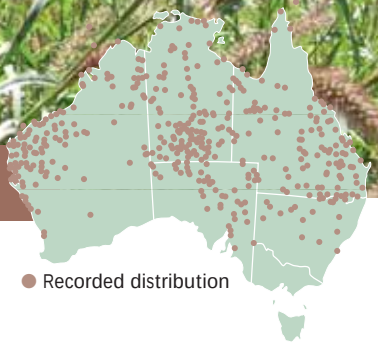
Weed Management Guide

Managing weeds for biodiversity



Buffel grass (*Cenchrus ciliaris*)

The problem

Buffel grass (*Cenchrus ciliaris*) is an introduced, perennial pasture grass that is found across much of the Australian continent, including arid and semi-arid regions. For many decades it has been widely planted for livestock production and land rehabilitation. Its palatability is moderate but it is well regarded as pasture because it grows rapidly under warm, moist conditions and persists under heavy grazing and drought. Buffel grass has spread well beyond planted areas and dominates the ground layer in many native plant communities. It reduces native plant diversity and can affect vegetation structure by changing fire regimes. In arid Australia, buffel grass invades some of the wetter, more fertile parts of the landscape, important for the survival of native plant and animal populations in this highly variable climate. Although it was planted for dust control in central Australia, it also imposes economic costs through the need to manage fire risks and to protect biodiversity assets and infrastructure. Some pastoralists are also concerned that productivity of buffel grass-dominated pastures can decline in the longer term.

Buffel grass has been identified as a major threat to biodiversity in regional natural resource management strategies across Australia (SA Arid Lands, Rangelands (WA), Fitzroy (Queensland) and the Northern Territory). It is becoming recognised that new policies are needed to address the problem of weeds that are also considered useful.

Buffel grass is just one of many perennial grasses invading Australia's native vegetation, particularly grassy plant communities, rangelands and coastal areas. Grasses introduced as pastures, such as gamba grass (*Andropogon gayanus*), mission grass (*Pennisetum polystachion*) and Birdwood grass (*Cenchrus setiger*) are a particular threat to tropical savannas in northern Australia.

Buffel grass (*Cenchrus ciliaris*) can dominate the understorey in arid regions. Central Australia, NT. Photo: R. Davies

Key points

- Buffel grass is widespread in central and northern Australia and has invaded a range of native plant communities.
- It can dominate the ground layer, displacing native grasses and other plants.
- Its rapid regrowth and high biomass may alter the intensity, frequency and extent of fires, changing vegetation structure and composition.
- Buffel grass is still spreading, assisted by continued planting and new cultivars.
- Its seed is readily dispersed by wind, water and animals.
- Control measures can reduce impacts at sites of high conservation significance.
- Mature plants are difficult to remove physically. Herbicide can be effective if applied when plants are actively growing and follow-up action is undertaken. Correct timing is essential.
- The value of buffel grass as a pasture species is well recognised and it is not a declared weed. Public policy issues arising from its positive and negative aspects need to be resolved.

The weed

Numerous forms of buffel grass have been imported to Australia from across its native range. They differ in their drought, temperature and soil tolerance, growth form, palatability, and in quantity and timing of seed production. Eleven have been registered as cultivars in Australia. Two closely related species, *Cenchrus pennisetiformis* (Cloncurry grass) and *C. setiger* (Birdwood grass), have also been planted as pastures in Australia and are naturalised. Their range is similar, but they are less common than *C. ciliaris*.

The most common uses of buffel grass in Australia are:

- as a pasture for livestock production in semi-arid and arid lands (where sowing often follows native vegetation clearing)
- to stabilise areas disturbed by mining, infrastructure development or overgrazing.

Buffel grass is a long-lived tussock grass with a deep, tough root system. While some cultivars can grow up to 1.5 m tall, others are less than 1 m tall. Some have rhizomes up to 0.5 m long. The tough, branched stalks have swollen bases and produce leaves at the basal and higher nodes. Leaves are rough-textured downwards, hairless or with fairly sparse, long hairs. Leaf blades have prominent midribs and leaf sheaths are keeled. The ligule at the junction of the leaf blade and sheath is a row of hairs, 0.2–2 mm long.

Birdwood grass (*Cenchrus setiger*) seed head lacks long, fine bristles.
Photo: Jose Hernandez @ USDA-NRCS PLANTS Database

The flower head is cylindrical, erect, dense, spike-like, 2.5–15 cm long and varies in colour from straw-coloured to purple. It consists of bristly burrs borne on a zigzag central axis. The burr has whorls of flexible bristles, a thin outer whorl and a ciliate (hairy) inner whorl with one longer bristle, 8–16 mm long. The bristles are joined at the very base into a disc. Mature burrs contain a small seed (<2 mm long) and are dispersed by wind, water, animals, clothing, boots and vehicles.

