



CENTRE FOR
INVASIVE SPECIES SOLUTIONS

USING EXCLUSION FENCING TO MANAGE FERAL DEER IMPACTS IN AUSTRALIA

DAVID M. FORSYTH



www.pestsmart.org.au

This publication is licensed under a Creative Commons Attribution 4.0 International license, except for photographic and graphical images contained within it. Photographs and other graphical material must not be acquired, stored, copied, displayed and printed or otherwise reproduced — including by electronic means — for any purpose unless prior written permission has been obtained from the copyright owner.

Copyright of photographs and other illustrations is variously owned by Invasive Animals Ltd, individuals and corporate entities. For further details, please contact the Communications and Marketing Manager, Centre for Invasive Species Solutions.

The Creative Commons Attribution 4.0 International license allows you to copy, distribute, transmit and adapt material in this publication, subject to the exception for photographic and other graphic material set out above, and provided you attribute the work as shown below. The license does not transfer ownership of the copyright. A summary of the license terms is at: <https://creativecommons.org/licenses/by/4.0/>

© Invasive Animals Ltd 2023

Citation: Forsyth, D M (2023) *Using exclusion fencing to manage feral deer impacts in Australia*. Produced by the NSW Department of Primary Industries, Orange, for the Centre for Invasive Species Solutions, Canberra, ACT.

Print ISBN: 978-1-922971-17-3

Web ISBN: 978-1-922971-16-6

Published by: the Centre for Invasive Species Solutions.

The Centre for Invasive Species Solutions gratefully acknowledges the funding support for this publication through the Australian Government Department of Agriculture, Fisheries and Forestry. In-kind support was provided by Vertebrate Pest Research Unit, NSW Department of Primary Industries, Orange, New South Wales.

Disclaimer: The information contained in this publication has been prepared with care and is based on knowledge and understanding at the time of writing (2023). Some of the information in this document is provided by third parties, and all information is provided “as is”, without warranty of any kind, to the extent permitted by law. After publication, circumstances may change and before relying on this information the user needs to take care to update as necessary.

No Product Preferences: The product trade names in this publication are supplied on the understanding that no preference between equivalent products is intended and that the inclusion of a product name does not imply endorsement over any equivalent product from another manufacturer.

ACKNOWLEDGEMENTS

The author thanks all the private and public land managers who provided information about, and images of, deer exclusion fencing. The preparation of this document was funded by the Centre for Invasive Species Solutions project ‘Cost-effective management of wild deer’ (PO1-L-001) and the NSW Department of Primary Industries. Elaine Thomas, John Silins, Sarah A. Matthews, Danny Hudson and Ben Fahey (all Parks Victoria) kindly provided information about fences constructed by Parks Victoria. Matt Gentle (Biosecurity Queensland) provided information about wild dog and feral pig fences. Andrew Bengsen, Troy Crittle, Tony Pople and Matt Gentle made valuable comments on a previous draft, but any errors or omissions are those of the author.

Cover image: Deer exclusion fence on the Bogong High Plains, Victoria (Elaine Thomas, Parks Victoria).

CONTENTS

Summary	5
Introduction	6
Methods	7
Key findings	8
Deer fence height	8
Deer netting specifications	8
Posts and spacing	9
Wires	10
Clearing and grading the fence line	11
Aprons (or footers or skirts)	12
Electric outriggers	13
Deer gates	14
Stay or end assemblies	14
Fencing gullies, waterways and floodways	14
Excluding multiple other medium-sized and large-sized mammals	14
Animal welfare considerations	15
Monitoring fences	16
Removing deer (and other pests) from inside the fence	16
Cost of deer exclusion fencing	16
Examples of deer exclusion fences	17
Agricultural settings	17
Topping up (or retrofitting) existing livestock fences	17
Agricultural example 1: Topped-up cattle fence on the Liverpool Plains, NSW	17
Constructing a new fence	17
Agricultural example 2: Fallow deer and macropod exclusion fence, Midlands, Tasmania ...	18
Agricultural example 3: Fallow deer, feral pig and macropod exclusion fence, Liverpool Plains, NSW	19
Agricultural example 4: Fallow deer exclusion fence, Cressy, Tasmania	20
Conservation settings	21
Conservation example 1: Maisie's Rocky Valley Plot, Bogong High Plains, Alpine National Park, Victoria	21
Conservation example 2: Pheasant Creek Flora Reserve, North East Victoria	22
Conservation example 3: Sambar deer exclusion fence, Mount Bullfight Nature Conservation Reserve, Victoria	24
Major manufacturers and distributors of fencing materials in Australia	25
Further information	26
Exclusion fencing	26
Deer fencing	26
General fencing	26
Wild dog fencing	26

Macropod fencing.....	26
Feral pig fencing.....	27
Managing wombat damage to fences.....	27
Animal welfare considerations	27
References.....	28
Appendix A. Deer fencing regulations	30
South Australia.....	30
Tasmania	30
Western Australia.....	31
Queensland	32
Appendix B. Excluding other medium-sized and large-sized mammals.....	33
Macropods.....	33
Feral pigs.....	33
Wild dogs	33
Wombats	34
Appendix C. Maisie’s Plot fence design.....	35
Materials used in Maisie’s Plot fence	35

SUMMARY

Exclusion fencing is widely used in Australia to manage the undesirable impacts of medium-sized to large-sized mammals, including wild dogs, feral pigs and macropods. The method has high social acceptability. Fencing has been widely used to manage the impacts of deer overseas, and there is a demand from private and public land managers for information about how to use this method in Australia. This document summarises the key issues around using fencing to manage feral deer impacts in Australia.

Evidence-based fencing standards for deer have been developed as a result of the long history of farming deer in Australia and New Zealand. To exclude deer, fences should be a minimum of 1.9 m in height, have a mesh netting of 17/190/15, and posts spaced at a maximum of 10 m are recommended. Macropods, feral pigs, and wild dogs are also prevented from jumping over or pushing through fencing to these specifications. To prevent animals from pushing or digging under fencing and creating holes for deer to move through, a 30 cm netting apron is also desirable. If an apron is used, the pole spacing needs to be shorter (typically at 5 m intervals). An electric outrigger wire outside the fence (20–60 cm above the ground, depending on the mix of species to be excluded) can reduce the pressure on the fence and apron from deer, feral pigs, macropods and wild dogs.

The key issues around using deer-exclusion fences relate to whether they are being constructed in agricultural or conservation settings. In agricultural settings, it is usually desirable for the fence to also exclude macropods, feral pigs and wild dogs (if they are present), and fences are typically constructed

along boundaries or around high-value paddocks; existing sheep/cattle fences can be modified to exclude deer, and new fence lines are usually cleared and levelled with heavy machinery. In conservation settings, fences typically enclose smaller areas and are more remote, and it is often not desirable or practical to clear and grade the fence lines with heavy machinery. Deer exclusion fences in conservation settings can be designed to facilitate the movement of native mammals by having a gap at the bottom of the fence, although this increases the risk of small deer getting through.

The key strategic design considerations when constructing a deer exclusion fence are whether the fence needs to keep all deer out, and how easy it will be to inspect, maintain and repair the fence. Well-constructed fences are expensive but should last more than 15 years with minimal maintenance. Regular inspection for holes and breaks is needed if there are trees within falling distance of the fence, and as soon as possible after floods.

The cost of constructing a deer exclusion fence depends on the design of the fence, the topography, and the difficulty of clearing the fence line (including any need to remove trees). An indicative total cost for using heavy machinery to clear and grade a fence line on an agricultural property, and constructing a fence that will exclude deer, macropods, feral pigs and wild dogs (i.e. including an apron) is \$16,000 per kilometre. Constructing fences in remote forested or alpine areas costs much more than this per kilometre.

INTRODUCTION

There is a long history of fence construction for the exclusion of unwanted wildlife, including wild deer (Conover 2001). A key advantage of fencing over other methods of controlling deer, such as shooting and trapping, is that it can completely exclude the deer from an area and prevent their undesirable impacts. Although the initial cost of construction is considerable, fences can last 15-30 years with minimal maintenance. Hence, fencing is the strategy usually adopted for excluding deer from relatively small high-value areas (Conover 2001). The high cost of fence construction may be offset by savings from the averted impacts and the expense of alternative methods of controlling deer, but the costs of ongoing inspection and maintenance of fencing needs to be taken into account.

In Australia, fences have been constructed to exclude wild deer from areas in national parks (Bennett and Coulson 2011; Fahey 2017) and on agricultural properties (Lindeman and Forsyth 2008; McLeod in press). Standard cattle and sheep fences (1.2 m in height) are easily jumped by deer, and hence higher fences are needed to exclude deer (Conover 2001). Fences that exclude deer can also exclude native macropods (kangaroos and wallabies); in agricultural areas this could be desirable (because they too can

have undesirable impacts), but in native ecosystems it could be desirable to not exclude macropods (Bennett and Coulson 2008).

Internationally, there has been considerable research into the design and effectiveness of fencing to exclude deer (Conover 2001). Hence, multiple deer fence designs exist, and the costs of construction vary greatly. Unfortunately for land managers, there are no guidelines on how to use fencing to exclude the six non-native species of wild deer present in Australia (listed in Table 1). The objective of this document is to summarise the key options, issues and costs associated with using fencing to exclude wild deer in Australia.

