). In a recent paper published in *Biological Sciences,* Johnson and colleagues suggest that the rate and number of mammal extinctions in Australia over the past 150 years highlights the relationship between the presence of top predators and abundant populations of smaller predators. When top predators are persecuted and their numbers decline there are also declines and even extinctions of some prey due to the proliferation of red foxes and feral cats; the introduced mesopredators. The authors suggest that top predators like the dingo play a crucial role in maintaining prey diversity (Johnson *et al* 2007). Johnson (2006) argues that rather than dingoes accelerating species extinction by their presence, the opposite is the case; species extinction is accelerated by dingoes' absence. He suggests the only way to stop the decline and extinction rate of Australia's small mammals is to focus on bringing back the top-order predator, the dingo (Johnson 2006). "*The presence of dingoes is the most powerful predictor of the survival of ground-dwelling marsupials across Australia*" (Johnson 2007 in de Blas 2009). Dingoes can therefore be referred to as a keystone species as their removal from an ecosystem results in "*the reorganisation of trophic webs and loss of biodiversity*" (Glen *et al* 2007, Letnic *et al* 2009). Previously subordinate predators may increase unchecked, potentially decimating prey populations. Some herbivores may become over-abundant, leading to overgrazing on plant populations. Competitive relationships between prey species may be altered and in some cases these effects may ultimately lead to community-level trophic cascades in which plant biomass is redistributed throughout a system (HSI 2005). In recent years, there has been a concern that 'pure' dingoes are now gone from many regions of Australia and eventually will be gone from all of Australia due to hybridisation between dingoes and domestic dogs. However according to Dr Laurie Corbett an eminent dingo expert the replacement is essentially an evolved dingo that performs the same or similar ecological functions as previously, and most of the replacement hybrids will just look a bit different (HSI 2005). Conservation therefore needs to be focussed on understanding the role of modern dingoes in different regions and habitats in Australia and managing dingoes so that they can fulfil a particular ecological, cultural or economic role (Daniels and Corbett 2003 in HSI 2005). Purcell (2009) agrees suggesting dingoes' function in ecosystems may be a better consideration to concentrate on than focussing on its DNA and physical attributes.

A rangeland region of some 325,000 square kilometres in New South Wales has been studied and analysis of the results suggests that 21 threatened native animals could benefit from reintroduction of the dingo (Dickman 2007).

Because the dingo is a keystone species that aids in the protection of biodiversity in Australian ecosystems and is an essential element in biodiversity conservation,management of dingoes should be given high priority (Johnson *et al*. 2006). In their 2006 paper to the Royal Society, Johnson, Isaac and Fisher stated "*Our analysis identified overlap with dingoes as a significant extrinsic factor that acted to protect ground-dwelling marsupials from decline and extinction*" (Johnson *et al.* 2006). They went on to state "*The dingo clearly occupies a stable and significant role in Australian ecosystems*," and "*the rarity of top order predators, however it is caused, leaves prey species vulnerable to over predation by meso-predators*" (Johnson *et al.* 2006).

Norris and Low contend that the lack of dingo abundance in the southern region of Australia, "*corresponds with the region from which most native mammal extinctions have occurred, and in which goats are most destructive and the role of dingoes in suppressing fox, cat and goat numbers appears to be very significant to biodiversity.*" (Norris and Low 2005).

Allen and Fleming (2004) agree; "*wild dogs probably have a positive impact on wildlife*" mainly by suppressing fox numbers and by preying on other feral animals including goats, cats, rabbits and pigs.

The Parks & Wildlife Service in the NT published *A Management Plan for the Dingo* in which it is noted that because of the widespread distribution of dingoes in the top end, feral goats have never become established there. "*The removal of dingoes has the potential to severely affect species richness and abundance further down the food chain*" (PWS NT n.d.).

In 2006 Chris Johnson asked several key questions around the role of dingoes and native mammal extinctions in his book *Australia's Mammal Extinctions; A 50,000 Year History.* He asks if dingoes have been around for 5,000 or so years why it is that Australia's mammal extinction rate has only raced out of control since white settlement; and, why don't other countries with feral foxes and cats have the same disturbing reputation of high native fauna extinction rates as Australia (Johnson 2006)? The answer could be that where other countries have feral foxes and cats they also have numbers of top order predators to keep the feral animals in check. Johnson believes that dingoes are not responsible for the high extinction rate of native fauna on mainland Australia but that the introduced mesopredators, foxes and cats are the main perpetrators along with human activities during the last 200 or so years. (Johnson 2006). As Geoff Wise so succinctly put it "*The dingo lived in harmony with the whole of Australia as an open paddock*" (Wise 2001).

There is little doubt that since the arrival of feral foxes, cats and rabbits into Australia these animals have caused enormous damage to biodiversity and agriculture (Glen *et al* 2007). The dingoes' range has contracted greatly since white settlement due to various eradication programs implemented because of dingo (and dingo hybrids') impacts on livestock. However if dingoes and wild dogs are removed from an area foxes and cats move in, this could prove disastrous for critical weight range native mammals (Meek and Shields 2001).

Because dingoes are a top-order predator their interactions with other animals - whether feral or native - has consequences and these could be serious. Relentless persecution of the animal "*may have impacts that*

	cascade through the trophic levels from predator to meso-predator to herbivore and ultimately to primary producers" (Glen *et al.* 2007). Although invasive species dominate much of the desert, studies have shown that if the dingo is present native fauna persist. Newsome (2001) has noted that there is observational evidence that "*where dingoes are locally abundant, foxes and cats are rare*" (Newsome 2001 in Johnson 2006). Johnson argues that should the conservation value of dingoes be assessed the conclusion may be drawn that dingoes work more for conservation than against it (Johnson 2006)! Letnic et al (2009) found that abundance of the dusky hopping mouse (*Notomys fuscus)* was positively associated with the presence of the dingo, while Wallach et al (2009) showed that dingoes coexisted with Malleefowl (*Leipoa ocellata)* (listed as vulnerable under the EPBC Act) and with the Yellow-footed rock-wallaby (*Petrogale xanthopus xanthopus)* (listed as vulnerable under the EPBC Act) providing further evidence that the presence of dingoes is associated with the survival of threatened species.

Australian Distribution

10. *Describe the species' **current and past distribution in Australia** and, if available, attach a map.*	The dingo, having existed in Australia for possibly 5,000 years prior to European settlement, has interacted with indigenous animals and responded to and changed aspects of the environment, and thus is considered to be a native species (Corbett 2001) (Flannery 2004) (Soulé 2007). Listing on the IUCN Red List as Vulnerable (IUCN 2009) indicates that dingo populations in Australia have declined by more than 30% over the last three generations. Prior to European settlement research studies indicate that the dingo was common throughout all mainland states. Dingo distribution across the continent has contracted and been fragmented since white settlement due to land clearing, agricultural practices, urbanization and hybridisation with domestic dogs, lethal control, State and Territory laws and, in the earlier part of the 20th Century the erection of the Dingo Barrier Fence (DBF) to protect sheep farming regions from wild dogs. See Figure 1 for a map of the distribution of dingoes in Australia. Dingo populations in the remote areas of central Australia, on the other side of the DBF have more stable pack structures and as such packs are more difficult for domestic dogs or hybrids to infiltrate (HSI 2005, 2001). This is a vastly different situation to south-eastern Australia where hybrids proliferate (Claridge and Hunt 2008). In the south eastern highlands region of Australia, Jones (2009) suggests the abundance of pure dingoes (measured by skull morphometrics) dropped from 49% to 17% in the 20 years between the 1960s and 1980s (Jones in Corbett 2004 cited in HSI 2005). Jones (2009) also concludes that in the Victorian Eastern Highlands, there is no reliable method of differentiating hybrids from dingoes. All share a common gene pool and "pure" dingoes may now not exist in these areas at all. Corbett (2001) suggests pure dingoes may be locally extinct particularly in south eastern Australia although remnant populations are thought to occur in Central and Northern Australia (Corbett in IUCN, 2008). Control laws in the Northern Territory are less intense than in other states possibly due to a preference there to grazing cattle rather than sheep.

	Consequently there has been little change in dingo distribution. Johnson asserts that due to the abundance of dingoes in stable packs, there has been less extinction of dingoes in the NT than in areas that have been subjected to rigid dingo extermination policies (Johnson 2006). The Northern Territory's Parks and Wildlife Service recognise dingoes are top order predators and as such may help to control feral predation on native wildlife. The Management Program states "*dingo control will be conducted only in cases when the dingo is definitely identified as a significant threat to the survival or re-establishment of endangered fauna populations*" (PWS NT n.d.). The animal is common where there is drinking water in the Territory but sparse in areas of less water availability such as the Tanami Desert. Dingoes are found throughout most of Western Australia although they are thought to be absent from closely settled farms in the south west. Agriculture Western Australia is responsible for controlling dingoes on Crown Land close to pastoral leases and land owners must carry out their own controls and mostly use 1080 baiting and to a lesser extent trapping and shooting (Thomson 2000). At present Danielle Stephens, a PhD student from the University of Western Australia is conducting research analysing wild dog tissue samples from throughout Australia to identify areas where DNA pure dingoes remain in the wild. She expects to have some data sets available late 2010 ([redacted] pers coms).
11. *What is the **extent of occurrence** (in km^2) for the species (described in Attachment A); explain how it was calculated and datasets used.*	
a. *What is the **current** extent of occurrence?*	The extent of occurrence in terms of square kilometres has not been determined for dingoes.
b. *What data are there to indicate **past declines** in extent of occurrence (if available, include data that indicates the percentage decline over the past 10 years or 3 generations whichever is longer)?*	Dingo distribution across the continent has contracted and been fragmented since white settlement due to hybridisation with domestic dogs, lethal control, State and Territory laws and, in the earlier part of the 20th Century the erection of the Dingo Barrier Fence (DBF) to protect sheep farming regions from wild dogs. See Figure 1 for a map of the distribution of dingoes in Australia. It should be kept in mind that the thylacine was subject to similar controls including bounties. Johnson (2006) describes the demise of the thylacine following intense destruction circa 1900, following which the numbers continued to decline until the last animal died in 1936. Dingo populations in the remote areas of central Australia, on the other side of the DBF have more stable pack structures and as such packs are more difficult for domestic dogs or hybrids to infiltrate (HSI 2005, 2001). This is a vastly different situation to south-eastern Australia where hybrids proliferate (Claridge and Hunt 2008). In the south eastern highlands region of Australia, Jones suggests the abundance of pure dingoes (measured by skull morphometrics) dropped from 49% to 17% in the 20 years between the 1960s and 1980s (Jones in Corbett 2004 cited in HSI 2005). Jones (2009) also concludes that in the Victorian Eastern Highlands, there is no reliable method of differentiating hybrids from dingoes. All share a common gene pool and "pure" dingoes may now not exist in these areas at all. Corbett (2001) suggests pure dingoes may be locally extinct particularly in south eastern Australia although remnant populations are thought to occur