Advantages, disadvantages and broader impacts of buffel grass

Buffel grass has proved useful for pasture and soil retention in a wide range of environments due to its drought tolerance, high biomass, deep roots, rapid response to summer rains, relative palatability and resistance to overgrazing. It produces viable seed so that stands can be self-replacing and pastures may not need to be reseeded. These same characteristics also make it an environmental weed.

Like any pasture species, buffel grass has limitations, such as:

- Through competition with native species, it reduces diversity of pasture including native grasses that are highly valued fodder after rain. The effect may be exacerbated by selective grazing of more palatable species.
- The initial increase in productivity when buffel grass pasture is established is not always maintained, and pastures may run down over time (10 years or less in some soils), especially where environmental conditions do not favour legumes. This problem is difficult to address in a cost-effective manner, especially on less productive lands.
- Once buffel grass has been established as the dominant ground cover, conversion to an alternative pasture would be prohibitively expensive.
- Some cultivars are more palatable than others. The less palatable forms may gradually become dominant in grazing lands through selective grazing.

Buffel grass (*Cenchrus ciliaris*)

Flowering head.
Image: M. Robertson

Shedding seed head, with zigzag axis.
Image: M. Robertson

Burr.
Image: M. Robertson

Ligule at the junction of leaf blade and sheath is a fringe of hairs, 0.2–2 mm long.
Image: M. Robertson

- Old leaves and stalks may persist for several years and are of no value to stock but may restrict their access to fresh growth.

Broader environmental impacts of buffel grass include the following:

- Dry buffel grass foliage forms a relatively continuous flammable ground layer that can carry extensive and intense fires. It recovers its biomass very rapidly when moisture is sufficient and can burn when partly green. Therefore it can carry fire at much shorter intervals than native understorey. More frequent hot fires alter native plant community structure because established trees and shrubs can be killed and young ones destroyed before they have produced seed.
- Patch burning is needed in some native vegetation types such as hummock (*Triodia*) grasslands to maintain biodiversity and bush food resources, and to reduce the risk of large wildfires. It becomes more difficult to manage after buffel grass has invaded the landscape.
- Food sources and habitat for native fauna may be altered. In particular, native grass seed that is eaten by granivorous birds can be depleted, and habitat patchiness and diversity of invertebrates reduced. Loss of trees and shrubs to fire reduces habitat diversity.
- Native plants affected by invasion of buffel grass provide a diminished resource for traditional indigenous livelihoods including bush food, timber and medicine.
- Where buffel grass pasture occurs adjacent to fire-sensitive native vegetation, it can burn hot enough to carry fire into the remnants, opening up the canopy. The edges are then more prone to degradation, including by weed invasion. In this way, the area and integrity of habitat can be progressively reduced.

Mature buffel grass (*Cenchrus ciliaris*) tussocks grow rapidly after summer rains. Uluru NT.
Photo: R. Davies

- Restoration of native vegetation on previously cleared lands may be needed for recovery of threatened species or ecological communities. Buffel grass can be a major constraint to such efforts.

Weed identification and similar native species

A number of grasses in the genus *Cenchrus* and the closely related genus *Pennisetum* occur in Australia, including native and introduced, annual and perennial species. Most have flower heads that are spike-like, consisting of a central axis bearing numerous hairy, bristly or spiny burrs that are actually very short floral branches.

How to identify *Cenchrus* species

The introduced perennial pasture species, buffel grass (*Cenchrus ciliaris*), Birdwood grass (*C. setiger*) and Cloncurry, white or slender buffel grass (*C. pennisetiformis*) have burrs that lack sharp, rigid spines. They are closely related—in fact *C. pennisetiformis* and *C. ciliaris* are sometimes considered to be the same species. Alternative species names for the buffel grasses are *Pennisetum ciliare*, *P. setigerum* and *P. pennisetiforme*. Burrs of buffel grass and Cloncurry buffel grass have soft, ciliate bristles but these are lacking in Birdwood grass. Other *Cenchrus* species in Australia are native perennials and introduced annuals.

Mossman River grass (*Cenchrus echinatus*) is a spiny annual weed in both northern and southern Australia.
Photo: C. Wilson

Annual *Cenchrus* species with spiny burrs can be a nuisance and are often declared noxious. Mossman River grass (*C. echinatus*) is the most widespread in Australia. Innocent weed or gentle Annie (*C. longispinus*) is most prevalent in the south, especially along the Murray River. Indian sandburr or Gallon's curse (*C. biflorus*) is naturalised in northern Australia. *C. brownii* occurs along the northern coast and offshore islands and spiny burr-grass (*C. incertus*) occurs mainly in eastern Australia.

