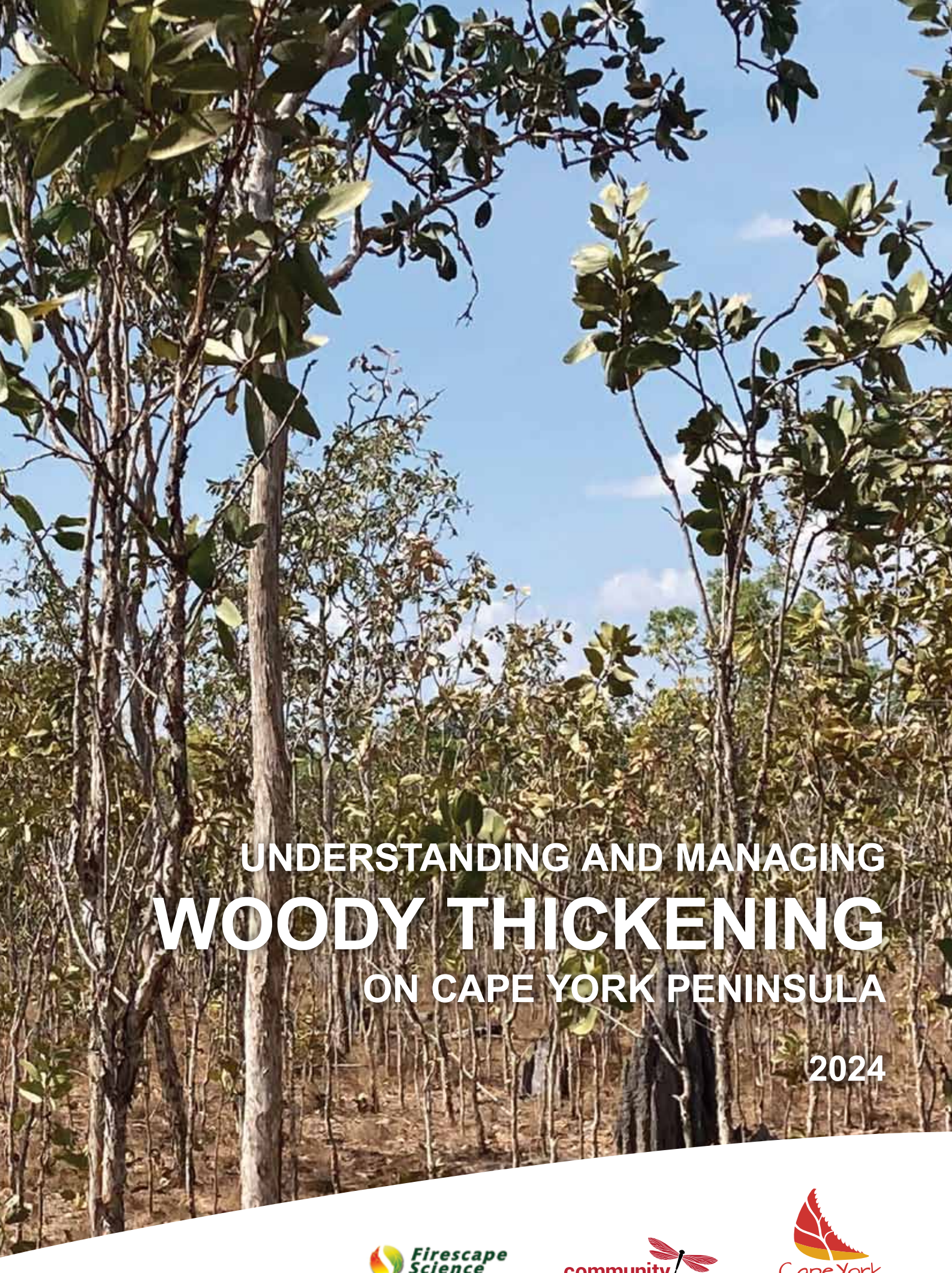

UNDERSTANDING AND MANAGING
WOODY THICKENING
ON CAPE YORK PENINSULA

2024

Firescape Science
MANAGING FIRE FOR SAFETY & SUSTAINABILITY

community BRED

Cape York
Natural Resource Management

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Acknowledgement of Country

Cape York Natural Resource Management acknowledges the Traditional Custodians of the land upon which we work and recognises their continuing connection to Country and community. Cape York NRM pays its respect to Elders past, present and emerging.

