Advice to the Minister for the Environment, Heritage and the Arts from the Threatened Species Scientific Committee (the Committee) on Amendment to the list of Threatened Subspecies under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act)

1. Scientific name (common name)

Bettongia penicillata ogilbyi (Woylie)

2. Reason for Conservation Assessment by the Committee

This advice follows assessment of information gathered through the Commonwealth's Species Information Partnership with Western Australia, which is aimed at systematically reviewing species that are inconsistently listed under the EPBC Act and the Western Australian *Wildlife Conservation Act 1950*.

The Woylie was listed as endangered under the former *Endangered Species Protection Act 1992*, but was not transferred to the EPBC Act threatened species list in 1999, reflecting an increase in Woylie distribution and abundance up to about year 2000. This assessment is in response to reported decline since that time.

The Committee provides the following assessment of the appropriateness of the Woylie's inclusion in the endangered category in the EPBC Act list of threatened species.

3. Summary of Conclusion

The Committee judges that the subspecies has been demonstrated to have met sufficient elements of Criterion 1 to make it **eligible** for listing as **endangered** and of Criterion 2 as **vulnerable.** The highest level of listing recommended is **endangered.**

4. Taxonomy

The Woylie is conventionally accepted as *Bettongia penicillata ogilbyi* . Family: Potoroidae. Other common names include: Brush-tailed bettong, Brush-tailed Rat-kangaroo. Indigenous names include: Woylyer and Karpitchi.

5. Description

The Woylie is a small potoroid marsupial weighing 1-1.5 kg. It has a distinctive black brush at the end of its tail. It uses its tail to carry nesting material (Troughton, 1973; Christensen, 1980). It rests during the day in a well-concealed nest, built over a shallow depression that is most commonly built using long strands, preferably grasses, but will use other material such as strips of bark (in the forest) or dried seagrass and/or triodia (in arid coastal areas) (Christensen and Leftwich, 1980; Armstrong pers. com. 2006 cited in Freegard, 2007). When disturbed from the nest, Woylies will move quickly with head low and tail extended, sometimes colliding with obstacles in their haste to flee.

6. National Context

The Woylie is one of two subspecies of Bettongia penicillata. The other subspecies, *Bettongia penicillata penicillata* (Brush-tailed Bettong (eastern subspecies)), is listed as extinct under the EPBC Act and is listed under Schedule 7 of the South Australian *National Parks and Wildlife Act 1972* as 'endangered'. The Woylie is the remaining surviving subspecies.

The Woylie once occupied most of the Australian mainland south of the tropics, including the arid and semi arid zones of Western Australia, the Northern Territory, South Australia, New South Wales and Victoria.

Aboriginal oral history has confirmed that Woylies were even more broadly distributed in the central deserts — ranging over much of the Gibson Desert in central Western Australia and into the southern region of the Northern Territory (Burbidge and Fuller, 1984, Burbidge et al., 1988).

By the 1970's, the geographic distribution of the Woylie had been reduced to three locations in Western Australia: Perup forest, Tutanning Nature Reserve and Dryandra Woodland. There are now only three natural populations in WA as well as 12 translocated populations, five translocated populations in SA and one translocated population in NSW. Most of these are in national parks, nature reserves and conservation parks but eight populations are in state forest, private land and pastoral lease.

The Woylie is on *Wildlife Conservation (Specially Protected Fauna) Notice 2008(2)*, pursuant to section 14(2)(ba) of the *Wildlife Conservation Act 1950* , Schedule 9 of the South Australian *National Parks and Wildlife Act 1972* as Rare, it is listed under the Victorian *Flora and Fauna Guarantee Act 1988* as Threatened, and under the Northern Territory *Territory Parkes and Wildlife Act 1988* as Extinct.

7. Relevant Biology/Ecology

Woylies live to approximately 4-6 years in the wild and can breed in their first year (Christensen, 1995) although in captivity, a male lived for over 14 years and was still breeding (Keynes, 1989). Generation length is 2-3 years.