Native species: black bottle-washers (*Enneapogon nigricans*).
Photo: T. Reynolds

Similar native species

The native *Cenchrus* species (*C. elymoides*, *C. robustus* and *C. caliculatus*) are perennial, with various burrs, but lacking the long flexible bristles of buffel grasses and most *Pennisetum* species. *C. elymoides* is confined to the tropics of northern Australia (Kimberley, northern NT and Cape York regions). *C. robustus* and *C. caliculatus* mainly occur in the eastern districts of Queensland and NSW. The flower head of *C. caliculatus* is loosely packed, 4–24 cm long; its burrs have rigid inner bristles (4–11 mm long) and are often dark purplish. *C. robustus* has 45–60 rigid, 9–13 mm long bristles in a single whorl.

Other native grasses with spike-like heads include annual and perennial nine-awn grasses or bottle-washers (*Enneapogon* species), smaller grasses that have florets crowned with a ring of nine hairy awns.

How it spreads

Buffel grass has been spread throughout the dry tropics, subtropics and arid lands of the world by human activities. It is thought to have been introduced inadvertently to Australia in the 1870s in camel harness from western Asia. Camel trains were major means of transport through inland Australia and it is likely that buffel grass became locally established along their routes. Some of its early spread may have been deliberate. From 1910 buffel grass was actively distributed for planting as pasture, initially in WA, then more widely. Introductions of new forms from Africa began in the 1920s and were evaluated by government agencies, mainly in NSW and Queensland. From the 1940s seed was imported from around the world for trials. There is evidence that buffel grass had been planted in central Australia before systematic planting for land rehabilitation began there in the 1960s. Prior to 1972, nine introduced forms had been registered as cultivars in Australia and their seed produced commercially. Buffel grass pastures have been sown in a range of environments across Australia, on land cleared for the purpose, or into native vegetation.

Buffel grass spreads through dispersal of its fluffy burrs by wind, water and animals, particularly along drainage lines and roads. Its spread along roads can also be assisted by vehicle draughts and movement of soil by graders and other vehicles. Buffel grass may be slow to establish initially but it may then spread readily beyond planted areas under favourable seasonal conditions. In the arid zone, it has spread extensively during infrequent episodes when summer rainfall was well above average for several years. This has been documented in the Ashburton River catchment in WA, from 1978 to 2002.

Where it grows

Buffel grass is native to Africa, the Middle East and Asia and naturalised elsewhere, including the USA and Mexico where it is planted for cattle pasture. In Arizona it invades fire-sensitive plant communities and the increased risk of fire poses a threat to the distinctive Saguaro cactus communities.

Buffel grass can survive in areas with average rainfall of more than 200 mm annually (or 170 mm in summer). It occurs naturally in regions having up to 1000 mm annual rainfall. Under higher rainfall, tropical conditions or in regions with winter rainfall of 400 mm or more, buffel grass is less competitive with other plant species, including perennial grasses.

In northern and central Australia buffel grass occurs mainly in the semi-arid to arid zone. In arid regions it is most common along ephemeral watercourses, on alluvial plains, other run-on sites and calcareous rises. It thrives in sandy loam but may be slow to establish on heavy clay and prefers neutral to alkaline soils. It is not highly tolerant of severe frost or prolonged water logging.

At the local scale, studies in central Australia have found that buffel grass is most likely to be found nearer to drainages and tracks, in less rugged terrain, with lower hummock grass cover and on soils with greater clay content than rocky slopes or sand plains. Drainage lines and tracks provide opportunities for dispersal and also favourable sites for establishment (disturbed or bare ground, higher fertility, moisture and lack of plant competition). In fragmented landscapes, small or narrow remnants of native vegetation are more vulnerable to buffel grass invasion than larger patches with an intact canopy.

Native plant communities invaded by buffel grass include:

- Poplar box (*Eucalyptus populnea*) and silver-leaved ironbark (*E. melanophloia*) woodlands in Queensland.
- Mountain coolabah (*Eucalyptus orgadophila*) woodlands in Queensland.
- Brigalow (*Acacia harpophylla* dominant and subdominant) listed as Endangered under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

- Gidyea / gidgee (*Acacia cambagei*) shrublands in central west Queensland.
- Riparian and floodplain woodlands throughout the semi-arid and arid zones, eg river red gum (*Eucalyptus camaldulensis*) and teatree (*Melaleuca* species) woodlands on ephemeral rivers in central Australia.
- Vegetation on alluvial plains and other sites of relatively fertile soils in central Australia (eg *Acacia* woodlands and ghost gum (*Corymbia aparrerinja*) and bloodwood (*Corymbia opaca*) open woodlands).
- Coastal vegetation and islands off the Pilbara coast (Western Australia), riparian zones and wetlands, alluvial plains; tussock grasslands, eucalypt woodlands, chenopod shrublands and overgrazed hummock grasslands.
- Mulga (*Acacia aneura*) open / woodlands and shrublands are sometimes invaded at sites of higher moisture and soil fertility.
- Dry rainforest or 'softwood scrub' remnants dominated by species such as bottle tree *Brachychiton rupestris*, belah *Casuarina cristata*, vines etc can be invaded along edges adjacent to pasture if burnt, including semi-evergreen vine-thickets listed as Endangered under the EPBC Act.