Table 1. The six deer species that have wild populations in Australia (naming follows Jackson and Groves 2018)

Common name	Genus and species
Sambar deer	<i>Cervus unicolor</i>
Red deer	<i>Cervus elaphus</i>
Rusa deer	<i>Cervus timorensis</i>
Chital deer	<i>Axis axis</i>
Fallow deer	<i>Dama dama</i>
Hog deer	<i>Axis porcinus</i>

METHODS

The national and international literature on deer fencing (for farmed and wild deer) was reviewed for information relevant to the deer species and environments present in Australia. Concurrently, I consulted my network of private and public land managers to identify deer exclusion fences in New South Wales (NSW), Victoria and Tasmania. These land managers provided information about fence designs, effectiveness and costs. I visited some of the fenced sites, but others could not be visited due to COVID-19 travel restrictions.

This document distils the key learnings for people interested in using exclusion fencing to reduce the impacts of wild deer in Australia.

There are many guides on how to construct livestock and vertebrate pest-exclusion fences in Australian conditions, and those documents should be consulted (see 'Further reading'). In addition, it could be expected that some local fencing contractors would have experience in constructing deer exclusion fences, and they will be able to provide further advice about materials and construction relevant to local conditions (topography, soil and the mammal species present). Hence, the objective of this document is to describe the key features of deer exclusion fences that should be considered when planning a deer exclusion fence.

KEY FINDINGS

DEER FENCE HEIGHT

Deer can jump higher than sheep, cattle and goats. Hence, standard sheep, cattle and goat fences (typically 1.2 m in height) do not exclude deer. In Australasia, the recommended minimum height for boundary fencing for deer farms (where red deer and fallow deer are the dominant species) is 1.9–2.1 m (Tuckwell 2003; Appendix A). Fences that are lower than 1.9 m are much more likely to have deer jump over them. Note that this height recommendation applies when there is no higher ground within 3 m of the fence on the side where the deer are; higher ground would necessitate a higher fence. A fence ≥ 1.9 m in height will also prevent other medium-sized and large-sized mammals (macropods, wild dogs and feral pigs) from jumping over it (Appendix B).

DEER NETTING SPECIFICATIONS

The design of most exclusion fences is based on prefabricated wire mesh netting. For deer, prefabricated mesh netting is strongly preferred over horizontal wires, because small deer can slip between the latter. Fence netting is described by three numbers separated by a slash (/) or colon (:). The first number indicates how many horizontal (line) wires are used in the netting, the second number indicates the total height (in cm) of the netting, and the third number is the spacing (in cm) of the vertical (picket) wires. Netting described as 17/190/15 has 17 horizontal wires, a total height of 190 cm, and vertical wires 15 cm apart (Figure 1a). Note that horizontal wires in wire mesh netting are usually not equally spaced; this is why the number of horizontal wires, rather than a spacing, is specified. Deer-

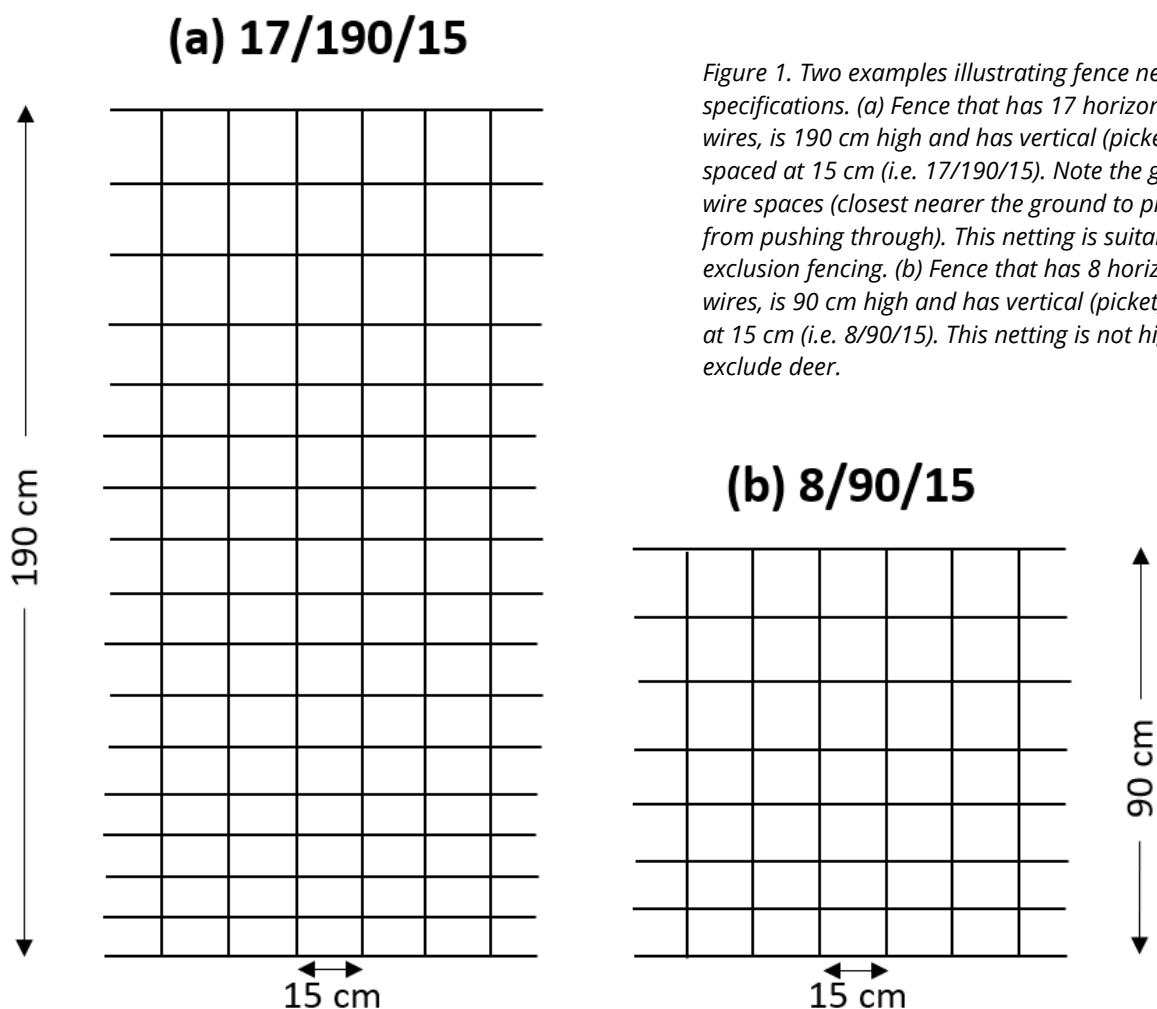


Figure 1. Two examples illustrating fence netting specifications. (a) Fence that has 17 horizontal (line) wires, is 190 cm high and has vertical (picket) wires spaced at 15 cm (i.e. 17/190/15). Note the graduated line wire spaces (closest nearer the ground to prevent fawns from pushing through). This netting is suitable for deer exclusion fencing. (b) Fence that has 8 horizontal (line) wires, is 90 cm high and has vertical (picket) wires spaced at 15 cm (i.e. 8/90/15). This netting is not high enough to exclude deer.

specific mesh netting has horizontal wires that are closer together at the bottom of the fence and the spacing successively increasing towards the top of the fence (the closer wires at the bottom of the fence reduce the potential for fawns to move through the mesh; Figure 1a).

On deer farms, mesh with 13 horizontal line wires is typically used for red deer and larger deer species (but may not always contain/exclude the smallest fawns), and either 17-line or 15-line wire mesh is used for fallow and smaller deer species (and should contain/exclude fawns). A 15 cm vertical wire mesh will contain/exclude the smallest fawns (Tuckwell 2003).

Given that deer fences need to be ≥ 1.9 m in height, it is recommended that 17/190/15 deer netting (i.e. has 17 horizontal line wires, is 190 cm high and has vertical wires spaced at 15 cm; Figure 1a) be used for deer exclusion fencing. The 17/190/15 netting will also prevent macropods, feral pigs, wild dogs and wombats from pushing through, although an apron and/or an electric outrigger are additional desirable features that will help exclude these species (see below).

POSTS AND SPACING

To ensure fence stability, at least one-third of each post length should be below ground. Hence, a 1.9 m-high deer fence is typically supported on 3.0 m posts driven 1.0 m into the ground. The material, either treated wood (Figure 2a) or steel (Figures 2b and 3), and diameter are two further key considerations in choosing fence posts. Steel posts last longer than wooden posts but are more expensive. Steel posts will survive low-intensity fires. Posts of larger diameter are stronger but more expensive. The choice of post diameter is governed by soil type, netting specifications, spacing of posts and the length of strain to be supported. Droppers (i.e. galvanised steel or hardwood lengths that are clipped or stapled to the horizontal wires to provide additional strength to the fence) are not usually used with deer mesh netting. Waratah® Jio® Star® and



Figure 2. Two deer fence designs, both ≥ 190 cm in height. (a) This design uses 190-cm-high netting with one high-tensile wire 15 cm above that and treated timber posts spaced at 5 m. (b) This design uses 190 cm-high netting (17/190/15) with steel star posts spaced at 5 m intervals (note alternating taller and shorter star posts).