Woylies have the potential to breed continuously, producing a maximum of three young in a year (Serventy, 1970). Females at a monitoring site are often, either carrying young or suckling a young at heel. It is possible for females to carry a blastocyst in the womb, young in the pouch and a young at foot (Smith, 1989; Smith, 1996). These characteristics are summarised in the Table below. The proportion of females caring for young tends to be lower in the drier months when conditions for survival are harsher. Woylies usually produce a single young at a time, but twins have occasionally been observed (Sampson, 1971).

Table: Reproductive characteristics of the Woylie

Reproductive characteristic	**Duration/ Number**	**Reference**
Age of female sexual maturity	170-180 days	Christensen, 1995
Gestation	21.2 days	Smith, 1992

Number of pouch young	1, rarely 2	Sampson, 1971; Christensen, 1995
Pouch life	90 days	Christensen, 1995
Maximum number of young produced in a year	3	Serventy, 1970

Highest mortality in bettong species is associated with young at foot and sub-adult age categories, and is lowest for pouch young and mature individuals (Vernes, 1999; Vernes and Pope, 2002; Freegard, 2008).

Males tend to have larger home ranges than females, which enables them to mate with more than one female.

A wide range of food types has been recorded in the diet of the Woylie including leaf material, seasonal fruits/berries, roots, tubers, bark and invertebrates (Sampson, 1971; Nelson, 1989). During feeding activities at dawn, dusk or at night, woylies make a large number of small diggings that disturb the soil surface.

Woylies are known to cache food such as the nuts from sandalwood trees (*Santalum spicatum*) and wheat seeds (Sampson, 1971; Christensen, 1980; Murphy et.al., 2005). The seeds are buried and presumably the Woylie returns at a later date to consume the seeds or germinating plants.

Seasonal or migratory movements have not been recorded for the subspecies. Daytime movements of the subspecies have been observed but the subspecies is predominantly nocturnal.

Woylies rest during the day in nests they construct, and forage at night. If danger approaches they will wait until the last moment to flee from a nest. Predators with a keen sense of smell, such as the European fox, are therefore able to detect the presence of the Woylie and successfully ambush them as prey.

8. Description of Threats

Threats that are currently being investigated as possible causes of the recent Woylie declines are described below.

Predation.

Introduced predators, in particular the European red fox *(Vulpes vulpes)* and feral cat *(Felis catus)* are considered among the greatest threats to the survival of the Woylie — despite targeted management and research programs.

Introduced predators have also been implicated as the cause of several failed reintroduction attempts. Cats, dogs *(Canus familiaris)* and European foxes were identified as the main cause of mortality of reintroduced Woylie subpopulations at a number of sites. Cats were actually deliberately introduced to St Francis Island to exterminate the Woylies which were doing damage to garden produce (Wood Jones, 1925).

While the cause of recent declines is unknown, they could be a result of changed interactions between predators or abundance of predators. For example removal of foxes may have resulted in an increase in cat numbers that were previously limited by fox predation.

Given the lack of fox activity or density monitoring data associated with most of the recently observed Woylie declines, it is not possible to determine whether foxes may be a major agent of the decline.

Native predators also impact on the persistence of small and establishing populations, especially where the ecosystem has been significantly altered. Predation by *Morelia* sp. (carpet pythons) and *Haliaeetus leucogaster* (white-breasted sea-eagles) has been implicated in the failed woylie translocation to St Francis Island in South Australia (Department for Environment and Heritage, 2006) and *Aquila audax* (wedgetail eagle) predation contributed to the failed reintroduction to the Flinders Ranges in South Australia (Bellchambers, 2001).

Habitat Destruction

Inappropriate fire regimes causing loss of protective understory has negatively impacted upon the Woylie (DEC 2007).

A contributing factor to the recent decline in woylies could be habitat alteration caused by land clearing and grazing on private, state forest and pastoral areas. Fragmentation and loss leads to changes in the abundance, availability and/or suitability of resources such as water, food, shelter, reproductive mates and space (territories). Habitat destruction can also be caused by feral pigs *(Sus scrofa)* and the presence of dieback caused by the exotic pathogen *Phytophthora cinnamomi* (DEC, 2007).

Competition for increasingly limited resources with grazing species such as the rabbit *(Oryctolagus cuniculus)* and other stock has been a factor in the decline of the Woylie, particularly in more arid areas (DEC, 2007).