Potential distribution

Buffel grass is still spreading within and between regions, unassisted and through planting. Modelling based on climatic and soil requirements has predicted that 25% of Australia is potentially 'highly suitable and 43% suitable for buffel grass growth'.

Extensive areas were mapped as suitable or highly suitable, where buffel grass has not yet been recorded or records are sparse. These included northern SA and adjoining areas. Soil and climate data were classified at a broad scale for the continental mapping. Modelling at finer spatial scales is needed to predict with more certainty where areas of high biodiversity value are under threat.

Mapping of current buffel grass distribution is largely based on accumulated records, particularly herbarium specimens, though the collection of such records has not been comprehensive in space or time. Field surveys are needed to determine how accurately existing records represent the current limits of distribution.

Genetic studies suggest that forms of buffel grass that are not genetically identical to the main cultivars are naturalised in central Australia. Forms other than registered cultivars may have been introduced to the region or new types may be arising in the field. Research is also underway into breeding new types to extend its use as pasture in heavier soils and cooler regions. New forms of buffel grass may have potential to invade a wider range of habitats.

There is inherent uncertainty in predicting the potential limits of distribution due to the wide range of conditions in which buffel grass already occurs; imprecise knowledge of the current range, genetic variation, breeding system and ecology of naturalised populations; and the unknown effects of factors such as future land management changes, cultivar development programs and long-term climatic variation.

Buffel grass (*Cenchrus ciliaris*) infestation on calcareous loamy soil along a creek in Karijini NP, WA. Photo: S. van Leeuwen

Growth cycle

Buffel grass is summer-active. Established plants can respond rapidly to small rains in spring to autumn but make little growth during winter in the inland non-tropics. Seeds germinate rapidly, but will not germinate on light falls of rain. Generally, at least 20–25 mm of rain is required for germination and establishment, as buffel grass seeds need to be moist for about 3–5 days in order to germinate. Plants can germinate from seed, mature and flower within 6 weeks of a significant rainfall event.

Buffel grass seed may survive for up to an estimated 4 years in the soil, but plants can live for many years (possibly up to about 20 years). In drier locations, moisture levels sufficient for high seed production, or for widespread germination and plant establishment, may occur infrequently. The variable climate may result in a dynamic distribution of buffel grass across the landscape, with drier sites being recolonised from moist refuges after prolonged drought.

Buffel grass (*Cenchrus ciliaris*) burnt butts resprouting after summer rain. Uluru, NT.
Photo: R. Davies

What to do about it

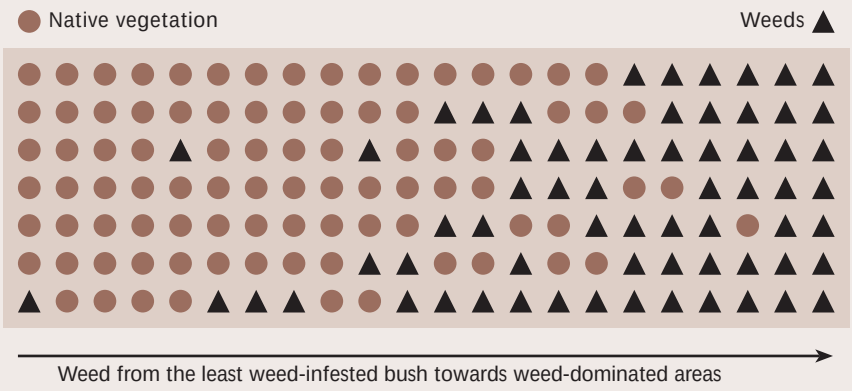
There is potential for buffel grass to spread within and beyond its current range. In regions where its distribution is limited, it may be feasible to contain its further spread through early intervention. Management options that would significantly reduce the abundance of buffel grass on a broad scale are yet to be developed. To minimise existing and potential threats to biodiversity, a range of strategies is needed.

