Eyre Peninsula Landscape Board

PEST SPECIES REGIONAL MANAGEMENT PLAN

Capra hircus

Feral Goat

This plan has a five year life period and will be reviewed in 2027.

INTRODUCTION

Synonyms

Capra aegagrus hircus

Goat

Biology

Feral goats *Capra hircus* (L.) are herbivorous eutherian mammals of the order Artiodactyla (even toed ungulates) and family Bovidae, the horned ruminants.

Goats are generalist herbivores, with a diet mainly determined by the available forage **[1]**. They select the highest quality food available **[2]**, eating mainly foliage, twigs, bark, flowers, fruit and roots, but also plant litter, seeds on the ground, and fungi **[3]**. They have an efficient four-chambered stomach that allows them to survive on sparse vegetation. Their digestive process also allows them to eat large quantities of food quickly. This reduces foraging time during which they are exposed to predators. When forage is abundant, goats feed selectively **[4]**, for example palatable grasses, and thistle flowers and seed heads are favoured when occurring with legumes **[5]**. Goats do not graze as low as sheep or horses. They take a proportion of senescent forage and browse, and digest lower quality, more-fibrous diets more efficiently than sheep **[6]**. Goats browse trees and shrubs more than sheep and other bovids **[7]**, with browse constituting up to 55 % of their diet **[8]**. Where goats are in high numbers they can remove virtually all foliage up to a forage line of 1.8 m **[9]**. Browsing is not obligatory **[6]**. Goats can exploit drought-affected habitats for longer than sheep **[8]**, even though their nutritional requirements are higher **[10]**.

The broad scale supplementation of drinking water, through artificial watering points, in arid Australia has enhanced goat densities **[11]**. During periods of drought, goats need adequate water to maintain food intake and to allow for cooling during hot periods. In semi-arid and arid environments and during hot, dry seasons, goats require free water at about 5.5–8.3% of bodyweight per day **[6]**. In deserts, goats typically drink every two to three days **[12]**. During hot dry periods more than 80% of feral goats will drink daily **[13]**. When shade is provided, goats consume less water than sheep, but when shade is absent, they drink more water than sheep **[13]**. When shade is not available, goats must control their body temperature by panting and sweating, particularly on hot days with strong winds **[14]**. Dehydrated goats sweat less than hydrated goats **[13]** with maximum sweat discharge rates of 45 g water / m^2 / hour being usual although the desert adapted Bedouin goat has a sweat rate of 140 g water / m^2 / hour **[15]**. These characteristics enable trapping on water points as a means of control of feral goats **[16]**. However, where forage is abundant and contains ample moisture, drinking may be rare or absent (16).

Goats prefer saline water with up to 12,500 mg / L total dissolved solids (TDS) compared with fresh water **[13]**. With saline water, some goats are able to maintain food intake with salinity levels up to 9500 mg / L **[13]**. TDS levels greater than this result in a decline in food intake. In the extreme, goats appear to be able to survive drinking seawater (35 000 mg / L) for extended periods **[13]**.

Goats are social, forming mobs. The basic social unit is an adult female and recent offspring, which associate in an area **[17]**. Herds or mobs typically consist of about two to six goats in arid and semi-arid regions, but can contain 40 or more goats in areas of higher rainfall. Feral goats live mostly in separate male and female herds, which mix during the breeding season in autumn and winter **[16, 17]**. The young males leave these matriarchal groups and form loose associations with similar aged males or larger mixed-aged groups. Herd ranges generally overlap, sharing common ground, but male herds tend to cover larger areas. Females that are about to give birth leave the group and give birth in a protected spot **[17]**.

The space-use system of feral goats can best be described as refuging with the rhythmical dispersal of animals from, and their return to, a fixed point in space **[17]**. Fixed points in the home range, in the form of permanent night-camps, are an important feature of space-use in most populations **[17]**. In the rangelands, goats have unusually large home

ranges of up to 600 km^2 (average 380 km^2) for sub-adult males **[16, 18]**. These are focussed on permanent water and decrease in size during droughts when goats have to drink more frequently. In areas with ample water and food they have relatively small, non-exclusive, home ranges e.g. eastern tablelands of NSW: males 3.8 km^2 and females 2.4 km^2 **[19]**.