Climate change may alter the availability of resources as rainfall and temperature patterns change, thereby acting as a threatening process.

Disease

Disease agents are possibly responsible (in part or wholly) for Woylie declines and can be categorised into the following groups: viral, bacterial, haemaparasites, endoparasites, ectoparasites, toxic and nutritional. Wayne (2008) has suggested that disease is likely to be a significant factor in the recent large declines in population size.

Direct Human Influence

Human influence could come in the form of disruption to natural behaviour associated with ecotourism and hand feeding of wild animals at key tourist destinations within the subspecies' range. The potential impacts of artificial feeding are closely linked with disease issues as increased local densities of Woylies provide an environment suited to the transmission of some diseases.

9. Public Consultation

The information used in this assessment was made available for public exhibition and comment for 30 business days. No comments were received.

10. How judged by the Committee in relation to the criteria of the EPBC Act and Regulations

The Committee judges that the subspecies is **eligible** for listing as **endangered** under the EPBC Act. The assessment against the criteria is as follows:

Criterion 1: It has undergone, is suspected to have undergone or is likely to undergo in the immediate future a very severe, severe or substantial reduction in numbers

The Woylie has declined in abundance since European settlement as the habitat became extremely fragmented and populations became isolated and more susceptible to threats such as predation by introduced predators, fire, competition and disease (DEC, 2007). Following a recovery during the 1970s in response to successful translocations and the Western Shield program, more recent documented declines since about 2000 have been rapid, substantial and extensive. These declines have most seriously affected the last remaining natural wild populations of Woylies.

Trap survey success figures are available for Woylie monitoring sites in WA and SA. Trap success is seen as highly correlated to other estimating methods in observing trends in population size although possibly conservative (Wayne, 2006).

Trap success figures for 16 WA monitoring sites from 1998 to 2006 demonstrated decline across all sites of 52%. Six of the sites demonstrated no change while the average decline in the others was 83%. Declines were most significant in the most important (large and indigenous) populations. Overall the results show Woylie numbers declined by 70 – 80 % between 2001 and 2006; from 37 - 40 000 in 2001 to 8 - 15 000 in 2006. The results also suggest that the declines are continuing. Freegard (2007) has indicated that these survey data are likely to underestimate decline because of the three year averaging method used.

The largest and most important populations, including the last remaining indigenous locations, have declined by more than 90% in most cases (Wayne, 2008). The decline at 11 sites in the upper Warren region has been documented and demonstrates that the declines are real (Wayne, 2006).

However, in considering the survey data the Committee notes that the subspecies may be subject to significant natural cyclical fluctuations in numbers (Christensen et al., 1985). A severe decline in the abundance of Woylies was observed in the early 1970s, followed by a rapid increase, and Christensen et al. (1985) predicted that a severe drop in numbers was inevitable. However, the Committee also notes that these cyclical changes have been studied for a relatively short period of time (most since the mid-1990's) and are therefore not well understood. The majority of Woylie reintroductions have been to a modified landscape with introduced predators, and other sites may be subject to the same pressures, so the capacity for any increase in abundance over time may be disrupted. Cyclical patterns are not known in sympatric and analogous species which suggests such patterns may not necessarily apply to the Woylie.

The Woylie has undergone a major reduction in numbers historically but as a result of significant conservation effort by WA and SA since the 1970s, population size and extent of occurrence increased for a period to about 1998. The Committee is satisfied that Woylie numbers have subsequently undergone a severe to very severe reduction in numbers over the last ten years and that the cause of these declines is not fully understood.

The Committee also notes that this subspecies has high fecundity, early sexual maturity and short generation-length and has previously demonstrated a capacity for populations to exceed the carrying capacity of its habitat. It is likely that this leads to a rapid decrease in population size before an equilibrium is reached. The natural cycling of populations may occur over longer periods of time than covered by the current monitoring programs, particularly in the more mild (mesic) parts of the subspecies' occurrence where fluctuations in environmental conditions may be more moderate.

Therefore the Committee considers that the subspecies has undergone a severe reduction in numbers and that this is likely to continue in the immediate future. Therefore, the subspecies has been demonstrated to have met the relevant elements of Criterion 1 to make it **eligible** for listing as **endangered**.