- **Regional planning:** in many regions, buffel grass is both a pasture plant and a major weed of native ecosystems. Processes are needed to resolve policy issues and enable a co-ordinated approach to vegetation management including weed control. Priority areas for control measures should be identified across the region. These include sites of significance for biodiversity and areas where buffel grass is just starting to invade. Long distance dispersal along roadsides into susceptible habitats is probably assisted by road grading and slashing operations. Strategies will be needed to prevent further spread along and from roadsides and other infrastructure corridors.
- **Fire:** the rapid build-up of buffel grass after favourable seasonal conditions can fuel fires of increased extent, frequency and / or intensity, which threaten biodiversity. Clumps of buffel grass under trees and shrubs can also increase localised fire intensity and flame height, damaging woody species. Strategies are needed to prevent more frequent, extensive wildfires. Areas dominated by buffel grass may need to be slashed or grazed to reduce buffel grass biomass where other values would not be at risk. Where fire has removed old buffel grass foliage, there is an opportunity to target fresh regrowth with control measures such as herbicides after significant rainfall.
- **Buffel grass pastures:** native vegetation adjacent to pastures is at risk from buffel grass invasion. To contain buffel grass within the pasture, grazing needs to be managed to minimise seed production and dispersal. A buffer zone with intact vegetation provides competition to buffel grass seedlings. It should be monitored and colonising plants removed. Fires in pastures should be prevented from escaping into native vegetation remnants as they can open them up to buffel grass invasion.
- **Native rangelands containing buffel grass:** it is beneficial for both pastoral and conservation purposes to maintain plant diversity in the long term. Paddocks need to be spelled from grazing to allow native grasses to set seed following rainfall.
- **Areas managed for conservation:** buffel grass is easily the most significant weed in many arid and semi-arid areas of high value for biodiversity conservation. Strategic management is needed to minimise its further spread while mitigating adverse impacts on fire regime, habitat quality, ecosystem processes and plant community restoration. The first step in planning such an approach is often to acquire adequate knowledge about buffel grass distribution patterns and the biodiversity values under threat.
- **Soil stabilisation / rehabilitation:** once buffel grass is established, it persists and may exclude other plant species, prevent recovery of complex vegetation structure in the long term and become an on-going fuel hazard. There are alternative pioneer species and methods for rehabilitation.

Prevent buffel grass spreading

At regional and local levels, a high priority should be to monitor and control buffel grass in locations where the species is absent or sparse. This requires understanding local seasonal conditions that trigger abundant seedling establishment and local dispersal patterns. Spread is most likely soon after adequate warm season rainfall, especially following drought conditions or fire when other ground cover is sparse. Most resources will be needed at this time.

Strategic weeding in native vegetation



- Locate and remove small, isolated infestations before they seed. Particular vigilance is needed along dispersal routes such as roadsides and drainage lines.
- Practise weed hygiene during slashing and road grading:
  - where possible, slash before seeds develop
  - slash into rather than away from patches of buffel grass
  - clean vehicles and clothing before moving to uninfested areas.

Reduce established infestations

Where buffel grass occurs in native vegetation a planned, strategic approach is essential to ensure that, after treatment, buffel grass is replaced by desirable plant cover rather than buffel grass regrowth, seedlings or other weeds. Sites of high biodiversity value should be identified and targeted first. As well as information on buffel grass biology and control methods, a plan should be based on specific knowledge about the site, including the distribution of other major weeds. It requires assessment of the need for revegetation following removal of buffel grass.

Steps to develop and implement a long-term weed management plan are:

1. Investigate the site

- Identify native plants (including grasses) and weeds.
- Map weed infestations: indicate buffel grass density across the site; identify major sources of seed from which re-invasion can occur.
- Map native vegetation condition: assess its capacity for recovery after buffel grass is removed and identify sites of high biodiversity values, such as habitats of rare flora and fauna.
- Values and risks: identify high risk sites for erosion and other factors.

2. Develop the site action plan

- Identify goals and priorities based on the site information.
- Define priority areas for control by overlaying maps of buffel grass density, native vegetation, site values and risks.
- Plan to weed strategically:
  - protect the better quality native vegetation first and consider the needs of rare fauna and flora
  - work from isolated buffel grass plants towards core infestations
  - control plants from upslope to downslope.
- Work in stages. The area targeted at each stage should be of a manageable size so that thorough follow up is possible.
- Include control of other weeds so that they do not establish where buffel grass has been removed.
- Select the most suitable control method for each buffel grass growth stage in each area to avoid damage to native vegetation. Plan appropriate disposal of weed material.
- Plan a rapid response to seasonal changes to maximise the effectiveness of control activities.

3. Implement the action plan

- Remove buffel grass from the least infested areas before tackling more infested areas. Ensure that activities do not spread the seeds into clean areas or disturb native ground cover. Adapt to local seasonal conditions to prevent seedlings maturing and seeding.
- Follow up by treating buffel grass regrowth in areas previously treated before moving to new areas of infestation.
- Seek mechanisms for managing spread from adjacent lands into weed-free or treated areas.

4. Monitor and evaluate outcomes and adapt the plan accordingly

Include monitoring of native plant regeneration. In weed management programs there is often a tendency to focus on the removal of weeds as a goal, but at the site level the ultimate goal is restoration of native vegetation. It is important to monitor native plant regeneration and respond appropriately.