	in Central and Northern Australia (Corbett in IUCN, 2008).
c. *What data are there to indicate **future changes** in extent of occurrence (if available, include data that indicates the percentage decline over 10 years or 3 generations whichever is longer (up to a maximum of 100 years in the future) where the time period is a continuous period that may include a component of the past)?*	While no formal data is available Breckwoldt (1988) is cautious in his assessment of the viability of the dingo under current regimes as *there are dozens of examples throughout the world where species that were abundant became rare or extinct where no one thought possible.* O'Neill (2002) suggests that a heart worm infestation in the 1980s in Kakadu National Park virtually eliminated dingoes leading to a massive decline in other fauna. Wilton (in Reach 2004) argues that the dingo will be extinct in 50 years due to hybridization if no action is taken, while Davidson (2004) asserts that the dingo is at grave risk of extinction. Rudolph (2003) states '*the dingo is under threat of extinction ... and unless there is a radical change in people's attitudes, the extinction of pure Dingoes seems inevitable'*. Rudolph is critical of all State Governments, and the farming lobby that continue to support the wholesale extinction of the dingo using all manner of techniques, including aerial baiting with 1080. She quotes Corbett as saying '*Pastoralists have so feared dingoes that many millions of dollars have been spent over the past 150 years or so trying to kill them or exclude them from pastoral areas'.* It is clear these techniques are not working, and a more sustainable solution must be sought.
12. *What is the **area of occupancy** (in km^2) for the species (described in Attachment A); explain how calculated and datasets that are used.*	
a. *What is the **current** area of occupancy?*	The area of occupancy in terms of square kilometres has not been determined for dingoes.
b. *What data are there to indicate **past declines** in area of occupancy (if available, include data that indicates the percentage decline over the past 10 years or 3 generations whichever is longer)?*	The distribution of dingoes in Australia and the impact of the Dingo Barrier Fence (DBF) can be clearly seen in Fleming's map in Figure 1 (Fleming 2001 in PWS NT n.d.). The distribution of dingoes and their purity in eastern Australia has been significantly altered since construction of the DBF. The animals' distribution and abundance has been and continues to be based on whether livestock benefit from dingoes presence or not rather than the animal's conservation value.
c. *What data are there to indicate **future changes** in area of occupancy (if available, include data that indicates the percentage decline over 10 years or 3 generations whichever is longer (up to a maximum of 100 years in the future) where the time period is a continuous period that may include a component of the past)?*	There is no data available to enable future changes in the area of occupancy to be indicated.
13. *How many **natural locations** do you consider the species occurs in and why? Where are these located?* *The term 'location' defines a geographically or ecologically distinct area.*	Pure dingoes are common in northern, northwestern and central regions, rare in southern and north-eastern regions, and probably extinct in the south-eastern and south-western regions (Corbett, 2009). The density of wild dogs (dingoes and hybrids) varies between 0.03 and 0.3 per km^2 according to habitat and prey availability (Fleming, 2001). In 2008 Humane Society International nominated 11 populations of dingo for inclusion on the National Heritage list. These populations reside in the Arafura Swamp, Bradshaw Training Area and Kapalga in the Northern Territory; five Kimberley Islands in Western Australia; Fraser Island in

	Queensland, Kosciusko in New South Wales and the Simpson Desert in central Australia (HSI 2005). The nominations were generally rejected as it was determined that they did not meet the necessary heritage criteria, but those populations that exist within World Heritage areas would be assessed as a part of a long-process that aims to review all World Heritage listed places for additional values.
14. *Give **locations of other populations**: captive/propagated populations; populations recently re-introduced to the wild; and sites for proposed population re-introductions. Note if these sites have been identified in recovery plans.*	The nominee understands that current proposed introduction sites include Wilson Promontory in Victoria, and the Little and Big Desert, all of which are past habitats for the dingo. There are a number of captive dingo populations, from enthusiasts who keep one or two dingoes, to those who keep in excess of 20 dingoes. Members of Dingo CARE Network Inc the peak dingo organisation in Victoria are responsible for almost 100 pure dingoes, mostly in Victoria. There are several other groups holding in excess of 20 dingoes, including the Bargo Dingo Sanctuary in NSW.
15. *Is the species' **distribution severely fragmented?** What is the cause of this fragmentation? Describe any biological, geographic, human-induced or other barriers causing this species' populations to be fragmented.* *Severely fragmented refers to the situation in which increased extinction risk to the taxon results from most individuals being found in small and relatively isolated subpopulations (in certain circumstances this may be inferred from habitat information). These small subpopulations may go extinct, with a reduced probability of recolonisation.*	Artificial water points are changing the distribution of dingoes and the health of biodiversity in arid zones. Dingoes drink at least twice daily much more than their feral opponents, cats and foxes. Opportunistic poison baits targeting dingoes are laid around artificial water points in arid environments and overgrazing causing land degradation and biodiversity loss is being observed. In order to turn this around it has been suggested that artificial water points be closed (Fensham and Fairfax 2008 in Wallach 2009a). However a top-down perspective suggests the reason for land degradation and biodiversity loss is because the top predator has been removed (Letnic *et al* 2009). So rather than closing the artificial water points, baiting should cease and this would lead to greater dingo presence, halt over grazing and restore biodiversity (Wallach 2009a). Although "exclusion fences" have been used for wild dogs since the 19th century they became more popular when wire netting was prefabricated in the early 1900s (Fleming *et al* 2006). Stretching through Queensland, along the New South Wales border and across South Australia the Dingo Barrier Fence (DBF) was constructed to keep dingoes out of sheep farming areas although Corbett estimates that sheep constitute only 4% of dingoes' diet (Corbett 2001; Breckwoldt 1988). The DBF became fully operational following the end of the Second World War in 1945. The fence was once reputed to be approximately 9,000 km long but in 2001 measured only 5,531 km long (Newsome 2001). Allen and Sparkes (2001) suggest there is a case for re-establishing a barrier fence in Queensland to stop the potential of sheep production contracting in the area. Wild dog kills are either driving graziers out of dog infested areas or are a deciding factor for them to convert to cattle production because cattle are less likely to be dingo prey than sheep even though dingo numbers are usually higher in cattle production areas. Pure dingoes have been all but eradicated in many sheep areas east of the DBF but are in abundance in cattle areas this is mainly due to the fact that sheep farmers have active eradication programs using baits, because of mechanical barrier fences, and as stated above, many cattle producers believe that dingoes keep numbers of other pest species such as kangaroos and feral pigs down and tolerate the occasional calf sacrifice to dingoes (Newsome 2001; Allen and Sparkes 2001). The distribution of dingoes in Australia and the impact of the DBF can be clearly seen in Fleming's map in Figure 1 (Fleming 2001 in PWS NT n.d.). The distribution of dingoes and their purity in eastern Australia has been

	significantly altered since construction of the DBF. The animals' distribution and abundance has been and continues to be based on whether livestock benefit from dingoes presence or not rather than the animal's conservation value. Continual baiting, trapping and crossbreeding with domestic dogs have caused fragmentation as detailed elsewhere in this nomination.
16. *Departmental Use Only:*	

Global Distribution

17. *Describe the species' **global distribution**.*	Fossil, molecular and anthropological evidence suggests that early primitive dingoes formerly had a cosmopolitan distribution (Corbett, 2008). These primitive dingoes were associated with nomadic hunter-gatherer societies and later with agricultural population centres where they were tamed and subsequently transported around the world, from mainland Asia to Australia and other islands in Southeast Asia and the Pacific between 1,000 and 5,000 years ago (Corbett, 2008). Apart from Australia pure dingoes can still be found commonly in Thailand and possibly, based on their phenotype, present in other countries including Malaysia, Vietnam, China, Cambodia, India, Indonesia, Myanmar, Papua New Guinea, Philippines and Lao PDR (Corbett 2004 in IUCN 2009) however their abundance in these countries is unknown except in Indonesia's Sulawesi where they are thought to be common (Corbett in IUCN/SSC 2008). Dingoes or their hybrids are kept as pets in some countries including Switzerland and USA (Corbett in IUCN/SSC 2008).
18. *Give an overview of the **global population**'s size, trends, threats and security of the species outside Australia.*	Formerly widespread throughout the world, the proportion of pure dingoes is declining through hybridisation with domestic dogs (Corbett, 2008). According to Corbett (2008) dingoes are: ▪ Rare in New Guinea and possibly extinct with no sightings for 30 years ▪ Common in Sulawesi but abundance elsewhere in Indonesia unknown ▪ Common throughout northern and central regions of Thailand, less so in southern regions. ▪ Rare in the Philippines and probably extinct on many islands ▪ Present in Malaysia, Vietnam, Cambodia, Lao PDR, China, Myanmar and India. Abundance unknown. ▪ Probably extinct in the wild in Korea, Japan and Oceania. Cross-breeding with domestic dogs is the most significant threat to the dingo, and in several Asian countries dingoes are also sold in human food markets (Corbett, 2008).
19. *Explain the **relationship** between the Australian population and the global population, including:*	
a. *What **percentage** of the global population occurs **in Australia**;*	As there are no population estimates for the dingo worldwide, it is difficult to determine the percentage of the global population that occurs in Australia.
b. *Is the Australian population **distinct**, geographically **separate** or does part or all of the population move in/out of Australia's jurisdiction (give*	The Australian population is geographically separate, being separated from other populations by oceans. Recent genetic research has shown that the Australian dingo population is

an overview; details in Movements section);	descended from a very small number of animals (hypothetically a single pregnant female), and most likely from a single introduction event. This means that Australian dingoes are the product of a genetic bottleneck and are genetically and phenotypically distinct from Asian dingo populations (Savolainen et al., 2004). This shows that in the past the dingo underwent a severe bottleneck.
c. *Do **global threats** affect the Australian population*?	Dingoes globally are primarily threatened by hybridisation, which they are subject to in each country.