Waratah® Jio® Maxy® steel posts are commonly used in deer exclusion fences (Figure 3a,b).

Typical post spacing for boundary deer fencing on farms is 10–15 m (Tuckwell 2003), but some Australian states require much closer spacing (Appendix A). In steeper terrain and where species occur that push or dig under the fence (e.g. pigs, wombats, wild dogs or macropods), closer spacing is needed to keep the bottom of the fence tight (including the apron, if present) and as close as possible to the ground. Hence, most deer exclusion fences have posts spaced at 5–8 m (Figure 1b). At sites where the terrain is undulating and the fence line cannot be cleared with machinery, posts are sometimes spaced at 3-m intervals (see [Conservation examples 1–3](#)).

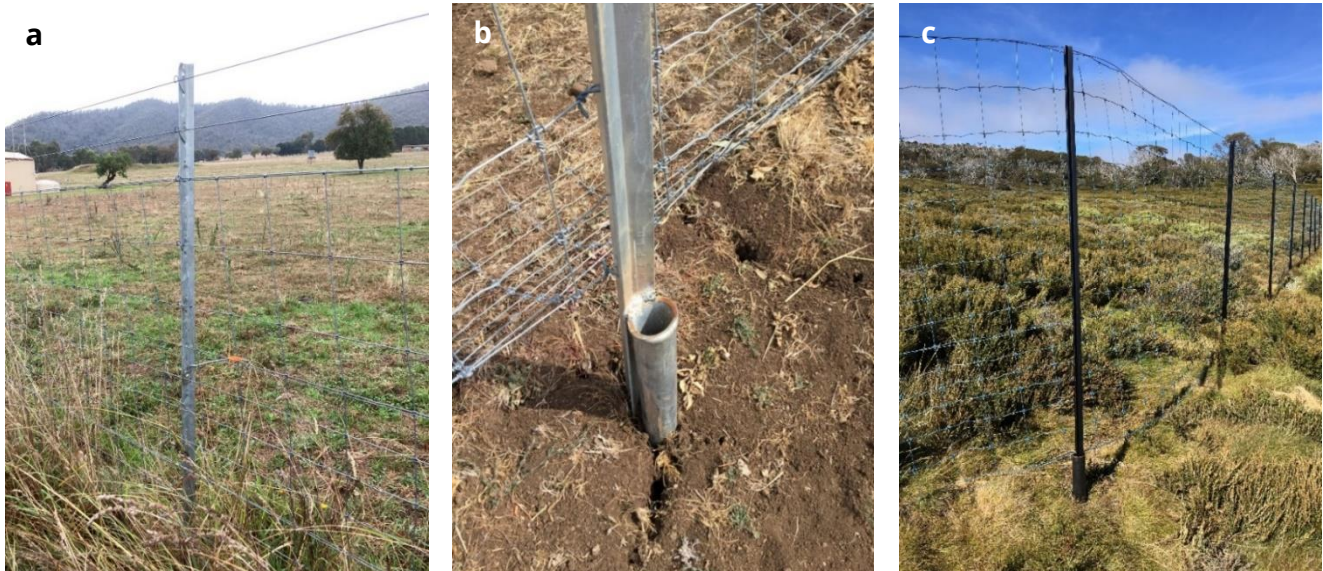


Figure 3. Examples of steel star posts in deer exclusion fences. (a) A Waratah® Jio® Star® post (note the electric outrigger on the inside of the fence to keep livestock off the fence). (b) Waratah Jio® Maxy® posts, each welded to a 1.65 m 50 mm pipe (with only 20 cm above the ground), in this case were spaced at 25 m intervals, with star posts spaced every 5 m. Note the apron on the outside of the fence and the absence of plain wires. (c) Black steel 50NB × 1 m-long pipes rammed into the ground at 3 m intervals for black steel star posts to be inserted into for a drop-down fence (see Conservation Example 1: Maisie's Rocky Valley Plot, Bogong High Plains, Alpine National Park, Victoria, for further details).

WIRES

Plain, rather than barbed, wires are typically used in deer exclusion fences. Regarding animal welfare, it is recommended that barbed wire is **not** used for the top wire(s) of deer fences. Typically, a deer exclusion fence has one plain wire at the bottom, to which an apron might also be attached (if it is not part of the prefabricated netting), and at least one belly (or mid-line) wire, to which the netting is tied. Fences may also have a top wire, to which the netting is attached, and one or more separate plain wires 10 or 15 cm above the netting to make the fence up to the desired height (Figure 2a). High-tensile 2.5 mm wire should be used. The closer the post spacing, the fewer wires are needed. Fewer wires are also needed with increasing strength and rigidity of the wire netting. An example of deer netting being clipped to a belly wire is shown in Figure 4.



Figure 4. Prefabricated deer mesh netting clipped to a plain wire

CLEARING AND GRADING THE FENCE LINE

Unless there is an existing fence line or road or track that the new fence will follow, in agricultural settings it will often be necessary to clear and level the fence line with heavy machinery (Figure 5). Trees that might fall and damage the fence can be cleared, and the ground levelled to make the bottom of the fence easier to protect against animals pushing under (including helping the apron to sit flat on the ground). Machinery can also be used to grade higher ground on the outside of the fence that would enable deer to potentially jump the fence, avoiding the need for a higher fence there.

The costs of clearing a fence line can be substantial in hilly and treed terrain, but this preparation will reduce maintenance costs (e.g. from trees falling on the fence) and make it easier and cheaper to erect the fence (e.g. because vehicles can be driven along the fence line).

In conservation settings, it will often not be desirable or practical to clear and grade the fence line. Hence, fencing materials may have to be transported as close as possible to the site and walked to the fence line. Making the bottom of the fence deer proof will be more difficult if the ground has not been levelled by machinery. The fence may need to be inspected more regularly because of the higher probability of a branch or tree falling onto it.



Figure 5. Prior to erecting this deer exclusion fence, the fence line was cleared (i.e. trees pushed aside) and levelled by a bulldozer.

APRONS (OR FOOTERS OR SKIRTS)

The presence of other medium-sized or large-sized mammals (particularly wombats, kangaroos, wild dogs, and feral pigs) that are adept at pushing under fences may require using a netting apron (also called a footer or skirt), which is usually 30 cm wide and extends out from the base of the fence (on the outside/animal approach side of the fence) (Figure 6).

An apron is not considered essential for a deer exclusion fence, but if any of the other medium-sized or large-sized mammals are present, then using one would minimise the likelihood of holes being established under the fence, through which deer could pass. For a land manager wishing to exclude all unwanted medium-sized or large-sized grazers, a 30-cm apron is considered essential.

Aprons are typically made from tightly spaced prefabricated wire. There are three main types of aprons or footers (Australian Wool Innovation Limited 2017):

- fixed aprons/footers are formed by allowing the bottom 30 cm of the fence to flare out over the ground
- hinged aprons/footers are attached to the prefabricated wire during manufacture via a hinge knot. Hinged aprons can be made to lie flat on the ground at a 90-degree angle to the fence and can be buried (either deliberately or by soil building up over time)
- removable aprons/footers are attached to an existing fence, either as reinforcement or repair. Hexagonal 'chicken wire' is sometimes used in this situation (Figure 6b).



Figure 6. Two examples of 30 cm aprons on deer exclusion fences. In (a), the bottom of the netting flares out. In (b), the chicken wire netting has been tied to the plain bottom wire at the base of the deer netting.

ELECTRIC OUTRIGGERS

Electric outriggers (Figure 7) protect netting and posts from rubbing and pushing by livestock, deer and other animals such as kangaroos and wombats. They also help prevent non-target animals from creating or enlarging holes that can be used by deer and other pests. Shorting of outriggers (e.g. by long grass or fallen branches) can reduce their effectiveness, so they require additional maintenance (often including spraying or cutting of vegetation under them) to remain effective.

A single plain electrified wire 20–60 cm above the ground and about 25 cm out from the outside of the fence (specifications depend on the mix of species to be excluded; Appendix B) will reduce rubbing and pushing against the fence and posts (and the apron, if present) by deer, livestock (if present outside the fence), feral pigs, macropods and wild dogs. Some fences have electric outriggers on both sides of the fence, the inside one reducing pressure on the fence from contained livestock. In low-soil-moisture areas, an extra earth wire should be placed 20 cm above the live wire to ensure conductivity.



Figure 7. Examples of electric outriggers on (a) the inside and (b) the outside of a deer exclusion fence. Both outriggers are 50 cm above the ground, and the outside wire is 30 cm out from the fence. The objective of the inside outrigger is to prevent livestock (in this case sheep and cattle) from pressing against the fence. The outside outrigger prevents deer, macropods and livestock from pushing against the fence.