In Australia, the greatest densities of feral goats and domestic livestock occur in the high rainfall zone (>500 mm mean annual rainfall) along the eastern tablelands and adjacent slopes of the Great Dividing Range **[19]**. Feral goats in the NSW Tablelands were found to have densities up to 94 goats/km^2 (mean density = 34.94 goats / km^2), with high annual adult survival and low annual adult mortality (annual survival range 81% to 100%) in the absence of harvesting and hunting **[19]**. Estimates of actual goat densities in arid and semiarid rangelands range from 0.5 / km^2 in central and south-eastern Western Australia to 5 / km^2 in eastern South Australia (mean annual rainfall 240 mm). An estimate of population density in the Gawler Ranges in 2012 was 1.95 goats / km^2 based on aerial survey.

The high reproductive rate of goats frustrates many efforts at control and eradication **[9]**. Goats are polygynous, with breeding occurring through most of the year, but at a reduced rate in early spring and during drought **[9, 16]**. Goats in milder climates typically breed all year round. Females breed when six months old and can produce kids on average every eight months **[9]**. Gestation is five months and females with a kid at foot are often pregnant **[9]**. Fecundity increases with age and reaches a maximum among females at about 21 months (four-tooth stage) and older. In one area in South Australia, goats on average produced 1.57 litters / year with an average of 1.59 embryos / litter **[16]**. In the absence of control measures, a population can increase by up to 75% a year **[9]**. In the Tablelands of NSW they had an observed instantaneous rate of increase of 0.112 **[19]**. But, rates of increase can be much higher where populations are harvested intensely.

In the NSW tablelands, feral goat habitat selection included a preference for wooded vegetation, on eastern and north eastern aspects, at higher elevations **[19]**.

Origin

Goats are among the earliest animals domesticated by humans, *ca.* 10 500 years ago **[20]**. Recent genetic analysis confirms the archaeological evidence that Eastern Anatolia, and possibly Northern and Central Zagros (i.e. Turkey, Iraq and Iran) are the likely origin of almost all domestic goats today **[21]**. The modern representative of their wild ancestor is the bezoar *Capra aegagrus* **[21]**. The domestic descendants of wild goats are now divided into a large number of breeds of uncertain genetic relationships **[22]**.

The Australian feral goat population is genetically diverse as a result of a diverse and mixed ancestry **[23]**. This ancestry includes indigenous goats from South Africa **[9]**, and present day Bangladesh, imported to the early European settlement in Australia (The first 19 goats came to Australia on the Golden Grove with the First Fleet in January 1788 **[9]**), Angora and Cashmere imported in the early to mid-1800's **[24]**, and milk goats such as British Alpine and Saanan **[1]**.

Distribution

Both managed and unmanaged (feral) rangeland goats, are found across approximately 2.13 million square kilometres (28%) of Australia **[25]** (Figure 1); in all states, the Australian Capital Territory and some offshore islands. The largest populations are found in the arid and semi-arid pastoral regions of Queensland, New South Wales, South Australia and Western Australia **[16]**, but the greatest densities occur in areas of higher rainfall. In 1996 it was estimated that Australia had about 2.6 million 'feral' goats **[16]**, but this was considered a conservative figure in view of the approximately one million animals harvested each year from 2001 to 2003 **[26]**. National population was estimated to be approximately 4.1 million in 2008 and 3.3 million in rangelands alone in 2010. In 2011, it was estimated 322,000 existed in the South Australian rangelands and is likely an under-estimation **[44].** Data from 1989 to 2013 aerial surveys suggest Gawler and Eyre IBRA subregion blocks exhibited the strongest increasing temporal trends in goat populations **[45]**.

The distribution of unmanaged (feral) goats is limited by the: type and nutritional quality of vegetation; availability of shelter; availability of water during dry times; occurrence of parasites and diseases; and predation from dingoes and wild dogs in areas where these predators occur **[26]**.

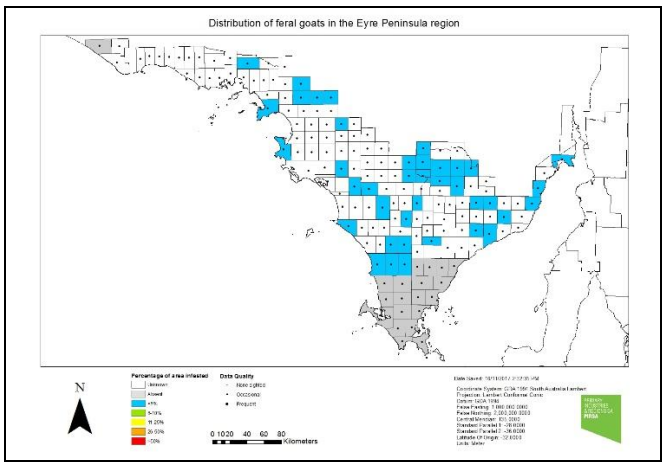

Figure 1: Feral goat occurrence, abundance and distribution in 2017. Source: [43].