Surveys and Monitoring

20. *Has the species been **reasonably well surveyed**?* *Provide an overview of surveys to date and the likelihood of its current known distribution and/or population size being its actual distribution and/or population size.*	A comprehensive and specific survey of Australia's dingo population has not been undertaken, nor has a global survey of the species been undertaken. Much of the detail about the dingo population exists as a result of other or combined survey work as follows: • A study of dingo and wild dog DNA is being undertaken by Danielle Stephens, PhD candidate at the University of Western Australia and preliminary results are towards the end of 2010 (Stephens, 2010). • A study by PhD candidate Brad Purcell in the Blue Mountains World Heritage Area of New South Wales used GPS tracking collars on 12 dingoes over a 14 month period and found that the animals remained in their home territories distinguished by natural markers and rarely crossed paths with other packs. "*The average home range was about 34 square kilometres but they spend 50 per cent of their time within a core area that was on average 5.9 square kilometres. Individual dingoes from different packs only briefly crossed paths and, importantly, there was only minimal or no visits to farmland by the GPS tracked dingoes. The dingo packs kept mostly in their own territories – inside the scheduled dingo conservation habitat.*" (Purcell in Science Alert 2009) • Wallach et al surveyed a number of wallaby colonies and mallee fowl nests and found that in all cases dingoes were present and "the mallee fowl nests were found to be scent marked by dingoes at the three sites surveyed" and "*all [survey] sites with active mallee fowl nests are potentially under the protective influence of dingoes*" (Wallach *et al* 2009b). • Data was collated on 19 threatened species occurring in areas of less than 350 mm annual rainfall over many sites on both sides of the DBF. Results of the study provide field-based evidence that "*dingo removal has cascading effects through lower trophic levels*" and its removal "*leads to widespread losses of small native animals*" (Letnic *et al* 2009). • From 1978 to 1992 Pople and colleagues carried out aerial surveys in three areas in the north and South Australian pastoral zone to ascertain numbers of red kangaroos, emus and dingoes on both sides of the DBF. The researchers found that even though the environment was similar on both sides of the fence numbers of red kangaroos were higher inside the fence than outside and their ability to recover after drought was faster inside the fence than outside. Dingoes were seen to be abundant outside the fence. There was a "marked step" in the density of kangaroos at the fence line consistent with the populations of red kangaroos being strongly influenced by the abundance of dingoes. The researchers concluded the data suggest "*a strong argument for predator*

	regulation of kangaroo and emu populations" (Pople *et al*. 2000). • An eight year study of the dusky hopping mouse by Moseby and colleagues reported that even though their two study sites were very different – one in south west Queensland and the other in north east South Australia, with respect to food availability and habitat quality, the little mouse persisted possibly because of low fox and cat activity and the abundance of dingoes (Moseby *et al.* 2006, Letnic in de Blas 2009). • Johnson and VanDeWal found a complex triangular relationship between wild dogs and foxes in eastern forests when they re-examined published data on the subject. They concluded "*Our analysis adds to evidence that dingoes may have negative effects on red foxes in a wide range of habitats and therefore that dingoes may be significant to conservation of mammal biodiversity in Australia*" (Johnson and VanDeWal 2009). • In a recent radio interview Chris Johnson gave the example of a population of rufus hare-wallabies in the Northern Territory that had been living alongside dingoes with only an occasional kill taking place. However when the dingoes were eradicated by baiting and shooting, foxes moved into the area and killed the entire population of wallabies in a very short space of time (Science Show 2007). • A rangeland region of some 325,000 square kilometres in New South Wales has been studied and analysis of the results suggests that 21 threatened native animals could benefit from reintroduction of the dingo (Dickman 2007). • The dingo has its overseas counterpart in the wolf. A recent wolf recovery program in the USA re-introduced 31 wolves into Yellowstone National Park and noted a cascade effect where birds and insects are once again thriving on the new vegetation growing as a result of declining elk numbers. Elk are the favoured prey of wolves. Juliette Jowit Environment Editor of the Observer newspaper recently wrote that wolves now roam in packs and have influenced ecological change across several states and that the re-introduction of wolves into Yellowstone is seen as being so successful a recent paper to the Royal Society backed the idea of re-introducing European grey wolves into Britain after having been extinct there for centuries (Jowit 2007). • Soulé (2007) also spoke of the positive effect on the ecosystem of the return of wolves to Yellowstone National Park and supported the conservation of dingoes in Australia to support the survival of 20 small to medium native animals now critically endangered. • Research using GPS technology was carried out in forested areas of south-eastern Australia by several agencies including State Forests NSW and the Department of Sustainability and Environment in Victoria. The team found the assumption that dingoes travelled long distances to seek out sheep grazing areas was unfounded as the majority of animals fitted with GPS collars stayed within their territories (DSE n.d.).
21. *For species nominated as extinct or extinct in the wild, please provide details of the* ***most recent*** *known* ***collection****, or authenticated* ***sighting*** *of the species*	***Not applicable***

and whether additional populations are likely to exist.	
22. *Is there an ongoing **monitoring programme**? If so, please describe the extent and length of the programme.*	[redacted] [redacted] is aware of no known coordinated international or national dingo monitoring program underway.

Life Cycle and Population

23. *What is the species' total population size in terms of **number of mature individuals**? How were population estimates derived and are they reliable? Are there other useful measures of population size and what are they?* In the absence of figures, terms such as common, abundant, scarce can be of value.	No population estimates have been undertaken for the dingo. Estimating dingo abundance is difficult as many hybrids are indistinguishable from pure dingoes. The term *wild dog* is also used as a more general term to describe dingoes, dingo/dog hybrids and feral dogs living in the wild, usually in areas where *wild dog* predation is a problem for stock owners. (Corbett 2004). Populations of wild dogs in the south-eastern highlands of Australia have been fairly abundant over the past 50 years. Pure dingoes are common in northern, northwestern and central regions, rare in southern and north-eastern regions, and probably extinct in the south-eastern and south-western regions (Corbett, 2009). The density of wild dogs (dingoes and hybrids) varies between 0.03 and 0.3 per km^2 according to habitat and prey availability (Fleming, 2001). According to Nesbitt (2007) pure dingoes are now only around 20% of wild dog populations and hybrids occur in the same locations as pure dingoes. Pure populations of dingoes still exist in northern Australia and these are considered threatened (Dickman and Lunney 2001). In 2001 Corbett suggested that over 90% of these animals are pure dingoes but this figure drops dramatically in south eastern Australia. Danielle Stephens (PhD candidate, University of WA) is at present using DNA technology to analyse tissue samples taken from dingoes and wild dogs Australia wide to ascertain where pure dingoes remain.
24. *Does the species occur in a **number of smaller populations**? How many? For each population give the locality, numbers and trends in numbers and tenure of land (include extinct populations). Can these be considered to be subpopulations and why?* **Subpopulations** are defined as geographically or otherwise distinct groups in the population between which there is little demographic or genetic exchange.	In his report Corbett selected and noted the following populations as worthy of nomination under National Heritage. These populations were proposed as they are considered to be populations of pure dingoes and therefore important to maintain. • Kimberley: Four Kimberley Islands, August, Bigge, Unwins and Wollaston and Middle Osborn Island in the Admiralty Gulf. No studies have been done to determine sizes of populations. Since the original nomination, an ongoing Kimberley Islands Biological Survey by WA DEC has shown that there are no dingoes on Bigge Island (the record was erroneous) and that the population on Middle Osborn has died out. ([redacted] [redacted], pers comm). • The Bradshaw Field Training Area: 600 km south-west of Darwin and representative of a large, self-sustaining dingo population although the population could contain hybrids given the previous history of Bradshaw pastoral station. • Kapalga: within Kadadu National Park. A good example of original type dingoes in shape and coat colour. Based on skull morphology 23 of 24 animals were classified as pure. 14 year study starting in the 1970s estimated 60 adults in packs or solitary and the population was kept fairly constant over that time. • Arafura: in north-central Arnhemland, no detailed studies • Simpson Desert: central Australia, self-sustaining population, opportunity for hybridisation limited by remoteness, stable packs up to 10 members. • Kosciusko: Probably one third of animals are hybrid, seen alone, in pairs or triplets but up to 9 animals share the same living area