DEER GATES

Purpose-built deer gates can be purchased from farm suppliers. Alternatively, standard farm gates can be extended to a height of 1.8 m (or higher) by welding an additional section of frame to the top of the gate and covering it with deer netting (Figure 8a). Gates can be 'weak points' in a fence, and it is important to minimise gaps around the gate (between the sides of the gate and the fence posts, and between the gate and the ground).

STAY OR END ASSEMBLIES

Stay or end assemblies are the straining points for a fence. They are used at the corners and bends of a fence, and are often where a gate is positioned. There are many options for deer fencing stay assemblies; what is best suited at a particular site will depend on the topography and the soil. Your local fencing contractors can advise on the best options for your situation.



Figure 8. Two examples of gates for deer exclusion fences. In (a), two stock gates have been welded together and mesh welded to them (with smaller-size mesh on the lower part of the gate). In (b), the lower four rungs have been spaced at 10 cm intervals to prevent small deer from pushing through them.

FENCING GULLIES, WATERWAYS AND FLOODWAYS

Fencing that spans gullies, waterways and floodways is at high risk of animals pushing through it and of damage during floods and therefore requires special consideration. These high-risk areas can be fenced independently of the adjoining fences using separate end assemblies and materials that are designed to lay down, fold over or even break away in the event of a flood. Examples of deer exclusion fencing for gullies, waterways and floodways are shown in Figures 9–11. Gullies, waterways and floodways increase the cost of fencing. Fences spanning gullies, waterways and floodways need to be inspected as soon as possible after a flood and, if necessary, repaired.

EXCLUDING MULTIPLE OTHER MEDIUM-SIZED AND LARGE-SIZED MAMMALS

It will often be desirable for a fence to exclude multiple other medium-sized and large-sized mammals. Using prefabricated deer netting with 15 cm vertical spacings will help prevent feral pigs, macropods and wild dogs from pushing through the fence. These species will not be able to jump a 1.9 m deer fence. Including a 30 cm apron extending out from the fence will help prevent these animals from pushing or digging under the fence, and including an electric outrigger is a further deterrent.

Wombats can scratch under the base of a deer netting fence and lift it to gain access to the other side. They then dig a hole under the fence, which other medium-sized and large-sized mammals can use. Wombats can also push under the leading mesh of an apron, lift it and get under it. An electric outrigger 125 mm above the ground is considered effective in stopping wombats digging under fences, but a high voltage needs to be maintained, and shorting (particularly on longer grasses) is an issue for a wire at this height. Such a low height for an outrigger is not recommended for deer, wild pigs, macropods and wild dogs, and is likely to be less effective at excluding those species. Wombat gates can be useful for minimising damage but, like low electric outriggers, are

expensive to install and maintain. Where wombats are present, fences will need to be inspected more regularly and any diggings under the fence blocked.

Further details on the design of fences for the exclusion of feral pigs, macropods, wild dogs and wombats are given in Appendix B.



Figure 9. Exclusion fencing across a small creek that is not expected to flood frequently. The solid mesh is tied to star posts and to the deer fence.



Figure 10. Exclusion fencing across a major creek that is expected to flood and destroy the lower section of netting. The steel cable holding the two sections of netting together can be seen most clearly in the lower right part of the image. A flood could be expected to remove the lower section of netting, which can easily be replaced. Note the large rocks holding the netting down across the dry creek bed.



Figure 11. Concrete reinforcing mesh used to prevent deer and other animals from getting under a deer exclusion fence where it crosses a small creek.

ANIMAL WELFARE CONSIDERATIONS

Exclusion fencing has moderate to high social acceptability. However, exclusion fencing can have adverse welfare outcomes by restricting access to natural watering points, altering movement and foraging patterns, and causing entanglement (and, in electric fences, electrocution). The frequency of animals becoming entangled in deer exclusion fences has not been documented, but constructing fences to the minimum standard outlined here is expected to minimise entanglement/injury of deer and other wildlife. Barbed wire should not be used as top wires on deer fences because of the risk of injury and entanglement to deer (Tuckwell 2003; see also <https://tinyurl.com/yhxc6dzk>). Goats can get their heads stuck in fences with vertical wires spaced at 15 cm (Kangaroo Management Taskforce 2020), so if goats are present fences need to be regularly monitored. Entanglements can be evaluated during fence inspections. Finally, fences can also prevent wildlife from fleeing a bushfire.

MONITORING FENCES

Assume that fences will be breached by deer (and other animals). It is therefore essential to have a plan to detect (e.g. by visual searches for deer and their signs) and respond to these breaches (e.g. by ground shooting). Fences should be inspected regularly to detect and repair breaks, and to block any holes under the fence. Monitor as soon as possible after a flood or storm event, as washouts and tree-falls can create gaps through which deer and other animals can move. The inspection interval should be shorter if there are trees within falling distance of the fence. Motion-sensitive cameras could be used inside and outside fences where it is difficult to visually detect incursions by deer or other animals (e.g. where there is dense vegetation inside the fence).

REMOVING DEER (AND OTHER PESTS) FROM INSIDE THE FENCE

Constructing a fence could enclose deer (and other pests) inside the fence, and animals could enter through a break in (or hole under) the fence. In most situations, it should be possible to remove these animals by ground shooting. In very large fenced areas, helicopter-based shooting could be more cost-effective than ground-based shooting for removing animals.

COST OF DEER EXCLUSION FENCING

The costs of constructing deer fencing will primarily depend on the fence materials selected, the design, the fence length and the topography (steeper country is more expensive to fence than flat country). If the fence line needs to be cleared, then this will add considerable cost. Self-construction can save labour costs, but will often be more time consuming than if a fencing contractor is engaged. A contractor could be used for the post work, and the owner or farm staff could attach and strain the wire. Contractors charge either by the hour or per metre of fence. McLeod (in press) reports that deer fencing (including an electric outrigger) in agricultural settings costs \$15,000 per kilometre for materials and labour. Fences in conservation settings will typically cost more to construct because of the difficulty of getting materials and people to the fence site, and because the fence line is often not already cleared. Some indicative and specific costs for fences are provided in the following section but, since costs vary greatly depending on the site characteristics and the fence design, it is important that quotes for materials and construction (including clearing the fence line, if necessary) are sought from local suppliers and contractors.

EXAMPLES OF DEER EXCLUSION FENCES

This section presents examples of fences constructed to exclude deer in agricultural and conservation settings.

AGRICULTURAL SETTINGS

TOPPING UP (OR RETROFITTING) EXISTING LIVESTOCK FENCES

There will often be existing livestock (sheep or cattle) fencing on a farm that can be modified to exclude deer (e.g. along a boundary, or around a paddock that is particularly attractive to deer). Clearing the fence line will usually not be needed when topping up an existing livestock fence. The existing fence posts must be in good condition; if they are not, then it is probably more cost-effective to remove the old fence and construct a new deer fence. Star posts (either 1.8 m or 2.1 m long) or sawn timber (100 mm × 50 mm and of similar lengths to the star posts) can be attached to existing posts to achieve 10 m spacings. The length of star posts or timber posts chosen depends on the current posts and should aim to achieve an overall height of 1.9 m from the ground and overlap the existing posts by 100 cm. The new timber posts can be attached to the existing posts with nails, bolts or No. 7 or 8 tie wire.

AGRICULTURAL EXAMPLE 1: TOPPED-UP CATTLE FENCE ON THE LIVERPOOL PLAINS, NSW

A topped-up barbed-wire cattle fence on the Liverpool Plains, NSW, is shown in Figure 12. The paddock enclosed by the fence grew lucerne, which was particularly attractive to fallow deer. Since the cattle fence was in good condition, the landholder topped it up with star posts at 10 m spacings and mesh netting. Note that the standard livestock gate was also topped by mesh netting, although that was not fully set up when photographed. This fence does not have an apron or electrical outriggers. The fence was considered effective by the landholder.

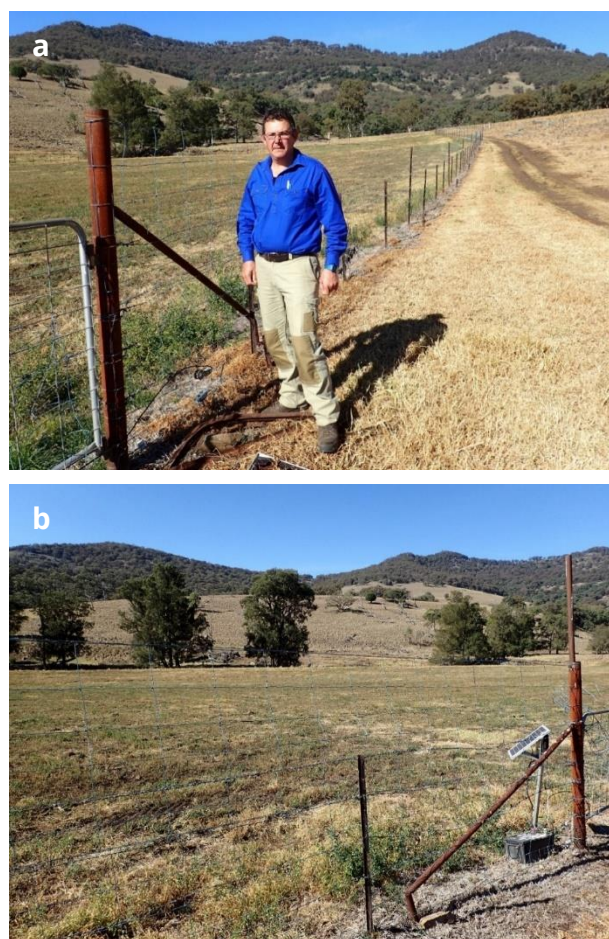


Figure 12. Example of a 'topped-up cattle fence' surrounding a lucerne paddock in the Liverpool Plains region of New South Wales. Star posts are spaced every 10 m, and deer mesh netting is strung from the ground to 1.8 m. Note that deer netting is strung above the standard gate (just visible in part b) during periods when the paddock is particularly attractive to deer.