In South Australia, feral goat populations have fluctuated markedly throughout most their range over the last 20 years (Figure 2).

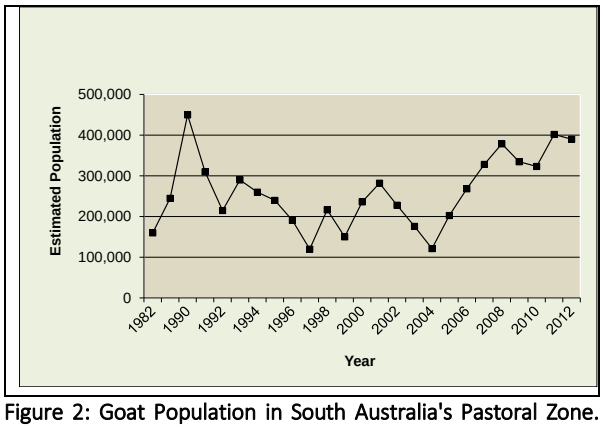

Figure 2: Goat Population in South Australia's Pastoral Zone. Source: DEWNR – Annual aerial kangaroo survey.

Feral goats are common in the South Australian pastoral zone south of the dog fence, and occur in and around numerous patches of scrub in the higher rainfall areas (mainly agricultural) of South Australia **[27]**.

Climate-matching analysis suggests that a large proportion of Australia is suitable for feral goats and that they may potentially inhabit all jurisdictions **[25]**. Analysis of the areas that combine preferred climate with suitable habitat suggests that feral goats could inhabit a much larger range **[25]**. However, climate and suitable habitat are not the only factors that determine the range, with dingoes, wild dogs and agricultural development and practices limiting potential range **[25]**.

RISK ASSESSMENT

Pest risk

Competition and land degradation by unmanaged goats is listed as key threatening processes under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (the EPBC Act). Under the EPBC Act, the Australian Government in consultation with the states and territories has developed the 'Threat Abatement Plan for competition and land degradation by unmanaged goats' **[26, 29]**. Feral goats are a significant driver of ecosystem degradation throughout Australasia **[16]**. Widespread biodiversity loss has resulted from the primary and secondary impacts of overgrazing by feral goats **[30, 31]**.

In 1995, calculable economic losses attributable to feral goats in Australia were estimated at $25 million per annum **[16]**. This consisted of $17.8m net loss caused by reduced stock production (after taking account of the profit obtained from mustering feral goats for sale); $6m contingency loss because of the threat of exotic disease; and $1.2m direct cost expended by Government agencies on goat control operations. This estimate does not include costs associated with the impact of goats on the environment, of soil erosion, or pasture degradation. No value has been calculated for these losses. However, more recent data estimate production losses in wool, sheep and beef meat industries at approximately $6.79m for 2013-14 due to feral goats, with the majority ($4.29m) from the wool industry **[46]**.

Feral goats affect terrestrial native fauna primarily by direct competition for resources such as food, water, and shelter, and by contributing to changes in ecosystems by reducing biodiversity **[16]**. Feral goats also adversely affect conservation values by damaging the vegetation and competing with native fauna **[16]**. Nationally there is scientific proof, anecdotal evidence or the potential for impact from competition and land degradation by unmanaged goats on 57 significantly threatened flora and fauna species (eight bird species, three mammal species, one insect species and 45 plant species) **[29]**. At the estimated national average density over the areas they occupy of two per square kilometre, feral goats consume about 0.35% (0.73 tonnes / year / goat) of the total net annual above ground vegetation production in semi-arid rangelands, and constitute about 10% of the total grazing pressure of all large herbivores **[16]**. In

many areas, goats reach much higher densities, and are sometimes the dominant large herbivore. Competition between native and introduced herbivores is not always significant, even though at times moderate dietary overlap occurs **[7]**. The loss of body condition, failure of breeding and reduced survival seen in these herbivores during droughts may be due more to intraspecific than interspecific competition **[7]**. Feral goats feed differently to native herbivores such as kangaroos – both in terms of the species they consume and the way they feed upon them **[16]** – this can lead to changes in plant species composition (as more palatable species are eaten and removed), as well as changes in vegetation structure. In combination with rabbits, goats are able to suppress the regeneration of a variety of palatable native tree and shrub species **[9]**. With the removal of shrubs, and also the lack of regeneration of small trees (due to goats and sheep), the long-term carrying capacity of a region is reduced and, additionally, the land is exposed to considerably increased erosion **[7]**.