	and sometimes cooperate in kills of large animals such as brumbies. Mean density is 1 / 6 km sq in Kosciusko National Park. • Fraser Island: About 100 adults and sub adults mostly in packs ranging from 2 to 9 members within territories (about 26 territories on island). Post breeding total population of about 200 adults and pups reducing to half immediately prior to following breeding season mostly due to dingo interactions within and between packs. Culling by national park rangers as part of dingo management plan. (Source: Humane Society International (2005). *Nomination of the dingo as National Heritage.* Prepared by Dr Laurie Corbett, October 2005.)
25. *Provide details on ages of the following:*	
a. *sexual maturity;*	Alpha males and females of pure dingo packs are the breeding pair and usually mate for life, care for the offspring is a duty shared by pack members, should pups be born to lower ranking females they are killed, usually by the dominant female. Sexual maturity occurs at 22 months and oestrus is once a year from March to April. The gestation period is 63 days and the average litter size is 5.4 pups (HSI 2005, Hintze 2002). Males in arid Australia also have a seasonal breeding cycle of about six months where the inability to breed successfully at other times is more probably due to a lack of seminal fluid than to a lack of sperm.
b. *life expectancy;*	Dingoes have a lifespan of up to but usually less than 10 years in the wild, with between 5 and 7 years being common in the absence of baiting, trapping or culling (Breckwoldt 1988), which is relatively short when compared to dingoes kept in a domestic situation of between 9 and 15 years ([redacted] [redacted] pers obs). Dingoes and domestic dogs interbreed readily when packs are fragmented by the death of dominant males and females.
c. *natural mortality.*	There are no figures available nationally for natural mortality of dingoes. Corbett (2009b) lists the mortality of Fraser Island dingoes from 2002-2008 as: • Humane destruction 25 (40%) • Vehicle Accident 9 (15%) • Dingo 7 (11%) • Unknown 21 (34%) Dingoes suffer many of the diseases that affect domestic dogs, these include, distemper, parvovirus, lungworm, sarcoptic mange, heartworm, ticks, and canine hepatitis (Breckwoldt 1988). Dingoes are also affected by food supply, and water supply, and in times of drought malnutrition and dehydration are a cause of death, the literature abounds with pictures of skeletal dingoes. An accident such as being kicked by a kangaroo or a pup being taken by an eagle are also causes of death. It has also been suggested that kangaroos are capable of drowning dingoes. Alpha females are also known to kill pups whelped by subordinate dingoes in a family group (Corbett 2001).
26. Reproduction	
For plants*: When does the species flower and set fruit? What conditions are needed for this? What is the pollinating mechanism? If the species is capable of*	***Not applicable***

vegetative reproduction, a description of how this occurs, the conditions needed and when. Does the species require a disturbance regime (e.g. fire, cleared ground) in order to reproduce?	
***For animals**: provide overview of breeding system and of breeding success, including: when does it breed; what conditions are needed for breeding; are there any breeding behaviours that may make it vulnerable to a threatening process?*	Given their restrained rate of reproduction dingoes are much slower to replace themselves than domestic dogs who reach sexual maturity at 7 or 8 months, come into oestrus twice yearly and have no breeding constraints based on social hierarchy. Dingo packs defend and remain in the territory of their birth and rarely interact with other packs except in defence. Stable pack sizes vary from 3 to 12 individuals and unlike dogs who bark, pack members use howling for two purposes "attracting pack members and repelling rivals" (HSI 2005). Dingoes also have a "cough" which they use to communicate danger (Breckwoldt 1988). Dingo pups are whelped during the winter months, weaned fully from 3 to 6 months of age (Breckwoldt 1988) and at this time the natal den is abandoned for temporary sites from which pups can roam by themselves but usually stay within three kilometres; for longer treks pups are accompanied by pack members. Pups are fed by whole food and liquid regurgitated by the mother and other pack members and become independent between three and four months. Dingo pups are often the prey of eagles (Hintze 2002). Pups often remain with their parents for over 12 months, assisting with the rearing of the next litter of pups. Although dingoes are often seen alone, many such individuals belong to socially integrated packs whose members meet every few days to coalesce during the breeding season to mate and rear pups. At such times scent marking and howling is most pronounced. Dingoes use scent-posts to indicate currently shared hunting grounds, to mark territorial boundaries and possibly to synchronise reproduction between pairs. The size of a dingo pack's territory varies with prey resources and terrain but is not correlated with pack size. For individuals, home range size also varies with age. The largest recorded territories (45-113 km^2) and home ranges (mean 77 km^2) occur in the Fortescue River area of north west Australia. Mean home ranges recorded elsewhere are 25-67 km^2 for arid central Australia, 39 km^2 for tropical northern Australia, and 10-21 km^2 for forested regions of eastern Australia. Most dingoes remain in their birth area, but some, especially young males, disperse and the longest recorded distance for a tagged dingo is 250 km over 10 months in central Australia (HSI 2005). According to Nesbitt (2007) pure dingoes are now only around 20% of wild dog populations and hybrids occur in the same locations as pure dingoes. Pure populations of dingoes still exist in northern Australia and these are considered threatened (Dickman and Lunney 2001). In 2001 Corbett suggested that over 90% of these animals are pure dingoes but this figure drops dramatically in south eastern Australia.
27. *What is the **population trend** for the entire species?*	
a. *What data are there to indicate **past decline** in size (if available, include data on rate of decline over past 10 years or 3 generations whichever is longer)?*	Listing on the IUCN Red List as Vulnerable (IUCN 2009) indicates that dingo populations in Australia have declined by more than 30% over the last three generations. The population trend is therefore one of decreasing numbers. Dingo distribution across the continent has contracted and been fragmented since European settlement due to hybridisation with domestic dogs, lethal control, State and Territory laws and, in the earlier part of the

	20th Century the erection of the Dingo Barrier Fence (DBF) to protect sheep farming regions from wild dogs. See Figure 1 for a map of the distribution of dingoes in Australia. Dingo populations in the remote areas of central Australia, on the other side of the DBF have more stable pack structures and as such packs are more difficult for domestic dogs or hybrids to infiltrate (HSI 2005, 2001). This is a vastly different situation to south-eastern Australia where hybrids proliferate (Claridge and Hunt 2008). In the south eastern highlands region of Australia, Jones suggests the abundance of pure dingoes (measured by skull morphometrics) dropped from 49% to 17% in the 20 years between the 1960s and 1980s (Jones in Corbett 2004 cited in HSI 2005). Corbett (2001) suggests pure dingoes may be locally extinct particularly in south eastern Australia although remnant populations are thought to occur in Central and Northern Australia (Corbett in IUCN, 2008). Control laws in the Northern Territory are less intense than in other states possibly due to a preference there to grazing cattle rather than sheep consequently there has been little change in dingo distribution. Johnson asserts that consequence of dingo abundance in stable packs means less extinction than in areas that have been subjected to rigid dingo extermination policies (Johnson 2006).
b. *What data are there to indicate **future changes** in size (if available, include data which will indicate the percentage of decline over 10 years or 3 generations whichever in longer (up to a maximum of 100 years in the future) where the time period is a continuous period that may include a component of the past)?*	There are no data readily available that indicate future changes in the size of dingo populations. However the major threats of hybridisation, wild dog extermination programs, conflicting government regulations and keeping dogs without pure dingo certification as pets, will inevitably lead to further introgression of domestic dog genes and inevitably to dingo extinction.
28. *Does the species undergo **extreme natural fluctuations** in population numbers, extent of occurrence or area of occupancy? To what extent and why?* **Extreme fluctuations** can be said to occur in a number of taxa when population size or distribution area varies widely, rapidly and frequently, typically with a variation greater than one order of magnitude (i.e. a tenfold increase or decrease).	There are no data available that provides evidence of extreme natural fluctuations in population numbers. Corbett (2001) describes a distemper epizootic in the Barkley Tablelands in 1970 as having a catastrophic effect on dingo numbers, and two epizootics of heartworm in the Kakadu National Park. Anthropogenic causes of natural fluctuations include concentrated efforts of baiting, trapping and shooting. Should more potent poisons become available to those responsible for wild dog/dingo management further severe fluctuations may occur.
29. *What is the **generation length** and how it is calculated?* **Generation length** is the average age of parents of the current cohort (i.e. newborn individuals in the population). Generation length therefore reflects the turnover rate of breeding individuals in a population. Generation length is greater than the age at first breeding and less than the age of the oldest breeding individual, except in taxa that breed only once. Where generation length varies under threat, the more natural, i.e. pre-disturbance, generation length should be used.	A literature search has failed to find any evidence of details of generation length.
30. *Identify **important populations** necessary for the species' long-term survival and recovery? This may include: key breeding populations, those near the edge of the species' range or those needed to*	In his report Corbett selected and noted the following populations as worthy of nomination under National Heritage. These populations were proposed as they are considered to be populations of pure dingoes and therefore important to maintain.

maintain genetic diversity.	• Kimberley: Four Kimberley Islands, August, Bigge, Unwins and Wollaston and Middle Osborn Island in the Admiralty Gulf. No studies have been done to determine sizes of populations. Since the original nomination, an ongoing Kimberley Islands Biological Survey by WA DEC has shown that there are no dingoes on Bigge Island (the record was erroneous) and that the population on Middle Osborn has died out. ([redacted], pers comm). • The Bradshaw Field Training Area: 600 km south-west of Darwin and representative of a large, self-sustaining dingo population although the population could contain hybrids given the previous history of Bradshaw pastoral station. • Kapalga: within Kadadu National Park. A good example of original type dingoes in shape and coat colour. Based on skull morphology 23 of 24 animals were classified as pure. 14 year study starting in the 1970s estimated 60 adults in packs or solitary and the population was kept fairly constant over that time. • Arafura: in north-central Arnhemland, no detailed studies • Simpson Desert: central Australia, self-sustaining population, opportunity for hybridisation limited by remoteness, stable packs up to 10 members. • Kosciusko: Probably one third of animals are hybrid, seen alone, in pairs or triplets but up to 9 animals share the same living area and sometimes cooperate in kills of large animals such as brumbies. Mean density is 1 / 6 km sq in Kosciusko National Park. • Fraser Island: About 100 adults and sub adults mostly in packs ranging from 2 to 9 members within territories (about 26 territories on island). Post breeding total population of about 200 adults and pups reducing to half immediately prior to following breeding season mostly due to dingo interactions within and between packs. Culling by national park rangers as part of dingo management plan. About 30% hybrid based on skull morphology. (Source: Humane Society International (2005). *Nomination of the dingo as National Heritage.* Prepared by Dr Laurie Corbett, October 2005.)
31. *Describe any **cross-breeding** with other species in the wild, indicating how frequently and where this occurs.*	The literature clearly identifies that a major threat to dingoes is hybridisation and that soon pure dingoes will be bred out of existence (Breckwoldt 2001; Corbett 2001; PSW NT n.d; Wilton 2001, Davidson 2004, Jones 2009). Wilton (in Dickmann and Lunney 2001) estimates of the proportion of hybrids in populations are as high as 78% in some areas, while Corbett (2001) notes surveys in NSW, in which 100% of samples were hybrids. According to Corbett "*given the current rate of hybridisation it is likely that most populations of pure dingoes will be extinct by the end of the 21st century, and Australia would then become a land of hybrids and feral dogs*" (Corbett 2001). Danielle Stephens (PhD candidate, University of WA) is at present analysing tissue samples from dingoes/wild dogs trapped and shot from throughout Australia, ascertaining and mapping the DNA purity of the samples, and hence the locations of any pure, or near pure dingoes left in the wild.
32. *Departmental Use only:*	

Populations In Reserve

33. *Which **populations** are **in reserve systems**? Which of these are actively managed for this species? Give details.*	Question 30 outlines a number of populations. At least one of these, the Kapalga population occurs within Kadadu National Park. This population is a good example of original type dingoes in shape and coat colour.