Control methods

Mature buffel grass plants are difficult to kill because they have a tough base and extensive root system and regrow after cutting, grazing or burning. Herbicide treatment is effective only on actively growing foliage. In arid or semi-arid regions the period of active growth may be short and unpredictable. Old, dry growth can shield growing leaves from contact with herbicide and a single application may not be sufficient to kill the plant. Spot spraying or grubbing individual tussocks minimises

chemical wastage and risk of damage to other species. Large-scale mechanical removal favours re-establishment of buffel grass and slashing needs to be combined with other methods to have significant, lasting impact. A combination of physical and chemical treatments may be most effective. Because buffel grass is a valuable forage species, biological control is not an option, but existing organisms affect seed production in some regions.

Physical removal of small or sparse infestations

Small, isolated plants can be dug out from key sites, but mature buffel grass plants have a very tough crown and deep roots. The butt can be more than 30 cm across. Remove the weeds before seeding if possible. Follow up within weeks after rain to check for regrowth and for seedlings.

Foliar spray

To be effective, spraying should be undertaken when the growth rate is high (leaves are bright green and glossy), and the herbicide applied to as much green foliage as possible. The period when conditions are suitable may be short. Spot spray using hand-held equipment (handgun and hose or knapsack) to avoid off-target damage. Persistent dry foliage may shield fresh growth. Follow up is essential using the same or other treatment methods.

The edge of Mazeppa NP, central Queensland 5 years after a hot fire fuelled by buffel grass damaged the tree canopy, promoting further invasion.
Photo: D. Butler

Buffel grass invasion of intact gidgee / brigalow in Mazeppa NP, central Queensland.
Photo: D. Butler

Combined treatment of extensive infestations

Initial slashing of old foliage followed by spraying after effective rainfall can be very effective. It may be desirable to leave slashed material on the ground to protect the soil from erosive rainfall. Follow up with further spraying or grubbing of surviving plants and seedlings when actively growing.

Contacts

State / Territory	Department	Phone	Email	Website
NSW	Department of Primary Industries Department of Environment and Climate Change	1800 680 244 131 555	weeds@dpi.nsw.gov.au info@environment.nsw.gov.au	www.dpi.nsw.gov.au/weeds www.nationalparks.nsw.gov.au/npws.nsf/Content/Weeds
NT	Department of Natural Resources, Environment and the Arts	(08) 8999 2020	weedinfo.nreta@nt.gov.au	www.nt.gov.au/nreta/natres/weeds/index.html
Qld	Environment Protection Authority	EPA Hotline 1300 130 372	Customer service centre csc@epa.qld.gov.au	www.epa.qld.gov.au
SA	Department of Water, Land and Biodiversity Conservation	(08) 8303 9620	N/a	www.dwlbc.sa.gov.au
WA	Department of Agriculture and Food Department of Environment and Conservation	(08) 9368 3333 (08) 9334 0333	enquiries@agric.wa.gov.au info@dec.wa.gov.au	www.agric.wa.gov.au www.naturebase.net/
Australia-wide	Australian Pesticides and Veterinary Medicines Authority (APVMA)	(02) 6272 5852 Fax: (02) 6272 4753	EnquiryLine@apvma.gov.au	www.apvma.gov.au http://services.apvma.gov.au/PubcrisWebClient

Contact details for state and territory agencies with responsibility for weeds are listed above, along with the Australian Pesticides and Veterinary Medicines Authority (APVMA). The APVMA website hosts the PUBCRIS database which contains information on all herbicides that are registered in each Australian state and territory, including minor use permits.

Consult your local natural resource management organisation or council to find local contacts on managing weeds for biodiversity, including community groups working on buffel grass.

Refer to the CRC for Australian Weed Management website (www.weeds.crc.org.au) for weed management guides in this series, as well as guides for Weeds of National Significance and Alert List species. The Introductory Weed Management Manual (also available from this website) may assist in developing a plan tailored to your situation.

Success managing buffel grass at Alice Springs Desert Park

Alice Springs Desert Park introduces visitors to central Australia's diversity of habitats, plants and animals and to cultural knowledge and use of the environment. The exhibits and infrastructure occupy a core area of 54 hectares within a wider park area of 1300 hectares of natural vegetation, extensively invaded by buffel grass. The park is situated on the lower slopes of the MacDonnell Ranges and the adjacent plain. Throughout the district, buffel grass typically dominates such habitats, where it has largely replaced native grasses and other herbaceous plants.

Chipping individual buffel grass (*Cenchrus ciliaris*) tussocks in Alice Springs Desert Park, NT. Photo: G. Dinham

A buffel grass control program has been conducted in the park since its inception in 1996. The first goal was to eradicate it from the core area, to enable visitors to see and understand more of the native ecosystem. A further goal is to reduce the level of buffel grass fuel in the wider park area to reduce the risk to biodiversity assets and infrastructure from wildfire.

Early control methods employed in the core area included grubbing out individual plants and following up with herbicide spot spraying whenever green shoots appeared after rain. The project is labour intensive and much assistance has been received from volunteers and community work programs. Follow-up work could be needed more than once a year, but the number of work hours decreased greatly over the first two years, both in dense and light infestations. A large proportion of the core area has now been cleared of buffel grass, in spite of unusually wet conditions in 2000 and 2001 which delayed this achievement.