High goat density (>20 / km^2) has been shown to increase average erosion levels by a factor of five compared with low density (<0.2 / km^2) areas **[35]**. Following feral goat removal from a region, an initial rapid reduction in erosion was recorded, followed by a continued decline over the next two years, coincident with a relative increase in ground cover. Goats create an impact directly through physical dislodgement of soil, and indirectly due to reduced or altered vegetation cover caused by grazing, trampling, or soil surface damage by hooves **[35]**.

Goats need to be considered when determining total stocking rates on an area as their numbers, combined with domestic livestock numbers, may exceed the safe stocking rates for the land **[26]**. This is particularly true during drought, because of competition for declining food and water resources **[26]**. The total feral goat grazing pressure can vary markedly between sites **[36]**. At densities of five per square kilometre, unmanaged goats can contribute 10–25 % of the total sustainable grazing pressure **[16]**.

Feral goats can carry many internal and external parasites, some of which can also infest sheep **[16]**. The importance of cross-infection is unknown, although it is probably low. The bacterial disease, melioidosis, may limit the spread of goats, and the rickettsial disease, Q-fever, is carried by goats and may be transmitted to people **[16]**. Goats are potential hosts of exotic diseases such as foot and mouth disease. But, modelling predicts that foot and mouth disease in a rural setting would die out in a mixed sheep and feral goat population in less than 90 days because of the low rate of herd-to-herd contact and herd-to-flock contact **[19]**.

Feasibility of control

The Federal Government's threat abatement plan (TAP) aims to minimise the impact of unmanaged goat competition and land degradation on biodiversity in Australia and its territories by: protecting affected native species and ecological communities; and preventing further species and ecological communities from becoming threatened **[29]**. To achieve this goal, the plan has five main objectives **[29]**:

- to prevent unmanaged goats occupying new areas in Australia and eradicate them from high-conservation-value 'islands';
- to promote the maintenance and recovery of native species and ecological communities that are affected by competition and land degradation by unmanaged goats;
- to improve knowledge and understanding of unmanaged goat impacts and interactions with other species and other ecological processes;
- to improve the effectiveness, target specificity and humaneness of control options for unmanaged goats; and
- to increase awareness of all stakeholders of the objectives and actions of the TAP, and of the need to control unmanaged goats.

There are numerous methods available to reduce the impact of feral goats **[16, 26]**. Methods regularly used in Australia include: limiting the introduction of goats; mustering; trapping at water; shooting from the ground or the air; using Judas goats; fencing; and habitat manipulation e.g. removal of access to artificial water supply. The most efficient and effective control method/s will often depend on the density of pests and the particular circumstances operating at each place. Therefore, it is often best to change tactics, or the mix of tactics, as a goat management operation proceeds, to reduce their numbers and to be flexible about which method is best **[16]**.

Local eradication of feral goats is usually only possible on small islands and in some mainland pockets **[16]**. In most areas, sustained management is required. Ideally managers need to

understand the relationship between the density of feral goats and the damage that they cause, so that they can determine how to maximise the benefits compared to the costs of management.

At the local and regional levels a strategic approach to feral goat management is recommended **[16]**. This consists of four components:

- Defining the problem. This requires determining the economic and/or environmental impact of goats, preferably directly, or indirectly measuring the abundance of goats and inferring their impact.
- Developing a management plan, the outcome of which should be to achieve some production or conservation objective, or both, with performance criteria formulated in terms of the resource goal.
- Implementation.
- Monitoring and evaluation to determine the effectiveness of the program and the program efficiency.