CONSTRUCTING A NEW FENCE

Building a new exclusion fence is costlier than topping up an existing fence. Following are two examples of new deer fences constructed on or near the back boundaries of agricultural properties. In both examples, the fences do not fully enclose the property; hence, the objective of both fences was to reduce (but not completely eliminate) grazing pressure inside the fence from wild deer and other medium-sized and large-sized mammals. Both landholders regularly inspect inside the fence for incursions by deer and other grazers, and use vehicle-based night shooting to remove deer that enter the property.

AGRICULTURAL EXAMPLE 2: FALLOW DEER AND MACROPOD EXCLUSION FENCE, MIDLANDS, TASMANIA

A 6.5 km fence was constructed over a 6-year period while pivot irrigators were being installed on lowland flat paddocks (Figure 13). The objective of the fence was to exclude fallow deer and macropods (primarily red-necked wallabies, pademelons and Forester kangaroos) from feeding on the irrigated land. Sheep and cattle are farmed on the property, and the pasture and crops grown on the irrigated land are primarily for summer and winter feeding of stock. The fence does not totally exclude animals because it is open-ended. Some animals go around it, and the occasional animal gets through at the gates or when the fence has been broken (e.g. along a drainage line after a flood). The landholder considers the fence to have been a worthwhile investment as it greatly reducing the grazing pressure on the irrigated land, and would like to extend it.

The purpose-built fence has treated timber posts 130–150 mm in diameter and 3.0 m in length, of which about 0.9 m is in the ground and 2.1 m above the ground, spaced at 5-m intervals. Strainers were fabricated locally from steel pipes (90 mm nominal bore, 3.25 m long). The netting is 16/190/15 deer mesh, with one plain wire 15 cm above the netting and a single wire at the bottom to hold the chicken wire apron, which extends 30 cm outward from the fence, to stop macropods (and possibly wombats) from getting under the fence. On the 'deer side' of the fence (i.e. 'outside') there is an electric outrigger 50 cm above the ground and 30 cm out from the fence. There is also an electric wire (not an outrigger) on the inside of the fence to prevent stock (sheep and cattle) from pushing against the fence.



Figure 13. The Midlands, Tasmania, fence. Note the electric outriggers ('hotwires') inside and outside the fence 50 cm above ground level and (b) the 30 cm apron extending out from the fence.

AGRICULTURAL EXAMPLE 3: FALLOW DEER, FERAL PIG AND MACROPOD EXCLUSION FENCE, LIVERPOOL PLAINS, NSW

An 8.9 km fence was constructed on private property on the Liverpool Plains, NSW (Figure 14). The landholder wished to minimise the impacts of fallow deer, feral pigs, and eastern grey kangaroos in his cropping paddocks (usually oats and sorghum). The fence does not fully enclose the paddocks, but nearly does. Since the fence was constructed, the landholder has not seen a deer or pig on those paddocks, but the occasional kangaroo has entered from the unfenced end of the property.

The fence netting is 2.1 m high with 20 horizontal wires and vertical wires spaced at 15 cm intervals (20/210/15). The lower 30 cm of the netting forms the apron on the bottom of the fence, so the fence is 1.8 m tall. The posts are 2.4 m and spaced at 5 m intervals. Every fifth post (at 25 m intervals) is a maxi-post, which is

welded to a 1.65 m × 50 mm pipe that is pushed nearly all the way into the ground. Strainers are only used on corners.

The fence crosses several gullies and a creek. Extra netting is used there, held down by rocks. For the creek, a wire cable was strung along the bottom of the standard fence, with additional netting hanging from this and held down by rocks. The landholder expects the lower section



Figure 14. A Liverpool Plains, NSW, fence. Note the absence of plain wires (top, bottom and belly), rather, the mesh netting is tied directly to the posts and the apron is hinged.

to be washed away when the creek floods, but it can be quickly replaced.

The cost of the fencing materials was about \$8,000 per kilometre, and the contractors charged about \$4,000 per kilometre to erect the fence. The fence line was cleared by the landholder.

AGRICULTURAL EXAMPLE 4: FALLOW DEER EXCLUSION FENCE, CRESSY, TASMANIA

A fence was constructed around a 17-ha paddock containing *Eucalyptus* seedlings in Cressy, Tasmania (Figure 15). The fence has 2.7 m treated pine posts (100–135 mm in diameter) spaced at 5 m intervals, with 2.1 m out of the ground. There are nine equally spaced plain wires, with the top wire at just over 2 m. Chicken wire (one layer of 50 mm opening and 1.2 mm wire diameter) was used from ground level up to 1.5 m, and above 1.5 m there are two plain wires. Three sides of the fence have one electric outrigger (with two wires) at 1.3 m high; the side of the fence with sheep present has additional 0.9 m-high mesh and has two outriggers at 0.6 and 1.3 m, 150–200 mm out from the fence. The electric outriggers are solar powered.

Fallow deer gained access to the paddock by jumping the fence (adult males) and by pushing through holes made in the chicken wire (smaller deer; mainly yearlings and fawns). (The deer

inside the fence were eventually detected and shot.) To counteract the holes in the chicken wire, Ringlock mesh netting (7/90/30) was rolled out over the worst-affected lengths of chicken netting. The landholder suggested that if only mesh or Ringlock netting was used (i.e. no chicken wire), then the posts could be spaced at 6 m or 7 m rather than 5 m intervals.

That adult fallow deer were able to jump this fence is likely partly due to the design having two widely spaced horizontal wires at the top of the fence. A better (but more expensive) design uses fabricated deer mesh netting (17/190/15) and just one plain wire 10 cm above that. Using fabricated deer mesh netting (with vertical wires at 15 cm intervals) would also stop smaller deer from pushing through the lower part of the fence, which was possible because weaker chicken wire was used.



Figure 15. The Cressy, Tasmania, fallow deer exclusion fence. Note the chicken-wire netting up to 1.5 m and the two widely spaced horizontal wires at the top of the fence. This netting enabled deer to push through the fence and the wide spacing of the wires allowed them to jump the fence.

CONSERVATION SETTINGS

CONSERVATION EXAMPLE 1: MAISIE'S ROCKY VALLEY PLOT, BOGONG HIGH PLAINS, ALPINE NATIONAL PARK, VICTORIA

Maisie's Rocky Valley Plot is a 7 ha site located in alpine vegetation on the Bogong High Plains. It was fenced in 1944 to exclude livestock and is the oldest research site of its type in the Australian Alps, serving as a scientific reference site for high plains vegetation that has been allowed to develop for more than 70 years without livestock grazing and its associated impacts. The fence was dismantled after cattle grazing ceased in 2005. Since 2012, sambar deer have been recorded visiting the bog, creating wallows in bog pools, grazing on herbaceous vegetation, and browsing shrubs. Parks Victoria engaged a contractor to construct a fence around the historic Maisie's Rocky Valley Plot to exclude sambar deer and horses (Figures 16 and 17). The total length of the fence is approximately 1.2 km.

Due to the high elevation, the site experiences snow loads that can damage fences. It was decided that sections of the fence in the open (830 m) would be drop-down. This allows the fence to be easily and safely disassembled before the snow season, to ensure that the fence is not damaged due to snow load, and

reassembled at the end of the snow season. The sections of the fence through snow gum woodland (420 m) remain year-round. To minimise impacts on bog communities, galvanised materials were not used. The fence includes a gate for people to access the plot, and to allow horses to be herded out should they become trapped inside the fence. The cost of the fence (materials and construction) was \$86,946 (2019). Further details and costs are provided in Appendix C.



Figure 16. The Maisie's Plot sambar deer and horse exclusion fence in the Bogong High Plains, Victoria. The upper right figure shows a gate allowing people to access the plot, and horses that become trapped in the plot to exit it. Source: Elaine Thomas, Parks Victoria.



Figure 17. The drop-down section of the Maisie's Plot sambar deer and horse exclusion fence, Bogong High Plains, Victoria. This section of the fence is dropped prior to the first snows and erected when the snow has melted. Source: Elaine Thomas, Parks Victoria.