At the start of the program, it was not known whether removal of buffel grass could be achieved. Also unknown was the likely vegetation response to its removal. In fact, there has been a transformation from an understorey consisting almost entirely of buffel grass to a remarkable diversity of native grasses and other herbaceous plants, occurring through natural regeneration. These results suggest that even where buffel grass has become dominant, native plants persist in the seedbank for a number of years and can germinate readily after rain, once the weed is removed. Some resilience of the native understorey is not unexpected, given its adaptation to long periods of little rain, but the maximum longevity of the native seedbank is not known. Much of the spread of buffel grass in central Australia has occurred in the past four decades.

Ongoing monitoring will be needed to prevent buffel grass reinvasion of the core area, especially where soil is disturbed or native understorey is very sparse. Since 2005 buffel grass in the wider park has been sprayed or chipped at strategic locations, with larger areas on relatively flat ground being slashed by machinery. Whipper snippers were used around the base of trees and shrubs. Where possible, the slashing was timed to prevent seed set and the viable seedbank is expected to diminish over time. There has been little recent buffel grass seedling recruitment due to dry conditions.

The slashing has been successful in reducing fuel loads and the threat of wild fire. The reduction in the amount of buffel grass has allowed native plants to grow between the slashed clumps. Slashing has been followed up with spot spraying and grubbing. Slashed clumps are easier to grub when dry and easier to spray after rain events.

The park managers emphasise that there is no point to any treatment unless you have the capacity to do the follow-up spraying after rain events as the buffel grass will return and you will have wasted your time.

case study

Herbicides

Herbicides, including grass-selective chemicals, are registered on labels for controlling buffel grass only in certain crop situations in Australia. A 'Permit to allow minor use of an AGVET chemical product' may be issued to allow registered products to be used for a purpose or in a manner that is not included on the approved label. Permits that include treatment of environmental weeds, including perennial grasses with glyphosate in some non-crop situations exist in NSW, Queensland, SA and WA. The Australian Pesticides and Veterinary Medicines Authority website includes the relevant permit for each state. Glyphosate is a non-residual, systemic chemical and affects both broad-leaved plants and grasses. Glyphosate herbicide formulated for aquatic situations has been effective on buffel grass when applied to actively growing foliage and regrowth.

Trials to control buffel grass in non-crop situations with systemic herbicides, both grass-selective and non-selective, have indicated that a range of factors are critical to successful control of both seedlings and regrowth. These include:

- The plants' condition at the time of treatment will determine its effectiveness. They must be actively growing with no sign of senescence and may be flowering but should not be seeding. If timed well, it may be possible to spray both resprouting mature plants and seedlings at the same time when seedlings are sufficiently developed after heavy summer rain.
- Herbicide should be applied to as much of the green leaf as possible. This is best achieved by spot spraying. Reduced contact in the spray shadow may be unavoidable, necessitating repeated treatment. Treatment that combines slashing followed by spraying may be most effective.
- An assessment should be made of native plants and their susceptibility to different herbicides in order to minimise off-target damage. In some situations, grass-selective and non-selective herbicides may be suitable during different phases of the control program.
- Follow up treatment, using the same or different methods, should be applied to actively growing plants and to seedlings.

To address these critical factors, forward planning is needed. A treatment program should be carefully tailored to each situation and responsive to rainfall events. Unpredictable variation in seasonal conditions may reduce treatment effectiveness at times. Perseverance is vital to maintain buffel grass at low density.

When using herbicides, always read the label and follow instructions carefully. Operators should have formal training in the safe storage, handling, preparation and use of the chosen herbicides. Particular care should be taken to ensure that rainfall runoff will not carry herbicide into waterways.

Legislation

Buffel grasses (*Cenchrus ciliaris*, *C. pennisetiformis* and *C. setiger*) are not proclaimed under any Australian weeds legislation. Buffel grass is a prohibited noxious weed in Arizona, USA, due to the threat to the environment and the fire hazard it creates.

Cenchrus species that are declared in one or more Australian states are: *C. biflorus* (Gallon's curse); *C. brownii* (fine-bristled burr grass); *C. echinatus* (Mossman River grass); *C. incertus*, synonym *C. pauciflorus* (spiny burrgrass); and *C. longispinus* (spiny burrgrass or gentle Annie). These species may also be known as innocent weed or hedgehog grass.

Buffel grass (*Cenchrus ciliaris*) plants have extensive roots.
Photo: M. Robertson

Invasion of native plant communities by exotic perennial grasses has been listed as a key threatening process under the NSW *Threatened Species Conservation Act 1995*. Buffel grass is one of the species of special concern. In WA, buffel grass was identified in the 2007 State of the Environment report among the top five environmental weeds in two of the four major biogeographic regions of the state.