	[redacted] [redacted] is not aware of any reserves which are actively managed specifically for the dingo, however it is likely, given the dingo's presence across Australia that dingoes would be found in many reserves.

Habitat

34. *Describe the **species' habitat** (e.g. aspect, topography, substrate, climate, forest type, associated species, sympatric species). If the species uses different habitats for different activities (e.g. breeding, feeding, roosting, dispersing, basking), then describe each habitat.*	Prior to white settlement dingoes occupied a diverse range of habitats Australia wide from alpine and forested regions to arid zones, coastal fringes and tropical wetlands. However as agriculture spread, habitats were lost. Although there is only one dingo 'species' in Australia, there are 'statistically distinct' sub-populations associated with tropical, desert and alpine climates and habitats in northern, central and south-eastern Australia respectively (HSI 2005). These sub-populations are sometimes referred to as tropical dingoes, desert dingoes and alpine dingoes.
35. *Does the species use **refuge habitat**, e.g. in times of fire, drought or flood? Describe this habitat.*	Specific refuge habitat is not known for the dingo.
36. *Is the **extent or quality** of the species' habitat **in decline**? If the species uses different habitats, specify which of these are in decline.*	Dingo distribution across the continent has contracted and been fragmented since white settlement due to hybridisation with domestic dogs, lethal control, State and Territory laws and, in the earlier part of the 20th Century the erection of the Dingo Barrier Fence (DBF) to protect sheep farming regions from wild dogs. All of these threats have also had an impact on the dingo's habitat. The DBF in particular has reduced the extent of habitat available to the dingo.
37. *Is the species part of, or does it rely on, a **listed threatened ecological community**? Is it associated with any other **listed threatened species**?*	The dingo performs the role of an apex predator in ecosystems. Removing apex or top order predators from a system can have profound effects at lower trophic levels affecting species richness and abundance (Corbett 1995a in HSI 2005, Fleming 2001, Glen and Dickman 2005, Glen *et al.* 2007, Harden 2001, Johnson 2006, Letnic in de Blas 2009, Soulé 2007). Secondary extinction can then occur in small native animals "*the top-predator hypothesis predicts that threatened species will not survive where dingoes are rare or absent*" (Wallach *et al* 2009a). In a recent paper published in *Biological Sciences,* Johnson and colleagues suggest that the rate and number of mammal extinctions in Australia over the past 150 years highlights the relationship between the presence of top predators and abundant populations of smaller predators. When top predators are persecuted and their numbers decline there are also declines and even extinctions of some prey due to the proliferation of red foxes and feral cats. The authors suggest that top predators like the dingo play a crucial role in maintaining prey diversity (Johnson *et al* 2007). Johnson (2006) argues that rather than dingoes accelerating species extinction by their presence, the opposite is the case; species extinction is accelerated by dingoes' absence. He suggests the only way to stop the decline and extinction rate of Australia's small mammals is to focus on bringing back the top-order predator, the dingo (Johnson 2006). "*The presence of dingoes is the most powerful predictor of the survival of ground-dwelling marsupials across Australia*" (Johnson 2007 in de Blas 2009). Dingoes can therefore be referred to as keystone species as their removal from an ecosystem results in "*the reorganisation of trophic webs and loss of biodiversity*" (Glen *et al* 2007, Letnic *et al* 2009). Previously subordinate predators may increase unchecked, potentially decimating prey populations. Some herbivores may become over-abundant, leading to

	overgrazing on plant populations. Competitive relationships between prey species may be altered and in some cases these effects may ultimately lead to community-level trophic cascades in which plant biomass is redistributed throughout a system (HSI 2005). Data was collated on 19 threatened species occurring in areas of less than 350 mm annual rainfall over many sites on both sides of the DBF. Results of the study provide field-based evidence that "*dingo removal has cascading effects through lower trophic levels*" and its removal "*leads to widespread losses of small native animals*" (Letnic *et al* 2009). A rangeland region of some 325,000 square kilometres in New South Wales has been studied and analysis of the results suggests that 21 threatened native animals could benefit from reintroduction of the dingo (Dickman 2007). Given the diverse range of habitats occupied by dingoes it is suggested that the dingo may rely on listed threatened ecological communities in some areas and be associated with listed threatened species, however this specific information is not readily available. Letnic et al (2009) found that abundance of the dusky hopping mouse (*Notomys fuscus)* was positively associated with the presence of the dingo, while Wallach et al (2009b) showed that dingoes coexisted with Malleefowl (*Leipoa ocellata),* listed as vulnerable under the EPBC Act and with the Yellow-footed rock-wallaby (*Petrogale xanthopus xanthopus)*, listed as vulnerable under the EPBC Act. This provides further evidence that the presence of dingoes is associated with the survival of threatened species; in this case in semi arid and arid scrublands.

Feeding

38. *Summarize the species' **food** items or sources and timing/seasonality.*	Generally dingoes hunt kangaroos, wallabies and ferrel animals including foxes and rabbits and are also opportunistic hunters of domesticated livestock such as sheep and calves. Intact dingo packs with minimal interference from humans exhibit enforced behavioural boundaries and Glen and colleagues suggest that this appears to limit their predation on livestock (Glen *et al* 2006). Attacks on stock especially sheep tend to occur when prey are scarce (HSI 2005). Such attacks could be attributed to hybrid dogs. It is often claimed that dingoes are a major predator of turtle eggs, other predators include foxes, dogs, pigs, cats, goannas and water rats (Norris and Low 2005). A study of packs of dingoes in the Blue Mountains west of Sydney found that feeding habits synchronised with changes to need such as whelping and raring pups. Analysis of scats indicated dingoes had a food preference for swamp wallabies, brush tailed possums and eastern grey kangaroos. "*The preliminary results of the study throw serious doubt on theories that dingoes breed in the protected areas and move into pastoral lands to prey on livestock*" (Purcell in Science Alert 2009). Dingoes eat a diverse range of prey types, from insects to buffalo. However, in a particular region they tend to specialise on the commonest available wildlife prey and change their group size and hunting strategy accordingly to maximise hunting success. Main prey are magpie geese, rodents and agile wallabies in the Kakadu National Park; rabbits, rodents, lizards and red kangaroos in central Australia; euros and red kangaroos in the Fortescue River area; rabbits in the Nullarbor Plain region; and wallabies and wombats in eastern Australia (HSI 2005). Coconut is often found in the stomach of Fraser Island dingoes.

	(Queensland Parks & Wildlife Service 2009).
39. *Briefly describe the species' **feeding behaviours**, including those that may make the species vulnerable to a threatening process.*	The dingo hunts within packs using coordinated behaviour. Intact dingo packs with minimal interference from humans exhibit enforced behavioural boundaries and Glen and colleagues suggest that this appears to limit their predation on livestock (Glen *et al* 2006). Hunting in packs allows for the bringing down of large prey such as kangaroos (Glen *et al.* 2007; Allen and Sparkes 2001; Pople *et al.* 2000). But when times are lean dingoes can disperse and solitary animals may even resort to eating crickets to survive (Breckwoldt 2001) although kills of small to medium-sized prey are more generally the case (Glen *et al.* 2007). Wallach (2009a) reports that following poison baiting on a sheep station in the Flinders Rangers attacks on sheep became more prevalent and concluded that the baiting may have fragmented dingo packs and promoted behavioural change in young dingoes. She suggests there is a tendency to 'shoot first and ask questions later' so caution is warranted because "*poison baiting may be a double edged sword*" (Wallach *et al* 2009a). In a later study Wallach et al (2009b) found that lethal control of dingoes systematically fractures social units which can in turn lead to increase in attach rates on stock. She cites research by Allen and Gonzales which showed experimental evidence that calf losses are higher where dingoes are baited. Since the early days of European settlement, dingoes have harassed stock, especially sheep and to a lesser degree cattle. However, most attacks occur when native prey is scarce (e.g. during droughts or after wildfire or as a result of human disturbance to habitats); cattle also die during drought and dingoes scavenge on their carcasses (HSI 2005). Although dingoes often assist humans in keeping down the numbers of rabbits, feral pigs, feral goats and other pastoral pests, governments and landholders have attempted to control or eradicate dingoes by offering scalp bonuses, by hunting with trap and gun, and by poisoning and fencing. These attempts have been largely unsatisfactory since most control measures merely harvest populations, or even promote increases in dingo numbers by disrupting the social organisation of packs and prompting an increase in breeding rates. Further, the widespread provision of watering points (dams and bores fed by subterranean water) for stock has encouraged dingoes to go beyond widely scattered natural waters; the provision of abundant non-native food sources, rabbits in good seasons and carrion during drought has had the same effect (HSI 2005).

Movement Patterns (fauna species only)

40. *Describe any relevant **daily and seasonal pattern of movement** for the species, or other irregular patterns of movement, including relevant arrival/departure dates if migratory.*	Although dingoes are often seen alone, many such individuals belong to socially integrated packs whose members meet every few days or coalesce during the breeding season to mate and rear pups. At such times scent marking and howling is most pronounced. Dingoes use scent-posts to indicate currently shared hunting-grounds, to mark territorial boundaries, and possibly to synchronise reproduction between pairs (HSI 2005). In remote areas where dingoes are not disturbed by human control operations, discrete and stable packs of 3-12 dingoes occupy territories throughout the year. Such packs have distinct male and female hierarchies where rank order is largely determined and maintained by apparently aggressive behaviour, especially within male ranks. The dominant pair may be the only successful breeders but other pack members assist in rearing the pups (HSI, 2005).