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This document does not provide advice or guidance on undertaking vegetation management activities in accordance with relevant legal requirements. Before conducting any woody thickening management activities, please contact any relevant authorities to understand, and ensure you comply with, all legislative and other requirements.

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In compiling this guide over 34 Cape York land managers have been consulted. These perspectives have been incorporated throughout the guide, providing practical examples of issues and solutions for woody thickening.

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INTRODUCTION

This guide was developed to support land managers in Cape York Peninsula to better understand and manage woody thickening.

Woody thickening has affected the peninsula since the introduction of cattle, and has intensified in recent decades, creating problems for land managers. Woody thickening impacts cattle properties by out-competing feed grasses and making mustering more difficult, it impacts cultural land management and story places, and threatens endangered species reliant on open vegetation, to name a few areas of concern. It is very difficult to manage because the invading woody plants when met with fire or other disturbance can sprout tenfold more suckers and multiply, if not managed properly.

This guide aims to give land managers more clarity over what woody thickening is, what causes it, and how they can manage it - particularly using fire. It also provides other considerations including how management of it might impact carbon projects. It is the reader's responsibility to ensure that all necessary approvals are obtained prior to undertaking works.

Information in this guide is gathered from scientific literature and perspectives from individual land managers and fire practitioners. It endeavours to provide a comprehensive practical guide on the topic of woody thickening, but there may be other knowledge, methods and perspectives missing. Cape York NRM welcomes feedback on this publication.

This document does not provide advice or guidance on undertaking vegetation management activities in accordance with relevant legal requirements. Before conducting any woody thickening management activities, please contact any relevant authorities to understand, and ensure you comply with, all legislative and other requirements.

Clearing of native vegetation in Queensland is regulated under the Vegetation Management Act 1999 (VMA). The Queensland Government provides resources and guidance to assist landholders in undertaking their vegetation management activities in accordance with the VMA. To find out more about vegetation clearing requirements go to www.qld.gov.au (search 'vegetation management') or contact the VEG HUB on 135 VEG (135 834).

In addition to the vegetation management framework, clearing activities may also be regulated under other Queensland Government legislation, Australian Government legislation and local government requirements. Landholders are encouraged to familiarise themselves with the Acts and regulations relevant to their operations, and to seek advice from the relevant agency if required.

WHAT IS WOODY THICKENING?

Woody thickening is the increase in the density of woody plants in a vegetation community. It includes woodland encroachment on grassland, which is also called woody encroachment or bush encroachment. It refers to the establishment of seedlings and suckers of long-lived woody plants that reach the canopy or subcanopy and outcompete ground layer plants, notably grasses.

On Cape York Peninsula, woody thickening involves an increase in native trees (e.g. broad-leaved tea-tree) and shrubs (e.g. thryptomene). In more arid environments – such as in Central Australia – woody thickening is dominated by shrubs.

Vegetation change can be episodic - for example, species like ironbarks are particularly prone to being killed by drought, and then re-establishing after wet years; and wattles can establish after fire but die off after a couple of years. These processes are natural, so do not cause woody thickening unless they are exacerbated by other disturbances.

Woody thickening must include an increase in the number of trees – it is not simply an increase in woody biomass or canopy cover from the growth of existing trees. It is important not to misinterpret the growth of existing trees as woody thickening.

"Woody thickening is a disturbance response - the species in that area are responding to a disturbance, whether that's cleared land, or a hot fire, or sometimes even rainfall (if you have a really wet year, a more than average wet year can bring on woody thickening)."
Ben Jones, Ecologist and Fire Scientist, Ecologistics

"We've seen it when it's been really open country and now it's slowly closing in on us… It's just been gradual. Turkey bush has come in probably in the last 20 years, it's got thicker. Soap bush is always there. It explodes - it doesn't have to be in the area [beforehand] but it seems to turn up anyway, especially if you disturb the soil."
Anne Raymond, Kimba Station

"Woody thickening is something that hasn't had a fire regime through it."
Gavin Bassani, Traditional Owner, Lama Lama Land Trust Board

"It's an abundance of new growth of certain species that wouldn't normally be dominant in an area, reducing openness in the landscape and preventing growth of species that are normally dominant in that ecosystem."
Christine Mauger, Ecologist, Bush Heritage