Criterion 2: Its geographic distribution is precarious for the survival of the species and is very restricted, restricted or limited

The subspecies once occupied most of the Australian mainland south of the tropics including arid and semi-arid zones of Western Australia, Northern Territory, South Australia , New South Wales and Victoria (Wakefield, 1967). Burbidge and Fuller (1984) and Burbidge et al., (1988) provide evidence that the Woylie was once the most common and widest ranging of all potoroids. Finlayson (1958) describes its distribution from south-west Western Australia, across southern Australia to the Great Dividing Range, and northward through much of Queensland, eastern Northern Territory and northern South Australia. Wood Jones (1925 cited in Start et al., 1995) mentioned that animals belonging to a species of *Bettongia* (later verified as *B. penicillata* in Finlayson 1958) were "swarming" on Saint Francis Island off the coast of South Australia in the 1880s.

Oral history from Indigenous people has confirmed that Woylies were distributed even more broadly in the central deserts than suggested by Finlayson, ranging over much of the Gibson Desert in central Western Australia and into the southern region of the Northern Territory (Burbidge and Fuller, 1984, Burbidge et al., 1988).

By the 1970s however, the Woylie's distribution had been reduced to three locations in WA. Like many medium-sized terrestrial mammals in arid and semi-arid Australia the subspecies had retreated to the most mesic parts of this former range since European settlement (Burbidge and Mckenzie, 1989).

In Western Australia widescale fox baiting and reintroduction projects implemented under the Western Shield program and similar programs in other states, led to an increase in the distribution and abundance of the Woylie from the mid 1970s to about 2000. The subspecies has been translocated with mixed success to 46 sites in Western Australia, South Australia and New South Wales, including a number of wildlife sanctuaries. It is now found at 21 locations, and while some of these populations are isolated and island sites (particularly in SA), many of the sites have large numbers and overall are not considered to be severely fragmented (DEC, 2007).

The estimate for the widest historic extent of occurrence for the Woylie is some 1 771 786 km² (Lomolino and Channell, 1995 using information contained in Strahan, 1983). The extent of occurrence of the Woylie in 2006 was estimated to be some 18 300 kms² (Freegard, 2007), about 1% of its former range. While these estimates are based on a variety of methods the Committee considers that they indicate that the extent of occurrence has been considerably reduced. The Committee considers its current extent of occurrence is limited.

The subspecies has undergone a fluctuation in its abundance and extent of occurrence, which is possibly extreme and, according to Christensen et al. (1985), possibly cyclical. It is likely any natural cycle of growth and decline is being exacerbated by predation from exotic species, habitat destruction and other threats.

The Committee considers the population is not severely fragmented but that the extent of occurrence has declined markedly from historic levels and that, since about 2001, population size and distribution have experienced a severe reduction at most locations. The Committee judges that its current geographic distribution is limited and, as a result of fluctuating population size and extent of occurrence which may be the result of threats, its geographic distribution is precarious for the survival of the subspecies.

The Committee considers that the subspecies has a limited geographic distribution, which is precarious for the survival of the subspecies and therefore, it has been demonstrated to have met the relevant elements of Criterion 2 to make it **eligible** for listing as **vulnerable**.

Criterion 3: The estimated total number of mature individuals is limited to a particular degree; and either

(a) evidence suggests that the number will continue to decline at a particular rate; or

(b) the number is likely to continue to decline and its geographic distribution is precarious for its survival

Population size is difficult to calculate, but in 2006 estimates were made using two methods. Using anecdotal estimates from experts familiar with the subspecies and its particular occurrences, the population was estimated to be 8 000 – 11 000 individuals while using population densities and extent of occurrence, population size was estimated to be 15 000. It is estimated that current numbers (as at June 2008) would be substantially lower than these 2006 estimates because of further recent severe declines. The number of mature individuals is not known but it is likely to be lower than the estimates above.

Estimates are not available for historic Woylie numbers but on the basis of its historic distribution, evidence suggests the population is likely to have declined historically and that it has experienced extreme declines in the recent past. There is evidence that the decline may be part of cyclical fluctuation (Christensen et al., 1985). However, the Committee considers that even if this decline is part of a cycle, the decline is likely to be more severe as a result of threats introduced since European settlement — such as introduced predators, habitat destruction and disease. The relative significance of these threats is unknown at this stage, but the Committee notes that while predation is a major factor, evidence may be increasing that disease is also a significant cause of decline.