41. *Give details of the species' **home ranges/territories**.*	The size of a dingo pack's territory varies with prey resources and terrain but is not correlated with pack size. For individuals, home range size also varies with age. The largest recorded territories (45-113 km^2) and home ranges (mean 77 km^2) occur in the Fortescue River area of north-west Australia. Mean home ranges recorded elsewhere are 25-67 km^2 for arid central Australia, 39 km^2 for tropical northern Australia, and 10-21 km^2 for forested regions of eastern Australia. Most dingoes remain in their birth area, but some, especially young males, disperse and the longest recorded distance for a tagged dingo is 250 km over 10 months in central Australia (HSI, 2005). A study by PhD candidate Brad Purcell in the Blue Mountains World Heritage Area of New South Wales used GPS tracking collars on 12 dingoes over a 14 month period and found that the animals remained in their home territories distinguished by natural markers and rarely crossed paths with other packs. "*The average home range was about 34 square kilometres but they spend 50 per cent of their time within a core area that was on average 5.9 square kilometres. Individual dingoes from different packs only briefly crossed paths and, importantly, there was only minimal or no visits to farmland by the GPS tracked dingoes. The dingo packs kept mostly in their own territories – inside the scheduled dingo conservation habitat.*" (Purcell in Science Alert 2009).

Survey Guidelines

42. *Give details of the **distinctiveness and detectability** of the species.*	Dingoes can be distinguished from hybrid dogs by their DNA (Wilton 2001) and once dead the dogs' phenotypes can be differentiated by their skull morphology (Corbett 2001), however Jones (2009) is critical of the skull morphology techniques. There is difficulty however in visual assessment as dingoes have been crossed with domestic dogs purposefully during the days of early white settlement. The highly valued Australian cattle dogs were originally bred by purposefully crossing various domestic breeds including Dalmatian with dingo in order to breed in 'positive dingo traits' such as courage. The process of introgression – genes from *ssp. familiaris* flowing into *ssp. dingo* – will eventually mean extinction of the dingo (Corbett 2001, Elledge *et al* 2006). The only unknown is when. When the balance is tipped from dingo to dog changes in biology and behaviour could be expressed. It is feasible that two oestrus cycles per year as in the domestic dog will replace one as in dingoes; the animals will mature earlier breeding at eight months instead of two years, and behaviour will no longer be confined to the limitations of pack hierarchy. Intervention and an ongoing monitoring of a similar hybridisation problem in Scotland between the European wildcat *Felis silvestris* and the domestic cat are showing good results. Hybridisation had occurred between wildcats and domestic cats (Daniels *et al* 1998 and Beaumont et al 2001 in Elledge *et al* 2006). A benchmark was set for 'pure' wildcat ignoring previous introgression (Beaumont *et al* in Elledge *et al* 2006) and wildcat populations are now recovering assisted by habitat restoration and legal protection (McOrist and Kitchener 1994 in Elledge *et al* 2006). In 2008 Elledge and colleagues published results for assessing dingo purity using three methods; genetics, skull morphology and visual characteristics and found "*a strong agreement between the status of hybridisation assigned to the animals*", at almost 70% using all three methods. The visual method asked 13 dingo experts to examine 56 photographs of anaesthetised animals and assess them using visual characteristics such as coat colour and floppy ears. Results "*showed that*

hybrids were more easily identified by visual characters than were dingoes" (Elledge *et at* 2008). This is a surprisingly good result given that still photographs of anaesthetised animals would not indicate behavioural characteristics nor conformation and gait which one would assume would make assessment a great deal easier.

When Wilton chose 20 loci to distinguish dogs' DNA from a group of reference dingoes (Wilton in DCN 2004) he acknowledged that the reference animals chosen were captive animals; indeed it has been pointed out by others that the reference animals could have been hybrids (Corbett in ECOS 2004, Elledge *et al* 2006). However even if the reference dingoes were hybrids the research is valuable in that the animals chosen for appearance could be on the high end of a "dingo purity continuum".

It is worth noting that Savolainen and colleagues used visual clues to identify "wild dingoes" in their study of 211 (captured n=19) and (wild n=192) dingoes to establish the animals' DNA heritage. "*The wild animals were chosen based on similarity in appearance to dingoes to exclude as far as possible feral dogs and dog x dingo hybrids*" (Savolainen *et al* 2004).

Compilation of an easy to use 'dingo toolkit' of visual indicators to identify animals that are pure or substantially pure from those that aren't would give land managers a reasonable amount of accuracy in identifying and disposing of those hybrids assessed as having a minority of dingo genes. Follow up DNA back-up tests of killed animals would indicate the degree of dingo present and thus visual indicators could constantly be refined and updated. Used in conjunction with less invasive DNA testing of hair, buccal swabs and scats would mean a progression toward purity particularly if used under a Threatened Species legal banner.

Apart from refining genetic analysis techniques Elledge and colleagues advocate further research "… *on improving the reference specimens used to visually classify animals on the basis of pelage colourations and markings, and in particular provide more detailed parameters of characters so that assessments can be more uniform between observers*" and they suggest "*a practical method that can estimate the different levels of hybridization in the field is urgently required so that animals below a specific threshold of dingo ancestry (e.g. ¼ or ½ dingoes) can reliably be identified and removed from dingo populations*" (Elledge *et al* 2006).

Corbett agrees that instead of concentrating on the genetic purity of dingoes we accept less-than-pure animals for their role in ecosystem management (Corbett 2004), but we should strive towards improving purity levels in the wild. It is now commonplace to hear the call by scientists that unless a stand is made to stop further hybridisation, dingoes will be another statistic on Australia's appalling rate of native animal extinctions. "*The proportion of dingo genes in a population will decline at a slower rate by dingoes breeding with hybrids rather than dogs*" (Elledge *et al* 2006).

It has been suggested that ginger coat colour is used as dingo identifiers (Corbett 2001) and "ticking" or spotting on coats used as non-dingo or hybrid identifiers (Elledge *et al* 2006) as ticking is found on many domestic dogs such as the Dalmatian, English Setter and Australian Cattle Dog.

Land managers need to be given tools to identify the most pure dingoes from wild dogs in the field such that hybrids can be removed. Apart from a few protected areas such as Fraser Island, it is for the most part mandatory for rural property owners and managers to exterminate wild dingoes and dingo hybrids throughout Australia regardless of their purity status.

	DNA tests on Fraser Island dingoes in 2004 suggest that the Fraser Island packs are possibly the only pure dingoes left in the wild in Australia. Dr Darryl Jones stated "*We have miraculously this astonishingly purebred group of dingoes which are the only remnant left of what the pure dingo was like*" (Catalyst 2005). Norris and Low in their *Review of the management of feral animals and their impact on biodiversity in the Rangelands* refer to dingoes as *Canis familiaris dingo* (Norris and Low 2005) as do both the Department of Natural Resources and Mines in their *Queensland Wild Dog Management Strategy* published in 2002, and Clarke *et al.* (2000) in the *State of the Environment Technical Paper Series* for the Department of Environment and Heritage. There have been claims—particularly in the popular press—of dingo sub-species occurring in different regions and habitats for example referring to alpine dingoes as a different sub-species to desert dingoes, however allocating sub-species to different regions is dispelled by Breckwoldt (2001) and Corbett (2001). Dingoes in different regions often display different coat colours (Hinze 2009) and should be referred to as sub-populations (Corbett 2001). "… *the continual integration of domestic dog genes will result in the loss of differentiation if there is no intervention or natural selection against hybrids and feral dogs*" (Elledge *et al* 2006). The rate of introgression shows no sign of abating rather it is escalating to such an extent that pure dingoes are considered to now be very rare indeed and the animals face extinction in the not too distant future (Wilton in ECOS 2004, Corbett 2001, Elledge *et al* 2008).
43. *Describe* ***methods for detecting species*** *including when to conduct surveys (e.g. season, time of day, weather conditions); length, intensity and pattern of search effort; and limitations and expert acceptance; recommended methods; survey-effort guide.*	Piggott and Taylor 2003 state that obtaining useful information about elusive or endangered species can be logistically difficult, particularly if relying entirely on field signs such as hair, feathers or faeces. However, recent developments in molecular technology add substantially to the utility of such "non-invasive" samples, which provide a source of DNA that can be used to identify not only species but also individuals and their gender. This now provides great potential to improve the accuracy of abundance estimates and determine behavioural parameters, such as home range size, individual habitat and dietary preference. A project being conducted by Danielle Stephens *Developing DNA-based monitoring techniques for improved management of wild dogs* which she describes the National Dingo Purity Survey by stating: *The dingo is an iconic Australian animal, yet it may be near extinction because of increasing instances of interbreeding (hybridisation) with domestic dogs A major difficulty in wild dog management is the lack of detailed knowledge of the distribution of pure dingos and the extent of hybridisation in most regions. I will be mapping the levels and rates of hybridisation to identify areas where pure dingoes can still be found, as no dedicated survey of dingo purity 'hotspots' has been undertaken before. I will also be measuring the level of genetic 'distinctness' among dingo packs across Australia, to determine how different dingoes are in different areas and potentially identify unique populations.* Stephens (2010)