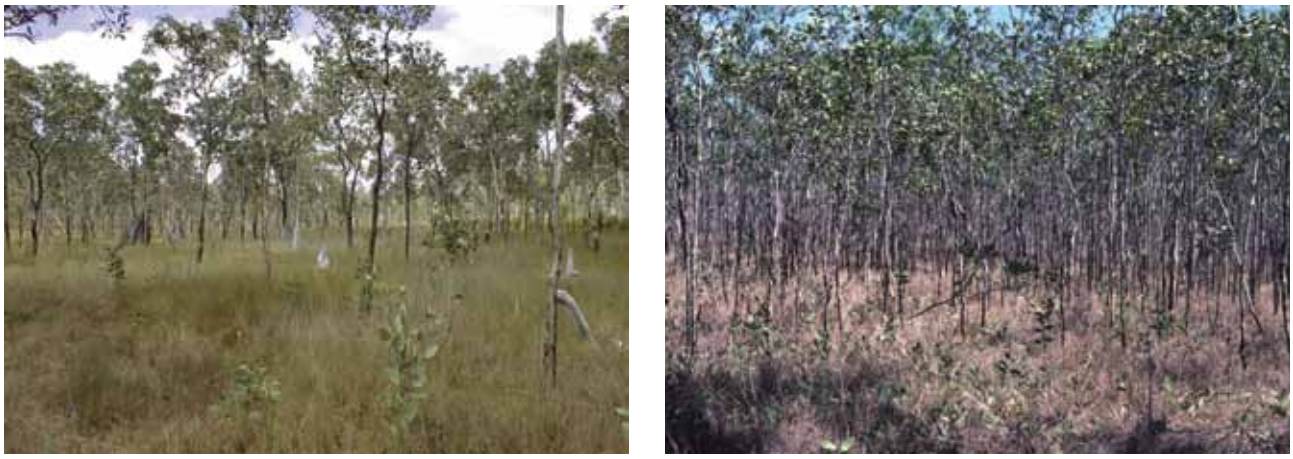


Figure 1. Two forms of woody thickening occurring on Cape York Peninsula.
In the left photo, episodic recruitment has seen the gradual progression of woody plants at all stages between the ground layer and the tree canopy. In the photo right, plants have erupted in a single recruitment event, producing a dense thicket that does not always form a tree canopy. (Gabriel Crowley).

Where does it occur?

Grasslands

Woody thickening is particularly prevalent in tropical savannas that are grazed by livestock or other herd animals, but it can also occur in other areas. It is mostly present and highly visible in grasslands, as woody species encroach on open areas. It is more likely to occur in run-on areas, where water collects in the wet season (such as basins, plains and valleys), than in well drained run-off areas. It can also occur on gravelly hill slopes where soils saturate in the wet season but appear to be well-drained through the rest of the year. Woody thickening tends to start from the edges of flats and floodplains and then spread out across them. It can be triggered by clearing that disturbs the roots of resprouting trees, especially along fence lines, or where vegetation has been burnt, as cattle gather in such areas to graze the sprouting grasses. It occurs in tropical savannas of Australia, Africa and South America and on the prairies of North America.

Throughout the peninsula, loss of grasslands and thickening of grassy woodlands has occurred through an increase of melaleucas, eucalypts, and other woody species. Different woody species thicken in different environments. Generally, tea-trees will prefer damp areas, and long-lived wattles will prefer sandy areas.

"I've seen an increase particularly on seasonally inundated country, areas of low relief that have water lying on them for part of the wet season. It's in most places on the Cape."
Barry Lyon, Cape York Ecologist and former Ranger

"It's probably not very fertile soil. It's very rocky and sandy… It goes down into river flats. I've been here for 50 years and [woody thickening] is everywhere. Even the hills, everywhere. It's got really thick. You can go to the places where it used to be really open, and [woody thickening] was probably happening before I came too."
Susan Shephard, Artemis Station

"It's everywhere on our homelands… Where you see different landscape changes – smaller trees, grasslands, and then you go up on the high ridge and there's woody thickets… there's a different variety of plants, and thickets and trees that grows in different parts of the country."
Karen Liddy, Traditional Owner, Lama Lama Land Trust Board

"It's in those in between bits, really. We have lots of decomposing granite and fairly well drained soils, and that's where you see most of your allocasuarina and most of your tea-tree."
Paul Hales, Healthy Landscapes Manager, Bush Heritage

Figure 2. Grassland, Coleman Catchment. *(Andrew Drenen. Cape York NRM)*

Woodlands and forests

Vegetation change is occurring in Cape York Peninsula and is thought to have increased in recent decades. Major changes have included the encroachment on the understorey of eucalypt communities by rainforest species in the wetter areas along the east coast and along the floodplains of the Archer River. Technically, this is conversion of one woody community to another (rainforest encroachment), rather than simple vegetation thickening.