Movement of feral goats may be influenced by topography, habitat quality, harvesting pressure and feed availability **[36]**. Movement patterns of goats in semi-arid woodlands are predictable – they usually move small distances and frequent lakes and plains with abundant tree and shrub cover – suggesting that a goat problem is owned, in the short-term, by individual landholders and their immediate neighbours **[36]**. In pastoral regions of Western Australia, aerial control activities had little effect on the home ranges of nearby resident feral goats, so this method was an effective control tool as it did not result in a rapid reinfestation of previously cleared areas **[37]**. Consequently, periodic removal of goats (e.g. once or twice per year) that substantially reduces the population (e.g. by 80% or more) may be an effective means of maintaining relatively low numbers of goats on any one property **[36]**.

The effectiveness of control methods varies with habitat. Best practice management of feral goats in mulga woodlands in south west Queensland was based on contract mustering with the aid of fixed-wing aircraft, followed by aerial culling using a helicopter, while ground-based shooting, was of only limited success **[38]**. Conversely, aerial shooting of goats in rugged and densely vegetated terrain using helicopters is limited in its effectiveness, and its repeated or exclusive use results in declining effectiveness as goats learn to evade the helicopter **[39]**. In this terrain only 31% of an estimated 462 goats were culled, at an average cost of $61/goat **[39]**. Half of the goats were in herds never seen by the helicopter crew. Where goats had no prior experience of aerial shooting, culling success was 40% without spotter assistance and 59% with spotter assistance **[39]**. Where there had been a history of aerial shooting evasive behaviours increased, and the cull was only 21%, even with spotter assistance. The use of thermal assisted aerial culling, in areas of dense vegetation, may help to increase the effectiveness of this control tool. In more arid and less vegetated conditions, this method has sometimes been an extremely effective control method, with estimates of population reductions reaching more than 99%, with multiple shooting episodes **[16]**. The per capita cost of shooting goats from a helicopter in rangelands are typically less than $5/goat, but costs increase substantially below a threshold density **[36, 40]** e.g. <1 goat/km^2. In an intensive and effective control program in Queensland **[36]** there was an overall failure to significantly reduce regional feral goat populations, even under sustained control effort. They conclude that goats need to be regarded as a managed component of the total grazing system, rather than a pest that can be eradicated.

As feral goat dispersion and distribution in the rangelands are affected by their proximity to water, their numbers can be significantly reduced at a local scale by manipulating their access to artificial watering points **[34]**. For example the construction of sections of goat-proof fencing, between where goats fed in a National Park and where water was available in neighbouring properties, significantly decreased their impact in the Park **[34]**, as the travel distance from the water to enter the park became too great.

The use of Judas goats involves exploiting the sociability of goats. A radio or global positioning system (GPS) collar is attached to a goat, the goat is released in the expectation that it will join up with other goats and is tracked along with the herd it has joined. The herd can then be easily located and eradicated. Judas goats are generally used where population density is low and herds are small or hard to find, to locate survivors of other control campaigns **[16]**, and to monitor areas thought to be free of goats **[41]**. The use of sterilisation and termination of pregnancy in Judas goats can increase the efficacy of low density control operations and eradication campaigns **[42]**.

Domestic goats have a place in Australian primary production **[27]**. The number of domestic goats in

South Australia has increased in recent years, resulting in more escapees and new feral goat colonies (e.g., on north-western Eyre Peninsula, in the Coorong National Park, the Ngarkat Conservation Park, and the Beetaloo Reservoir Catchment Area) **[27]**. Captured feral goats have been used to create some domestic flocks, and these goats are more likely than others to escape **[27]**. So long as domestic goats are kept, escapees will colonise new habitats, reinfest areas from which goats have been eradicated, and augment existing feral goat populations. Domestic goat owners need to ensure that:

- Goats do not escape through provision of appropriate fencing standards. The Chief Officer Control Notice (published in the Government Gazette on 11 September 2020 under section 192(3)(a) of the LSA Act and in accordance with regulation 25 of the General Regulations) states:
  - fencing must be "*constructed and maintained at all times to a standard sufficient to prevent the escape of any goats, taking into account the particular terrain*".
- There are also a range of other requirements in relation to the keeping of goats that are covered in detail in the Declared animal policy for Feral Goats.

For landholders (both government and private) with feral goats on their properties, the major issue is what level they should reduce feral goat numbers to in order to minimise environmental damage and other hazards.

Status

Within the EP Landscape Board region, a risk management assessment (

Table 1) shows that feral goats merit a Manage Pest Animal Populations management action in crop/pasture and native vegetation land uses.