CONSERVATION EXAMPLE 2: PHEASANT CREEK FLORA RESERVE, NORTH EAST VICTORIA

A 5 ha area within the 170 ha Pheasant Creek Flora Reserve (Upper Murray, North East Victoria) was fenced by contractors engaged by the Department of Environment, Land, Water and Planning and Parks Victoria (with other partners) to protect the critically endangered summer (or Shelley) leek-orchid (*Prasophyllum uvidulum*) from sambar deer and fallow deer (Figure 18). The objective of the fence was to exclude deer but to enable kangaroos, wallabies and wombats to move in and out; hence, this was termed a 'partial exclusion fence'.

Because of the high conservation values of this site, the fence line was selected to avoid large trees and hence it has 'kinks'. The netting is Waratah® Stocksafe-T® Longlife Blue® 15/150/15 with a 30 cm hinged apron attached to the bottom horizontal wire

(<https://www.waratahfencing.com.au/products/wire/prefabricated-fencing/stocksafe-t-longlife-with-apron>). Posts are spaced at 3 m. The fence has five plain wires (100 mm, 300 mm, 700 mm, 1.1 m and 1.8 m above ground). The wire is tied at 300 mm above the ground so that the top of the netting could be attached to the top of the steel 2.4 m black star posts (spaced at 3 m intervals) at 1.8–1.9 m. Four 2.5 mm Waratah® Longlife Blue® plain wires support the deer netting. All wires are strained and tied to end posts. The movement of native mammals is enabled by having a 300 mm mesh apron on the bottom of the fence that is clipped up so that small animals can pass under the deer fence (Figure 18b,c), as recommended by Bennett and Coulson (2008). If feral pigs become a problem (they are not currently at that site), then the apron can be dropped and clipped close. The mesh netting attaches to the plain wire with a fence clip (Figure 18b). There is a double gate that can be opened to allow animals inside the fence to be mustered out.

The cost of constructing the approximately 1.1 km fence (materials and labour) was about \$80,000. There are two and three motion-sensitive cameras permanently monitoring animal activity inside and outside the fence, respectively, at locations where deer are thought most likely to cross the fence.

The fence is inspected at least monthly when rangers are in the area and when the motion-sensitive cameras are serviced. Since completing the fence in early 2021, there has been only one known deer incursion; a deer was detected on a camera inside the fence and never seen again (presumably it went in and out under the fence). The cameras indicate that native animals (wombats, wallabies and eastern grey kangaroos) are entering and exiting the plot under the fence. The apron has not yet been dropped to exclude feral pigs. Several branches and trees have fallen over the fence and been removed (Figure 8e).

Figure 18. The partial sambar and fallow deer exclusion fence at Pheasant Creek Flora Reserve, North East Victoria: (a) a corner of the fence, (b) three-pin anchor (at gate post), (c) star post with raised apron, (d) double gate that can be opened to allow animals inside the fence to be mustered out, and (e) tree-fall over the fence requiring the tree to be cut up and the fence repaired



CONSERVATION EXAMPLE 3: SAMBAR DEER EXCLUSION FENCE, MOUNT BULLFIGHT NATURE CONSERVATION RESERVE, VICTORIA

Deer exclusion fencing was constructed around three alpine bogs in Mount Bullfight Nature Conservation Reserve, Victoria, that are occupied by the Alpine Tree Frog (*Litoria verreauxii alpina*; listed as Vulnerable under the Federal *Environment Protection and Biodiversity Conservation Act 1999*) and impacted by wallowing sambar deer (Fahey 2017). Bogs were fenced in 2016, 2019 and 2020. Due to the remoteness of the bogs, a helicopter was used to transport the materials and people (including Australian Deer Association and Sporting Shooters Association of Australia volunteers) to the site. (For the third bog, illustrated, 13 people

erected 350 m of fencing around four breeding pools within the area of the bog over two days in 2020.) The fence is made from 12/120/15 2.5-mm wire mesh, with three plain wires and one sight wire. Two plain wires above the mesh make the fence 1.8-m high (Figure 19). A pedestrian gate (1,800 × 950 cm; 1 m opening) allows people to enter. The 2.4 m star posts are spaced every 5 m, and there are 2.4 m 50NB galvanised posts and 2.1 m 32NB galvanised stays. Mega Anchor kits are used for corners, stays, end posts and the pedestrian gate. Fences are checked at least once annually. There have been no breaches since the first fences were constructed in March 2016.

Figure 19. Fencing bogs to protect Alpine Tree Frog breeding pools from wallowing by sambar deer in Mount Bullfight Nature Conservation Reserve, Victoria. (a) Fence construction. (b) Aerial view of a fenced bog. Source: Tegan Dalman and Roellen Gilmore, Project Leads for the Native Vegetation Improvement Project, Parks Victoria.



MAJOR MANUFACTURERS AND DISTRIBUTORS OF FENCING MATERIALS IN AUSTRALIA

Your local fencing contractors will be able to suggest local distributors of deer fencing materials. The companies listed below can also provide you with advice and quotes for deer fencing materials.

All websites were verified on 12 April 2023.

SOUTHERN WIRE

<https://www.southernwire.com.au/rural/>

WARATAH FENCING

www.waratahfencing.com.au

<https://www.waratahfencing.com.au/how-to/design-your-fence/deer-fencing>

WESTONFENCE

<https://www.westonfence.com.au/>

CYCLONE

<https://www.cycloneproducts.com.au/products/wire/>

RURAL FENCE AND TRADE

<https://www.ruralfenceandtrade.com.au/fencing/fabricated-fencing.html>

AUSTRAL WIRE PRODUCTS

<https://www.galmax.com.au/products/pro-tough-field-fence>

FURTHER INFORMATION

All websites were verified on 12 April 2023.

EXCLUSION FENCING

PestSmart. *Exclusion and cluster fencing options*.

<https://pestsmart.org.au/toolkit-resource/exclusion-and-cluster-fencing-options/>

Kondinin Group Research Report (2016) *Exclusion fencing fighting ferals*.

<https://www.wool.com/globalassets/wool/sheep/pest-animals/wild-dog-exclusion-fencing--australian-wool-innovation/kondinin-group-research-report---exclusion-fencing.pdf>

Long K and Robley A (2004) Cost effective feral animal exclusion fencing for areas of high conservation value in Australia. Report for the Department of the Environment and Heritage, the Australian Government. Arthur Rylah Institute for Environmental Research, Department of Sustainability and Environment, Heidelberg, Victoria, Australia.

<https://www.awe.gov.au/sites/default/files/documents/fencing.pdf>

DEER FENCING

Tuckwell C (2003). *The deer farming handbook*.

RIRDC Publication No. 03/029.

<https://www.deerfarming.com.au/deer-farming-handbook>

Department of Natural Resources and Environment Tasmania (2022) Fencing specification guidelines. Game Services Tasmania, Department of Natural Resources and Environment Tasmania. 4 pp.

<https://nre.tas.gov.au/Documents/Fencing-Specification-Guidelines.pdf>

[Deer hub \(undated\)](#).

<https://www.deernz.org/deer-hub/handling-and-welfare/handling/fencing/>

GENERAL FENCING

Landmark (Undated) *Landmark Fencing Handbook*.

https://www.nutrienagsolutions.com.au/sites/default/files/2018-07/documents/Fencing_Handbook.pdf

WILD DOG FENCING

PestSmart. *Exclusion and cluster fencing options*.

<https://pestsmart.org.au/toolkit-resource/exclusion-and-cluster-fencing-options/>

Australian Wool Innovation Limited (2017) *Wild dog exclusion fencing: a practical guide for woolgrowers*. Australian Wool Innovation Limited. 35 pp.

<https://www.wool.com/globalassets/wool/sheep/pest-animals/wild-dog-exclusion-fencing--australian-wool-innovation/wild-dog-exclusion-fencing---a-practical-guide-for-woolgrowers.pdf>

Long K and Robley A (2004) Cost effective feral animal exclusion fencing for areas of high conservation value in Australia. Report for the Department of the Environment and Heritage, the Australian Government. Arthur Rylah Institute for Environmental Research, Department of Sustainability and Environment, Heidelberg, Victoria, Australia.

<https://www.awe.gov.au/sites/default/files/documents/fencing.pdf>

MACROPOD FENCING

Department of Environment, Land, Water and Planning (2022) *Wildlife management methods: kangaroos and wallabies*. Department of Environment, Land, Water and Planning, Victorian Government. 5 pp.

https://www.vic.gov.au/sites/default/files/2021-01/Kangaroos-and-Wallabies-Wildlife-Management-methods_2018a.docx

Kangaroo Management Taskforce, New South Wales Government (2020) Options for integrated kangaroo management in the Western region. A practical guide for active management. 48 pp. Kangaroo Management Taskforce.

https://www.lls.nsw.gov.au/_data/assets/pdf_file/0005/1253705/Integrated-Kangaroo-Management_web.pdf

FERAL PIG FENCING

Choquenot D, McIlroy J and Korn T (1996) Managing vertebrate pests: feral pigs. Bureau of Resource Sciences, Australian Government Publishing Service, Canberra, ACT, Australia.

https://www.ohcg.org.au/uploads/1/0/1/5/101578888/managing_vertibrate_pests_pigs.pdf

Department of Agriculture and Fisheries, State of Queensland. Feral pig *Sus scrofa* (2020). Department of Agriculture and Fisheries, State of Queensland.

https://www.daf.qld.gov.au/_data/assets/pdf_file/0005/70925/feral-pig.pdf

Long K and Robley A (2004) Cost effective feral animal exclusion fencing for areas of high conservation value in Australia. Report for the Department of the Environment and Heritage, the Australian Government. Arthur Rylah Institute for Environmental Research, Department of Sustainability and Environment, Heidelberg, Victoria, Australia.