The Committee judges that the estimated number of mature individuals is limited and it is possible that numbers will continue to decline. It also notes that Woylie populations are subject to a range of threats and that fluctuation in numbers and area of occupancy may be extreme. Although its geographic distribution is not considered to be severely fragmented (see Criterion 3), it is considered precarious for its survival.

Therefore, the subspecies has been demonstrated to have met relevant elements of Criterion 3 to make it **eligible** for listing as **vulnerable**.

Criterion 4: The estimated total number of mature individuals is extremely low, very low or low

Population size is difficult to estimate, but in 2006, population size was estimated to be between 8 000 and 15 000, depending on the methodology used. Given the recent declines in population size, the current population size is likely to be significantly lower than this.

The Committee judges that the estimated number of mature individuals is not low for the purposes of Criterion 4 .

The Committee considers that the subspecies has been demonstrated not to have met the relevant element of Criterion 4 and is therefore **not eligible** for listing in any category.

Criterion 5: Probability of extinction in the wild that is at least:

a) 50% in the immediate future; or

b) 20% in the near future; or

c) 10% in the medium-term future.

There are insufficient data available to estimate a probability of extinction of the subspecies in the wild over a relevant timeframe. Therefore, as the subspecies has not been demonstrated to have met the required elements of Criterion 5, it is **not eligible** for listing in any category under this criterion.

11. CONCLUSION

Conservation Status

This advice follows assessment of information gathered through the Commonwealth's Species Information Partnership with Western Australia which is aimed at systematically reviewing species that are inconsistently listed under the EPBC Act and the *Wildlife Conservation Act 1950.*

The extent of occurrence of the Woylie in 2006 was estimated to be about 1% of its former range. While the estimates are based on a variety of methods, the Committee considers they show the extent of occurrence and population numbers have declined considerably. In 2006, the population size was estimated by various methods to be between 8 000 and 15 000 individuals, and in 2008 it is estimated to be substantially lower than these estimates.

Woylie numbers appear to have undergone a severe to very severe reduction in the last seven to ten years and, as threats are continuing and the cause is not fully understood, it is possible the decline will continue. The Committee notes however, that this subspecies appears to undergo natural cyclical fluctuations resulting from high levels of fecundity and limits to the carrying capacity of its habitat. It is likely that this leads to rapid population increases followed by rapid decreases before equilibrium is reached. It is also possible that the recent population cycles are shorter and more severe as a result of increased predation or other threats.

The Committee notes the subspecies' distribution is not severely fragmented but that the extent of occurrence has declined markedly from historic levels. The Committee judges that the geographic distribution of the Woylie is limited and, as a result of its fluctuating extent of occurrence and population size, probably exacerbated by introduced threats, its geographic distribution is precarious for the survival of the subspecies.

The Committee judges that this subspecies has met sufficient elements of Criterion 1 to make it **eligible** for listing in the **endangered** category, and sufficient elements of Criteria 2 and 3 to make it eligible for listing as **vulnerable**. The highest listing category that this subspecies is eligible for is **endangered**.

Recovery Plan

The Committee considers that there should be a recovery plan for this subspecies because it has experienced significant declines in extent of occurrence and population size since European settlement, and is currently undergoing a severe decline. While this decline may be cyclical and the Woylie may naturally recover, the impact of feral predators and other threats on this cyclical process is not known.

The Committee notes that Western Australia is preparing a state recovery plan (Freegard, 2008). The Committee also notes that the Woylie's distribution is cross jurisdictional and it encourages all relevant governments to work collaboratively in recovery processes.

12. Recommendations

(i) The Committee recommends that the list referred to in section 178 of the EPBC Act be amended by **including** in the list in the **endangered** category:

***Bettongia penicillata ogilbyi* (Woylie)**

(iii) The Committee recommends that there should be a recovery plan for this subspecies.

Associate Professor Robert J.S. Beeton *AM FEIANZ*

Chair

Threatened Species Scientific Committee

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