Section 2 - Threats and Threat Abatement

Threats

44. *Identify **past, current and future threats**, to the species indicating whether they are actual or potential. For each threat, describe:*	
a. ***how and where** it impacts on this species;*	The literature clearly identifies that a major threat to dingoes is hybridisation and that soon pure dingoes will be bred out of existence (Breckwoldt 2001; Corbett 2001; PSW NT n.d; Wilton 2001, Davidson 2004). Wild dog control is a major cause of decline in pure dingoes. It is believed that 1080 baiting campaigns not only directly reduce local dingo populations, but also facilitate hybridisation with wild dogs. Dingoes typically live in tight knit packs with one dominant breeding female breeding only once a year. Baiting breaks up packs, particularly through the loss of dominant animals. This loss of social cohesion encourages increased fecundity and a higher likelihood of dingos breeding with immigrant domestic and particularly hybrid dogs. Wallach *et al* (2009b) researched the impact of lethal control on the social stability of dingoes and found: *"Comparison of abundance and stability among all sites and years demonstrated that control severely fractures social groups, but that the effect of control on abundance was neither consistent nor predictable. Management decisions involving large social predators must therefore consider social stability to ensure their conservation and ecological functioning."* The confusing array of Government Acts and regulations relating to dingo control are hastening the animal's progress toward extinction. Various State, Territory and Federal Government Acts give conflicting "save" and "destroy" messages. In New South Wales the Wild Dog Destruction Act 1921 states "*It shall be the duty of the owner or occupier of any land, at all times, at the owner's or occupier's own cost, to destroy all wild dogs upon such land*." and it goes on "*Wild dog includes any dingo or native dog, or any dog which has become wild, or any dog which apparently has no owner and is not under control*" (Australasian Legal Information Institute 2007). While the Companion Animal Act allows dingoes to be kept as pets! Various wild dog/dingo management plans, including the Fraser Island Dingo Management Strategy (2009), the NT management program, the SA management policy (Downward & Bromell 1990), and the Wild Dog Management Plan for the Kempsy Rural Lands Protection Board District all purport to support the conservation of the dingo, but a close examination reveals that the focus is on wild dog/dingo control by pest managers, rather than conservation by conservation managers. According to some, another major threat to pure dingoes is the increasing prevalence of dingo preservation societies (Corbett in IUCN 2008, Oakman 2001). These institutions encourage breeding of animals they assume to be pure although such animals may be hybrids and if so their actions would accommodate hybridisation. Dingoes' purity is also threatened by people keeping dingoes with unproved purity status as pets in Australia (Oakman 2001). Abroad in countries such as Switzerland and USA 'dingoes' are selected for their looks and behaviour (Corbett in IUCN/SSC 2008). Some feel that it is very easy to get caught up on the purity argument, and by excluding animals that show only one dog like gene, we may be excluding very valuable

	genetic material, and in the wild they may well be performing the role of a pure dingo. The other issue in relation to what can be described as mild hybridization is the question of when the hybridization occurred. Jones (2009) quite rightly points out that the first hybridization of Victorian dingoes may have occurred as early as 1830 when pastoralists first introduced stock and their companion animals. Jones goes on to say of hybrids established in the wild that "*the terms 'hybrid' or 'cross breed' do not accurately describe these animals because they are essentially dingo-like wild canids and most represent the end product of a slow process of change or continuing change, and not the product of a simple cross between a domestic dog and a dingo".* And they are different from first generation hybrids bred in captivity. Jones asserts that it is not a realistic option where dingoes have undergone a long process of hybridization to devise management policies based upon unrealistic expectations of conserving *pure* dingoes. Policies must reflect the present realities. Problems associated with captive breeders include: • issues related to inbreeding due to a lack of pure stock • breeders failing to select unrelated dingoes as breeding pairs • attempting to breed for a certain *look* to confirm their perceived ideas about how a dingo should look • lack of pressure of survival of the fittest due to veterinary intervention ensuring all members of a litter survive The major threats of hybridisation, wild dog extermination programs, conflicting government laws and regulations and keeping dogs without pure dingo certification as pets will, experts agree inevitably lead to further introgression of domestic dog genes, impinging on the future of the dingo and inevitably to dingo extinction.
b. *what its **effect** has been **so far** (indicate whether it is known or suspected; present supporting information/research; does it only affect certain populations);*	Wilton (in Dickmann and Lunney 2001) estimates of the proportion of hybrids in populations are as high as 78% in some areas, while Corbett (2001) notes surveys in NSW, in which 100% of samples were hybrids. According to Corbett "*given the current rate of hybridisation it is likely that most populations of pure dingoes will be extinct by the end of the 21st century, and Australia would then become a land of hybrids and feral dogs*" (Corbett 2001). The results from research being conducted by Danielle Stephens (2010) will provide a more complete analysis of the degree of hybridization Australia wide. 1080 poison is used to eradicate dingoes and wild dogs using ground baiting or aerial baiting techniques although the latter has been significantly reduced since 1996 (Harden 2001). The poison is very potent to canids and is said to have less effect on native wildlife particularly wildlife from Western Australia as the poison comes from a native plant in that State thus WA native animals avoid it. However according to some scientists quolls are killed by the poison when the aerial baiting technique is used (Meek and Shields 2001). The Invasive Animals Cooperative Research Centre aims to reduce foxes and wild dogs by 10% and is working on delivering a new toxicant which it claims will be humane and canid specific (IACRC 2006, Flemming *et al* 2006).

	Apart from the inhumane implications of baiting, poisoning also disrupts social hierarchy in dingo packs particularly if baits are eaten by the alpha breeding pair leading to fragmentation of the pack. Previously non-breeding individuals end up as solitary animals and mate with other wild dogs. Killing pack leaders thus exacerbates the problem of hybridisation (Colong Foundation n.d., DCN 2007) and although baiting may initially decrease wild dog numbers, Meek and Shields suggest dog numbers return to their initial abundance within one year and this may lead to increased predation of livestock (PWS NT n.d.) by solitary animals. A South Australian station hand recently stated on ABC News that "*for every one we kill in a bait two return*" (ABC TV 2009). Wallach *et al* (2009b) found that the lethal control of dingoes made little difference to their abundance, but fractured their social structure disrupting the adhesion of the *pack.* She argues that it is the pack that is the top predator, not the individual dingo, without the pack the dingo is functionally the same as a large fox. A major consideration to take into account is that unlike foxes and cats, dingoes need to drink regularly (Norris & Low 2005) and are therefore easy prey for baiting around artificial water holes (see Wallach et al under "Surveys and Monitoring"). In its recent submission to nominate populations of dingoes as threatened species in New South Wales the Colong Foundation stated that current management practices of wild dog control in that State are in themselves a Key Threatening Process under the Threatened Species Conservation Act, 1995. The submission goes on to state "*Current wild dog management aims to prevent stock losses, not protect Dingo populations from hybridisation*" (Colong Foundation n.d.). Although some protected areas in Australia such as Fraser Island protect dingoes the animals are often culled if they threaten human safety and recently a large number of animals were 'culled' in response to their advance toward habituation. The Fraser Island population is small and quite possibly at the high end of genetic purity and although human safety should be paramount the question must be asked, would culling such a large proportion of individuals from a small population be considered management best practice in other protected areas around the world? In the AFIDMS 2009 Corbett restates concerns that the Fraser Island dingo population may have been culled below a naturally sustainable level.
c. *what is its **expected effect in** the **future** (is there supporting research/information; is the threat only suspected; does it only affect certain populations);*	The major threats of hybridisation, wild dog extermination programs, and conflicting government regulations will inevitably lead to further introgression of domestic dog genes and unless there is a change in policies and practices in relation to wild dog/dingo control, the outcome will be the extinction of the dingo. Breeding dingoes in captivity and keeping dogs without pure dingo certification as pets, will lead to possible increased inbreeding, changes due to small genetic stock, and breeding for a specific type.
d. *what is the **relative importance or magnitude** of the threat to the species.*	In light of 44c above, which suggest the major threats will lead to dingo extinction, it is suggested that the relative importance or magnitude of the threats are extremely high. As mentioned the level of hybridization in some areas, such as South East Australia is already very high.
45. *If not included above, identify **catastrophic threats**, i.e. threats with a low predictability that are likely to severely affect the species. Identify the threat, explain its likely impact and*	See section 44 above. Catastrophic threats that may affect wild dingo populations include: • Heart worm infestation as occurred in Kakadu National Park (O'Neill 2002)

indicate the likelihood of it occurring (e.g. a drought/cyclone in the area every 100 years).	• Fraser Island dingoes are suspect to diseases affecting domestic dogs. Gardiner (2009) describes concerns for Fraser Island dingoes after the escape of a cattle dog on the Island. As the Fraser Island dingoes are not vaccinated it is possible that a domestic dog could bring any number of canine diseases onto the Island that the dingoes would not have immunity to. • Other diseases affecting domestic dogs may also cause a catastrophic threat to dingoes in the wild, as they have no immunity. These diseases may include rabies, parvo virus, worm infestations and secondary infection from sarcoptic mange.
46. *Identify and explain any **additional biological characteristics** particular to the species that are threatening to its survival (e.g. low genetic diversity)?*	HSI has been unable to access further research at this time regarding additional biological characteristics, although it is noted that genetic studies of the dingo are underway (Stephens, 2010)
47. *Identify and explain any **quantitative measures or models** that address the probability of the species' extinction in the wild over a particular timeframe.*	HSI is not aware of any quantitative measures or models that address the probability of the dingo's extinction in the wild.
48. *Is there **other information** that relates to the survival of this species that you would like to address?*	No – these are all addressed in earlier sections.