<https://www.awe.gov.au/sites/default/files/documents/fencing.pdf>

MANAGING WOMBAT DAMAGE TO FENCES

Department of Natural Resources and Environment Tasmania (2020) *Managing wombat damage to wallaby fences*.

<https://nre.tas.gov.au/wildlife-management/management-of-wildlife/managing-wildlife-browsing-grazing-losses/wallaby-fencing/managing-wombat-damage-to-wallaby-fences>

ANIMAL WELFARE CONSIDERATIONS

RSPCA. What are the risks to wildlife associated with barrier and cluster fencing?

<https://tinyurl.com/yhxc6dzk>

REFERENCES

All websites were verified on 12 April 2023.

- Australian Wool Innovation Limited (2017) *Wild dog exclusion fencing: a practical guide for woolgrowers*, Australian Wool Innovation Limited, <https://www.wool.com/globalassets/wool/sheep/pest-animals/wild-dog-exclusion-fencing--australian-wool-innovation/wild-dog-exclusion-fencing---a-practical-guide-for-woolgrowers.pdf>
- Bennett A and Coulson G (2008) 'Evaluation of an exclusion plot design for determining the impacts of native and exotic herbivores on forest understoreys', *Australian Mammalogy*, 30:83–87.
- Bennett A and Coulson G (2011) 'The impacts of sambar *Cervus unicolor* on the threatened shiny nematolepis *Nematolepis wilsonii*', *Pacific Conservation Biology*, 16:251–260.
- Borchard P and Wright IA (2010) 'Bulldozers and blueberries: managing fence damage by bare-nosed wombats at the agricultural–riparian interface', *Human–Wildlife Interactions*, 4:247–256.
- Conover MR (2001) *Resolving human–wildlife conflicts: the science of wildlife damage management*, CRC Press, Florida, USA.
- Department of Environment, Land, Water and Planning (2022) *Wildlife management methods: kangaroos and wallabies*, Department of Environment, Land, Water and Planning, Victorian Government, https://www.vic.gov.au/sites/default/files/2021-01/Kangaroos-and-Wallabies-Wildlife-Management-methods_2018a.docx
- Department of Natural Resources and Environment Tasmania (2020) *Managing wombat damage to wallaby fences*, <https://nre.tas.gov.au/wildlife-management/management-of-wildlife/managing-wildlife-browsing-grazing-losses/wallaby-fencing/managing-wombat-damage-to-wallaby-fences>
- Department of Natural Resources and Environment Tasmania (2022) *Fencing specification guidelines*, game Services Tasmania, Department of Natural Resources and Environment Tasmania, <https://dpiwre.tas.gov.au/Documents/Fencing-Specification-Guidelines.pdf>
- Fahey B (2017) Tools for managing wild deer: fencing. In '2016 National Wild Deer Management Workshop Proceedings', report edited by DM Forsyth, T Pople, B Page, A Moriarty, D Ramsey, J Parkes, A. Wiebkin and C Lane, Invasive Animals Cooperative Research Centre, Canberra, Australia. https://pestsmart.org.au/wp-content/uploads/sites/3/2020/06/Proceedings-2016-National-Workshop-on-Deer-Management_FINAL.pdf.
- Hone J and Atkinson B (1983) 'Evaluation of fencing to control feral pig movement', *Australian Wildlife Research*, 10:499–505.
- Jackson S and Groves C (2018) *Taxonomy of Australian mammals*, CSIRO Publishing, Victoria, Australia.
- Kangaroo Management Taskforce, New South Wales Government (2020) *Options for integrated kangaroo management in the Western region. A practical guide for active management*, Kangaroo Management Taskforce, https://www.lls.nsw.gov.au/_data/assets/pdf_file/0005/1253705/Integrated-Kangaroo-Management_web.pdf
- Lindeman MJ and Forsyth DM (2008) *Agricultural impacts of wild deer in Victoria*, Arthur Rylah Institute for Environmental Research Technical Report Series No. 182, Department of Sustainability and Environment, Victoria, Australia, https://www.ari.vic.gov.au/_data/assets/pdf_file/0018/35235/ARI_Technical_Report_182_-_Agricultural_impacts_of_wild_deer_in_Victoria.pdf

- Long K and Robley A (2004) *Cost effective feral animal exclusion fencing for areas of high conservation value in Australia*, report for the Department of the Environment and Heritage, the Australian Government. Arthur Rylah Institute for Environmental Research, Department of Sustainability and Environment, Heidelberg, Victoria, Australia, <https://www.awe.gov.au/sites/default/files/documents/fencing.pdf>
- McLeod R (2023) *Annual costs of feral deer in Australia*, Centre for Invasive Species Solutions, Canberra, ACT, Australia.
- Mitchell J (2008) *Feral pig control: a practical guide to pig control in Queensland*, Queensland Department of Primary Industries and Fisheries, Brisbane, Queensland, Australia.
- Tuckwell C (2003) *The deer farming handbook*, RIRDC Publication No. 03/029, <https://www.deerfarming.com.au/deer-farming-handbook>

APPENDIX A. DEER FENCING REGULATIONS

Four states (South Australia, Tasmania, Western Australia and Queensland) have regulations for deer farm fences. New South Wales is considering such regulations.

All websites were verified on 12 April 2023.

SOUTH AUSTRALIA

Department of Primary Industries and Regions, Government of South Australia (PIRSA), Fencing farmed deer, https://pir.sa.gov.au/biosecurity/animal_health/deer

Fences and gates for deer farms first registered with PIRSA after February 2019 must:

- be at least 1.9 m in height
- be constructed using pre-fabricated deer mesh that is attached securely to poles that are a maximum of 8 m apart
- have a bottom wire (high tensile, either barbed or plain) that runs through staples on the posts and can be tightened as needed, and that is attached to the deer mesh no more than 50 mm above ground
- have a strainer wire at the top of the fence, which is attached to the pre-fabricated deer mesh and posts
- be maintained (including gates) in a state of good repair in accordance with these specifications, free from any gaps, holes or damage; and be kept free from fallen trees or branches.

TASMANIA

Department of Natural Resources and Environment Tasmania (2022) Fencing specification guidelines pursuant to the *Nature Conservation (Deer Farming) Regulations 2022*. Game Services Tasmania, Department of Natural Resources and Environment Tasmania. 4 pp.

<https://nre.tas.gov.au/Documents/Fencing-Specification-Guidelines.pdf>

The boundary fencing minimum standard is:

- a 2.0-m-high netting fence, supported by 3.0-m wooden posts 100 to 125 mm in diameter (1 m buried into the ground) and spaced no further than 10 m apart
- small mesh deer netting 17/190/15; horizontal wires spaced more closely at the bottom of deer netting to reduce the likelihood of fawns escaping and to aid in deterring predators
- one plain wire positioned 10–15 cm above the netting, plus additional plain wires to finish the total fence height at 2 m. A minimum of two wires to be positioned at the top and bottom of the netting for support and to aid in the prevention of deer going under the fence and escaping.

WESTERN AUSTRALIA

Department of Primary Industries and Regional Development, Government of Western Australia. Agriculture and Food. <https://www.agric.wa.gov.au/livestock-management/fallow-and-red-deer-keeping-requirements?page=0%2C2>

Boundary fence specifications:

- A boundary fence must be at least 2 m from ground level to the top. This may need to be increased where there is high ground inside within 3 m of the fence. It is recommended that there is a 2-m clear buffer between the fence and any tree line.
- Fabricated wire mesh for boundary fencing for all types of deer is specified as 17/190/15, or 13/190/30 for red deer only. Two lengths of livestock ring lock placed one on top of the other is acceptable, the provisos being: (i) the dimensions of the fence are equivalent to 17/190/15, (ii) there is considerable overlap, and (iii) the lengths are joined by a continuous threaded wire. There should be no protrusions that could cause injuries. The wire should be attached to the inside of the perimeter fence posts where possible.
- Strainer posts and assemblies can be made of steel, hardwood or treated pine of appropriate dimensions and should be heavy duty and well stayed. The strainer assembly must be sunk to a depth and built to specifications recommended by the netting manufacturer. It is recommended that strainers be sunk not less than 1 m into the ground; in certain soils (e.g. sand) the depth should be greater. The strainer assembly itself should be about 3.6-m long. It is also recommended that the maximum distance between strainers be 150 m.
- Line posts should be no more than 20 m apart. If the posts are 15m apart, 1 half-height line post must be placed within each 15m span. In undulating terrain line posts should be no more than 10m apart.
- The bottom line wire must be fastened with pegs securely anchored in the ground, or alternatively a barbed wire can be used along the bottom of the fence. In undulating areas, the fence must be pegged at the bottom. Only steel, hardwood or treated timber pegs should be used. In heavy soil, the pegs must penetrate at least 40 cm, in light ground at least 75 cm.
- Where the fence line crosses waterways and erosion-prone areas, stones or other appropriate material must protect it.