Table 1: Regional Assessment

Land Use	Pest Risk	Feasibility of Control	Management Action
Crop / pasture	Very High	Negligible	Manage Pest Animal Populations
Native Vegetation	Very High	Negligible	Manage Pest Animal Populations

REGIONAL RESPONSE

Special considerations/Board position

For the purpose of defining a goat as a 'feral goat' the Board shall use the following definition:

Feral goats are goats roaming at large on land without the consent of the owner of the land and where:

a) ownership of the goats is not known or it is reasonably believed no ownership is claimed by a person; or

b) the owner or person believed to own the goats, after being given notice to remove the goats from the land, fails to remove them.

Goats moved onto uninfested areas are feral goats.

Outcome

To protect the environment, primary producers and the public from damage and hazards caused by feral goats.

Objectives

To:

1. monitor goat populations and impacts;
2. prevent an increase in feral goat populations within the region;
3. identify when control is warranted to protect assets; and enable targeted control measures;
4. significantly reduce the environmental impacts of feral goats ;
5. raise community awareness about risk and ecological impacts potentially associated with feral goats; and
6. prevent the release or escape of domestic goats.

Area/s to be protected

All areas

Actions

In relation to feral goats

Land managers to:

1. undertake control programs on their property;
2. report sightings of feral goats.

Landscape Board staff to:

1. undertake systematic data collection (numbers, location of goats controlled/sighted) and

storage in a central spatial database (this will need to include a reporting mechanism at the district level for work undertaken by contractors);
2. work with neighbouring regions to monitor and respond to transient goat populations;
3. facilitate control in cooperation with the community, neighbouring districts and other government agencies;
4. develop and implement a protocol to determine distribution and estimate population on Eyre Peninsula
5. encourage, facilitate or compel landholders to control feral goats on their property; and
6. raise community awareness about the impact of feral goats.
7. Assess permit applications for the holding or domestication of feral goats.

In relation to domestic goats

Land managers to:

1. Maintain compliance with requirements relating to fencing standards;
2. Report any escapes of domestic goats.

Landscape Board staff to:

1. maintain accurate records of registered domestic goat properties;
2. liaise with relevant government agencies and stakeholders to obtain information on locations and size of domestic herds;
3. undertake inspections of registered goat farm boundary fences to ensure compliance with goat industry fencing standards and permanent identification requirements; and
4. undertake data collection and storage in a central spatial database.

Evaluation

Evaluation of success will be based on:

- annual analysis in July of monitoring data to evaluate the success of the pest plan actions (including the update of spatial layers);
- compliance database for goat related issues including reports of damage from primary producers e.g. number of reports, level of damage.;
- quality of goat farm boundary fences;
- the number and location of feral goats controlled by shooters or captured and the number and location of feral goats reported/sighted; and
- Review of this pest management plan every five years.

Declarations

Under section 185(1)(a)(i) of the *Landscape South Australia Act 2019,* the Minister for Environment and Water has declared that provisions 187(1), 189, 190 and 192(3) apply to goats for the whole of the area comprising the Flinders Ranges Development Plan; provisions 186(1), 187(1), 189, 190, 192(3) apply to goats for all offshore islands (excluding Wardang Island and Kangaroo Island); provisions 189, 192(3) apply to goats for the whole of the State (excluding any areas specified in other classes); and provisions 186(1)(3), 187(1), 189, 192(3) apply to captured feral goats that have been held in captivity for less than three months for the whole of the State (excluding any areas specified in other classes)) (

Table 2).

Table 2: Goats *Capra hircus* – relevant sections of *Landscape South Australia Act 2019*. Provisions for the whole of state.

Section	Description of how the section applies
Provisions for the whole of the State (excluding any areas specified in other classes)	
189	Must not release goats
192 (3)	Landowner must control goats on their properties
Captured feral goat that has been held in captivity for less than three months	
186 (1) (3)	Landholders cannot bring goats into the region or a control area Landholders cannot move goats to uninfested areas on their own land, or to any land within a control area
187 (1)	Cannot keep goats
189	Must not release goats
192 (3)	Landowner must control goats on their properties

In the Eyre Peninsula Landscape Board region, landholders cannot release goats and must control goats on their property.

Where feral goats have been captured and held in captivity for less than three months, the goats cannot be brought into the region or moved to another un-infested part of a property. They cannot be kept without a permit from the landscape board, as well as appropriate containment, and identification according to the *Livestock Act 2013*.

They must not be released, and landowners must control them on their property.

More information

Contact your local Eyre Peninsula Landscape Board office

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