Under the Commonwealth EPBC Act, three ecological communities threatened by buffel grass are listed as endangered:

1. Brigalow (*Acacia harpophylla* dominant and co-dominant)
2. Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions
3. Bluegrass (*Dichanthium* species) dominant grasslands of the Brigalow Belt Bioregions (North and South).

In most of Australia the clearance of native vegetation for establishment of improved pastures is now regulated. Sowing of non-native pasture species in native vegetation may not be defined as clearance but may be regulated on leasehold land. Introduction of non-native species to pastoral leases has been widely encouraged by some government agencies. However, in South Australia the Pastoral Board's permission would be required. Much of the area under threat from buffel grass is pastoral leasehold, conservation reserve, Aboriginal land or vacant crown land. Containing unwanted buffel grass invasion and rehabilitating key areas where it dominates is becoming a major issue for land managers.

A drainage line in buffel grass (*Cenchrus ciliaris*) pasture on heavy clay alluvium near Springsure, central Queensland.
Photo: D. Butler

Knowledge gaps

Relatively few resources have been directed at assessing the long-term consequences for biodiversity, pastoralism and the human population from buffel grass invasion of vast areas of Australia. Maps of current distribution often lack sufficient detail for planning local or regional management. Knowledge of the long-term sustainability of buffel grass pastures in various climates and soils is lacking. Where buffel grass is already widely established, methods to minimise its spread, and to maintain diversity of native understorey and overstorey plant species and vegetation structure, are required. In vegetation where buffel grass is dominant, the nature of its impacts on native fauna (including invertebrates) and on soil nutrient cycles is largely unknown. Its potential distributional limits and the susceptibility of various native vegetation types to invasion under specific management regimes and future climate change are poorly understood.

The possibility that buffel grass roots exude chemicals that inhibit growth of other plant species needs to be investigated.

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Map: Australia's Virtual Herbarium, (*Cenchrus ciliaris*), via Royal Botanic Gardens Melbourne, Council of Heads of Australian Herbaria. www.rbg.vic.gov.au/cgi-bin/avhpublic/avh.cgi.

Case study: G. Dinham, Alice Springs Desert Park.

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Strategic management of buffel grass

Quick reference guide

Regional / local status of buffel grass	Not yet established	Small, isolated outbreaks	Widely established
Management goals	Prevent establishment	Eradicate	Contain infestations and mitigate threat
Strategies required	Maintain native vegetation cover and integrity Regulate planting—define zones at greatest risk Practise weed hygiene Monitor, detect and identify new infestations especially drainage lines, floodouts, calcareous rises, roadsides and bare soil areas Where rainfall is variable, extra vigilance will be needed during a sequence of wetter than average summers	Physical removal or herbicide, or combined treatment Follow up is essential Prevent re-establishment or invasion by other weeds through passive or active site restoration	**Native vegetation:** Identify high priority biodiversity assets under threat from buffel grass and protect them through implementing long-term site management plans **Native / buffel pasture:** Manage grazing and fire to maintain diversity, eg allow native plants to recruit seedlings and set seed in good seasons **Cleared / improved pasture:** Manage seed production and minimise spread into adjacent areas, remove seedlings from outside planted area. Prevent fires spreading from pastures. **Roadsides and other infrastructure corridors:** Map infestations, practise weed hygiene and remove new outbreaks to prevent spread

Apply herbicides during periods of active growth

Herbicide should only be applied when plants are green, leafy and actively growing, generally soon after significant warm season rainfall. In semi-arid and arid climates, the period when spraying can be effective may be quite limited. Plan ahead to take advantage of these times. Follow instructions on the herbicide labels.

Follow up

It is essential to follow up physical or chemical treatment after the next significant rainfall. This will require advance resource planning. Spot spray regrowth from butts while still growing. Consider both physical and chemical treatments as combining them may increase their effectiveness and minimise off-target damage.

Prevent buffel grass re-establishment

Once mature plants have been killed, the focus is on preventing re-establishment from seeds in the soil seedbank or brought in by wind, water or animals. Buffel grass seeds may retain viability for up to 4 years or so and young plants can set seeds in their first season of growth.

1. Identify patterns of invasion and dispersal agents and manage major seed sources. Slashing can be done at any time but, if undertaken before seed set, it will minimise additions to the buffel grass seedbank.
2. Monitor weed-free areas after wet seasons to detect and remove seedlings before they establish deep roots and produce seed.
3. Restore ground-cover vegetation to areas from which buffel grass has been removed.
4. Avoid large-scale disturbance that would create extensive areas of bare soil and favour buffel grass invasion, such as too-frequent fire or overgrazing.

Buffel grass (*Cenchrus ciliaris*) along the highway near the Flinders Ranges, SA. Photo: D. Powell

CRC Weed management