QUEENSLAND

The State of Queensland, Department of Agriculture and Fisheries (2019) Feral fallow deer, https://www.daf.qld.gov.au/_data/assets/pdf_file/0005/69719/feral-fallow-deer.pdf

The State of Queensland, Department of Agriculture and Fisheries (2020) Feral chital deer, https://www.daf.qld.gov.au/_data/assets/pdf_file/0008/61586/feral-chital-deer.pdf

The State of Queensland, Department of Agriculture and Fisheries (2020) Feral rusa deer, https://www.daf.qld.gov.au/_data/assets/pdf_file/0007/62773/feral-rusa-deer.pdf

The State of Queensland, Department of Agriculture and Fisheries (2022) Feral red deer, https://www.daf.qld.gov.au/_data/assets/pdf_file/0016/73510/feral-red-deer.pdf

In Queensland, deer are not feral if they are enclosed by an escape-proof fence. The text relevant to fencing is identical in each of the above four documents, except for the deer species referred to:

- Generally, the minimum escape proof enclosure for farmed deer or an exclusion fence for feral deer is a well-maintained high netting fence or equivalent. An example of an effective deer fence is one that is 2.1 m high, has strainers and posts made of heavy-duty material such as hardwood or metal that are set deeply into the ground and no more than 9 m apart.
- The netting would be 17/190/15 or 13/190/30 for fallow/chital/rusa/red deer, supported by well-strained top, bottom and belly wires and pegged securely to the ground. Gates would be of similar standard and the same height. Fence lines should preferably be cleared to minimise trees falling on the fence.
- Note that this is an example only and fence construction should be appropriate for the individual circumstances.

APPENDIX B. EXCLUDING OTHER MEDIUM-SIZED AND LARGE-SIZED MAMMALS

A well-constructed and maintained deer fence that is at least 1.9 m in height will also exclude goats, sheep, cattle and horses, and many kangaroos, feral pigs and wild dogs. Additional design features will increase the effectiveness of a deer fence for also excluding macropods, feral pigs, wild dogs and wombats.

MACROPODS

Kangaroos will usually jump a fence in a near-vertical fashion from as close to the obstacle as possible. To prevent kangaroos from attempting to jump a fence in the first instance, the fence should be at least 1.8 m high (Department of Environment, Land, Water and Planning 2022). Hence, a deer exclusion fence that is ≥ 1.9 m high should prevent kangaroos from jumping over it. The recommended vertical wire spacing of 15 cm for pre-fabricated deer netting should stop kangaroos from pushing through it (Kangaroo Management Taskforce 2020).

Macropods will push under a fence, either themselves or by using holes created by other animals. A strained 30 cm apron (with uprights no further than 8 m apart) is recommended to prevent kangaroos from pushing under a deer exclusion fence. A leaning poly-pipe (or wood) offset with hot wires also helps deter macropods from pushing against the bottom of a fence. For further information on aprons and electric offsets for kangaroos, see Kangaroo Management Taskforce (2020).

FERAL PIGS

Pigs move through plain wire fences, usually between the wires at snout level (Hone and Atkinson 1983). Pigs also push under fences (Hone and Atkinson 1983), using existing holes or making new ones. There should be little or no gap between the base of the fence and the ground. Trials indicate that an unelectrified fence of 8/80/15 mesh topped with two top barbed wires spaced at 5 cm and posts spaced at 5 m excluded all pigs, whereas a similar design of 6/70/30 allowed some pigs to cross it (Hone and Atkinson 1983). Adding an electrified outrigger wire at 20–25 cm may improve the fence's effectiveness (Mitchell 2008).

A deer fence that is ≥ 1.9 m in height is too tall for feral pigs to jump. Deer netting with at least 17 horizontal wires and vertical wires spaced at 15 cm will stop feral pigs moving through it. A 30 cm netting apron will prevent feral pigs from pushing under the fence. An electric outrigger would further reduce feral pig pressure on the bottom of the fence.

WILD DOGS

When a wild dog approaches a fence with the intention of getting to the other side, it will first try to push through the fence, at or below snout level (about 45 cm). It will then try to burrow under the fence, usually where the fence meets the ground. Only rarely will a wild dog try to climb or jump a fence. Effective wild dog fencing therefore must include an effective barrier at and below snout level (450 mm and under) and also along the bottom of the fence.

A deer exclusion fence that is ≥ 1.9 m in height is unlikely to be jumped or climbed by a wild dog. A wild dog is unlikely to push through pre-fabricated deer netting with at least 17 horizontal wires (note that deer netting horizontal spacing is closer at the bottom of the fence) and vertical wires spaced at 15 cm. To ensure that small wild dogs cannot push through the fence, pre-fabricated netting with more tightly spaced horizontal wires (e.g. 75 mm) from ground level up to 450 mm is needed. To prevent wild dogs from burrowing under the fence, include a well-strained 30 cm apron and an offset electric outrigger at or below snout level (450 mm).

Further information on wild dog exclusion fencing: <https://www.wool.com/globalassets/wool/sheep/pest-animals/wild-dog-exclusion-fencing--australian-wool-innovation/wild-dog-exclusion-fencing---a-practical-guide-for-woolgrowers.pdf>

WOMBATS

Wombats can scratch under the base of a deer netting fence and lift it to gain access to the other side. They then dig a hole under the fence, which other small-sized and medium-sized mammals can use to cross the fence line (Borchard and Wright 2010). Installing an 80-cm (8/80/15) hinged-joint wire-mesh apron onto a deer fence does not completely prevent wombats from digging under the fence, because if wombats find the leading edge of the apron they scratch and lift that (Borchard and Wright 2010). An electric outrigger 125 mm above the ground is considered effective at stopping wombats digging under fences, but a high voltage needs to be maintained, and shorting is an issue for a wire at this height. Wombat gates can also be useful for minimising damage (Department of Natural Resources and Environment Tasmania 2020) but, like low electric outriggers, would be expensive to install and maintain. If wombats are present, fences need to be inspected more regularly and any diggings under the fence blocked.

Further information on managing wombat damage to fences is available at: <https://nre.tas.gov.au/wildlife-management/management-of-wildlife/managing-wildlife-browsing-grazing-losses/wallaby-fencing/managing-wombat-damage-to-wallaby-fences>

APPENDIX C. MAISIE'S PLOT FENCE DESIGN

The Maisie's Plot fence was constructed by Advanced Ag Services, Healesville, Victoria.

MATERIALS USED IN MAISIE'S PLOT FENCE

(NB = nominal bore)

END ASSEMBLIES

Mega Anchor black steel 50NB posts with 3.25 m stay, with a Mega Anchor kit to anchor it into the ground

Materials: 2.4 m 50NB black steel posts; 3.25 m 32NB black steel stay posts; Mega Anchor kits

GATES

Black PVC chain mesh gate: 2.1 m wide and 2.1 m high

Materials: black chain mesh gate; chain to lock or latch gate; 1 gate hinge set

ANCHOR POSTS

2.4 m 32NB black steel post with a 2.4 m black steel star post welded to it; Mega Anchor kit to anchor it into the ground

Materials: 2.4 m 32NB black steel posts; 2.4 m black steel star posts; Mega Anchor kits

POST OVER ROCKS

Base plate welded to black steel star post and then dyna-bolted to rock (note: only where required)

Materials: 2.4 m black steel star posts; 100 mm × 100 mm steel base plates; 50 mm dyna bolts

FENCING – PERMANENT

2.4 m black steel star posts @ 3 m spacing; 4 mm × 2.5 mm Waratah® Longlife Blue® plain wires run to support deer wire; deer wire 16/180/15 Waratah® Longlife Blue®, which is clipped to 2.5 mm support wires; all wires strained and tied at all end posts

FENCING – DROP-DOWN

Black steel 50NB × 1 m-long pipe rammed into ground @ 3 m spacing for black steel star posts to be inserted into for ease of set-up and removal

2.4 m black steel star pickets @ 3 m spacing

4 mm × 2.5 mm Waratah® Longlife Blue® wires run to support deer wire

16/180/15 Waratah® Longlife Blue® wire clipped to 2.5 mm support wires

All wires are tied to the second end post (which is chained to the end assembly), so it can be removed to be dropped down; hand winch supplied to increase tension of fence to undo chain and then to release the tension in order to drop the fence.

Remove steel star posts from steel pipe to drop all temporary fencing to ground.

Table 2. Key costs (2019 AUD) for the Maisie's Plot fence. Labour costs are included in the assemblies and fencing meterage prices.

Item	Unit price (AUD excl GST)
Single-end assemblies	\$350
Double-end assemblies	\$480
½ assemblies	\$150
Anchor posts	\$200
Gates	\$500
Drop-down fencing	\$45 per metre
Permanent fencing	\$33 per metre

CENTRE FOR INVASIVE SPECIES SOLUTIONS

Building 22, University of Canberra
University Drive South, BRUCE ACT 2617
T 02 6201 2887
E communications@invasives.com.au