Threat Abatement and Recovery

49. *Give an overview of how broad-scale **threats** are **being abated**/could be abated and **other recovery actions** underway/ proposed. Identify who is undertaking these activities and how successful the activities have been to date.*	In late 2008 a daily newspaper, The Herald Sun stated an action plan to protect the dingo would be established by Victoria's Department of Sustainability and Environment and went on to quote the Victorian Environment Minister Gavin Jennings as saying "*Dingoes have been part of the Australian ecosystem for thousands of years and have an important ecological role*" (Wotherspoon 2008). As required under the FFG 1988 a working group was convened by DSE in Victoria to write an Action Plan to ensure the survival of the dingo. Work on the action plan is ongoing and recommendations will be forwarded to the Minister later in 2010 ([redacted] 2010 pers. comm.). The Northern Territory's *Management Program for the Dingo 2006-2011* states "*the aim of this management program is to ensure the continued existence of wild dingo populations in Northern Territory ecosystems, strategically reducing their negative impacts as required*" (PWS NT n.d.). Hybridisation minimisation will be ongoing in the NT by working with Aboriginal communities to encourage de-sexing of companion dogs, having a permit system for public ownership of the animals with conditions that animals must be de-sexed and by promoting awareness programs of dingoes and their role as an environmental regulators (PWS NT n.d., National Resources, Environment, The Arts and Sport 2007). The Wild Dog Management Plan for the Kempsey Rural Lands Protection Board District (2008-2011) focuses on monitoring of the effectiveness of wild dog management programs and provides only negligible reference to the monitoring of the conservation status of dingoes on Schedule 2 lands. The data appearing in the document provides no evidence of data obtained from monitoring the conservation status of the dingo. The Management Program for the Dingo in the Northern Territory makes provision for the following research: 1. Assess the genetic status of dingo populations in the Northern Territory 2. Further investigate the relationship between 1080 baiting, dingo abundance and predation of cattle 3. Evaluate the interaction between dingoes, their prey and

	subordinate predators 4. Determine the effect of rabbit calicivirus on dingo diet and the predation of livestock 5. The suitability of factory-manufactured baits for use in the Northern Territory 6. Support external research and development aimed at improving dingo management The focus on baiting and management and the role of *Pest Animal Management* in the conduct of this program suggests a focus on *control and management* rather than *conservation.* Professor Iain Gordon, a research scientist with CSIRO supports scientists working with land managers to "put new management regimes on the ground" to help reduce the threat to native wildlife. In an article published online on ABC Science's Opinion page, he outlines Professor Chris Johnson's view of bringing back the dingo because stable dingo populations are known to suppress numbers of feral predators thus reducing the carnage feral pests cause to small mammal populations. Gordon suggests that although sheep farmers may not like the idea current trials on a sheep property using Maremma dogs as dingo deterrents have been successful (Gordon 2009). Since buying 24 Italian Maremma dogs to protect their flock of 12,000 sheep on their vast 46,500 hectare cattle and sheep property in north-west Queensland owners Ann and Ninian Stewart-Moore have changed their view from "*the only good dingo is a dead one*" to "*feeling quite happy about living alongside them*" (de Blas 2009). Since introducing Maremma dogs their losses have dropped from 15% to 3% at a cost of $12,000 for food and Veterinarian bills (Stewart-Moore 2007). However, as no one else in their area uses guard dogs, they are still cooperating in local wild dog management. In an article published in *Ecological Management & Restoration*, Claridge and Hunt write "*Is there any evidence to suggest that hybrid Dingo–Dog populations in south-eastern mainland Australia are having negative environmental impacts, given the backdrop of current management regimes*?" (Claridge and Hunt 2008). The Queensland Parks and Wildlife Service have published a Fraser Island Dingo Management Strategy on a regular basis since 2001 (See FIDMS, AFIDMS, FIDMSR. & AFIDMS 2009) with: *The two major aims of the ongoing monitoring and review program are to ensure the conservation of a sustainable wild dingo population on Fraser Island and that the risk of negative dingo impacts on humans is reduced to an acceptable low level, both as a result of the implemented management strategies.* AFIDMS 2009 This management plan focuses on decreasing dingo/human interactions, with very little published science to identify the numbers of dingoes on Fraser Island, or whether a sustainable wild population is being conserved. The latest AFIDMS 2009 states that a population and behavioural study of the dingoes was commenced in 2002, and due for completion in 2006, is yet to be published. Some data has been made available to QPWS, but this as yet remains unpublished.
50. *For species nominated as extinct in the wild, provide details of the locations in which the* ***species*** *occurs* ***in captivity*** *and the level of human intervention required to sustain the species.*	***Not applicable***

Mitigation Approach

51. *Describe any **mitigation measures or approaches** that have been developed specifically for the species at identified locations. Identify who is undertaking these activities and how successful the activities have been to date.*	The Northern Territory's *Management Program for the Dingo 2006-2011* states "*the aim of this management program is to ensure the continued existence of wild dingo populations in Northern Territory ecosystems, strategically reducing their negative impacts as required*" (PWS NT n.d.). Hybridisation minimisation will be ongoing in the NT by working with Aboriginal communities to encourage de-sexing of companion dogs, having a permit system for public ownership of the animals with conditions that animals must be de-sexed and by promoting awareness programs of dingoes and their role as an environmental regulators (PWS NT n.d., National Resources, Environment, The Arts and Sport 2007). The Wild Dog Management Plan for the Kempsey Rural Lands Protection Board District (2008-2011) focuses on monitoring of the effectiveness of wild dog management programs and provides only negligible reference to the monitoring of the conservation status of dingoes on Schedule 2 lands. The data appearing in the document provides no evidence of data obtained from monitoring the conservation status of the dingo. The Management Program for the Dingo in the Northern Territory makes provision for the following research: 1. Assess the genetic status of dingo populations in the Northern Territory 2. Further investigate the relationship between 1080 baiting, dingo abundance and predation of cattle 3. Evaluate the interaction between dingoes, their prey and subordinate predators 4. Determine the effect of rabbit calicivirus on dingo diet and the predation of livestock 5. The suitability of factory-manufactured baits for use in the Northern Territory 6. Support external research and development aimed at improving dingo management The focus on baiting and management and the role of *Pest Animal Management* in the conduct of this program suggests a focus on *control and management* rather than *conservation.* Professor Iain Gordon, a research scientist with CSIRO supports scientists working with land managers to "put new management regimes on the ground" to help reduce the threat to native wildlife. In an article published online on ABC Science's Opinion page, he outlines Professor Chris Johnson's view of bringing back the dingo because stable dingo populations are known to suppress numbers of feral predators thus reducing the carnage feral pests cause to small mammal populations. Gordon suggests that although sheep farmers may not like the idea current trials on a sheep property using Maremma dogs as dingo deterrents have been successful (Gordon 2009). Since buying 24 Italian Maremma dogs to protect their flock of 12,000 sheep on their vast 46,500 hectare cattle and sheep property in north-west Queensland owners Ann and Ninian Stewart-Moore have changed their view from "*the only good dingo is a dead one*" to "*feeling quite happy about living alongside them*" (de Blas 2009). Since introducing Maremma dogs their losses have dropped from 15% to 3% at a cost of $12,000 for food and Veterinarian bills (Stewart-Moore 2007). However, as no one else in their area uses guard dogs, they are still cooperating in local wild dog management. In an article published in *Ecological Management & Restoration*, Claridge

	and Hunt write "*Is there any evidence to suggest that hybrid Dingo–Dog populations in south-eastern mainland Australia are having negative environmental impacts, given the backdrop of current management regimes*?" (Claridge and Hunt 2008). The Queensland Parks and Wildlife Service have published a Fraser Island Dingo Management Strategy on a regular basis since 2001 (See FIDMS, AFIDMS, FIDMSR. & AFIDMS 2009) with: *The two major aims of the ongoing monitoring and review program are to ensure the conservation of a sustainable wild dingo population on Fraser Island and that the risk of negative dingo impacts on humans is reduced to an acceptable low level, both as a result of the implemented management strategies.* AFIDMS 2009 This management plan focuses on decreasing dingo/human interactions, with very little published science to identify the numbers of dingoes on Fraser Island, or whether a sustainable wild population is being conserved. The latest AFIDMS 2009 states that a population and behavioural study of the dingoes was commenced in 2002, and due for completion in 2006, is yet to be published. Some data has been made available to QPWS, but this as yet remains unpublished.

52. *Departmental use only:*	

Major Studies

53. *Identify major studies on the species that might relate to its taxonomy or management.*	With the exception of Stephens (2010) [redacted] [redacted] is not aware of any major studies underway with relation to the dingo.

Management Documentation

54. *Identify* ***key*** ***management documentation*** *available for the species, e.g. recovery plans, conservation plans, threat abatement plans.*	The Northern Territory Parks and Wildlife Service has a Management Program for the Dingo (2006) which has the overall objective of ensuring the continued existence of wild dingo populations in the Northern Territory ecosystems, strategically reducing their negative impacts as required, allowing for their destruction. Downward & Bromell (1990) describe the development of a policy for the management of dingo populations in South Australia which purports to provide a compromise between the protection of the livestock industry while ensuring the survival of the dingo in the wild. However while the policy gives equal emphasis to the eradication of the dingo to ensure the protection of livestock and the conservation of the dingo, there are 6 actions to protect live stock, and only three to conserve the dingo. These only restrict where and how bait may be laid, and prevent the keeping of dingoes in a domestic situation. There is not one positive action aimed at conserving the dingo, such as relocation or defining areas where they are legally protected. The Great Sandy Region Management Plan (2005) states that the area will be managed to protect and conserve the biological heritage of the area. The dingo is indigenous to both the Fraser Island area covered by this plan, and the mainland area, and thus the dingo should be afforded the same protection as on Fraser Island, but baiting and trapping continues in the areas around Rainbow Beach, the Inskip Pennisular and south to Noosa North Shore. There appears to be no justification for this action other than the *dingo is a declared Class 2 pest.* (Land Protection (Pest and Stock Route Management) Regulation 2003 Schedule 2 Part 2 s2)

	In New South Wales, a Wild Dog Management Plan for the Kempsy Rural Lands Protection Board District (2008) *provides a framework for the eradication of wild dogs on controlled lands and the conservation of dingoes within specific parts of Schedule 2 lands, known as Dingo Management Areas.* However, wild dog control can still be conducted in Schedule 2 lands, rendering dingo conservation problematic. See also item 51 above. Ironically, many of these Management Plans with the purported aim of dingo conservation also provide for their eradication.
55. *Departmental use only:*	

Section 3 – References and Reviewers

Notes:

- The opinion of appropriate scientific experts may be cited (with their approval) in support of a nomination. If this is done the names of the experts, their qualifications and full contact details must also be provided in the reference list below.
- Please provide copies of key documentation/references used in the nomination

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Australian Government

Department of the Environment