Increase in woody plants may be occurring in woodlands and other vegetation communities, especially after wet periods. However, it is often followed by thinning in dry years. Eucalypts undergo natural cycles of thinning and thickening from drought and wet conditions, which makes it difficult to say for certain that woody thickening of eucalypt woodlands is occurring. In the Gulf Savannah NRM region, landholders are concerned about an increase in ironbarks, although it is not clear if this change is permanent. However, other species, such as breadfruit, do appear to be invading their woodlands.

Scientific studies have shown there to have been no increase in the density of trees in the eucalypt woodlands or rainforests of Cape York Peninsula.

Over the last two decades, trees across Cape York Peninsula appear to have been responding to increases in atmospheric carbon dioxide by increasing their canopy cover, without the number of trees increasing. It is important not to mistake this change for woody thickening, even though the vegetation may appear more dense.

"There's definitely more vegetation [in recent decades]. However, I wouldn't qualify it as being all about woody thickening. I think a fair chunk of it is wooded savannas becoming more carbon-dense, which is the very reason fire management carbon projects exist. While some land managers might say 'this is woody thickening because I find it harder to round up my cattle', it's probably not the kind of thickening that we worry about in terms of land degradation."

Julien Gastaldi, CEO Maki Planet Systems, a subsidiary of Corporate Carbon Group

Figure 3. Woodland post burn, Mitchell Catchment. *(Cape York NRM)*

Common woody thickening species

On Cape York Peninsula the species responsible for most thickening is broad-leaved tea-tree, although other species of tea-tree and related species are also a problem. Broad-leaved tea-tree is identified as the species causing thickening in about one-third of all grassland and tea-tree woodland Regional Ecosystems in the Cape York NRM region. Many land managers have also noticed that wattle (Acacia) is also increasing in abundance, as these flourish after fire.

On Cape York Peninsula, the most common form of woody thickening is the conversion of grasslands to tea-tree woodland, or when existing tea-tree woodlands thicken. Encroachment by exotic weeds, such as rubber vine or sicklepod, is not woody thickening.

Arid peach
Broad-leaved tea-tree
Clarkson's bloodwood
Cypress pine
Lakefield coolabah
Liniment tree
Matchwood
Other tea-trees
Purple orchid tree
Rose butternut
Quinine bush
Thryptomene
Yellow wood

Table 1. Woody species increasing in abundance on Cape York Peninsula

Figure 4. Terminalia aridicola (arid peach) invading grassland. *(Gabriel Crowley)*

How do woody plants grow and respond to fire and grazing?

Like all plants, trees and shrubs start off as seedlings. Mass germination can occur after particularly wet seasons, but most seedlings will die if the rains don't continue through the year. They will also struggle to emerge through the dense thatch of grass and may even rot if the grass stays wet for long periods. Once the grass dries off, the seedlings may also be killed by fire. So, in a natural system, only a few woody plants per hectare might establish in a grassland.

Once established, many Australian plants, including tea-trees, develop a hard woody storage organ, called a lignotuber. This is really a modified part of the stem but grows underground. If the top of the plant is burnt, the lignotuber can sprout, sending up many suckers. Some plants can also send up suckers from roots damaged by graders. It's extremely difficult to kill a sucker, as they are part of a large network of a single plant.

Figure 5. Exposed lignotubers of broad-leaved tea-trees. (Cape York NRM)

Tea-trees that manage to emerge above the grass layer grow rapidly through the wet season, and into the early dry season. But as the dry progresses, these small trees become dormant, and may even lose some leaves as they withdraw their nourishment into the lignotuber. Once this happens, they are almost immune to fire. So, while a late dry season wildfire may seem to clean up the country, the trees will recover their canopies as soon as the wet season begins. Once the sap begins to rise with the onset of wet season rains, the plants will again be vulnerable to fire.

Burning in the early dry season can also be problematic, as cattle will be attracted to the green pick, leaving the soil bare of grass. The resultant lack of fuel makes it difficult to get a fire going, and the suckers will get away. So, it is essential to spell areas that are burnt to prevent woody thickening.

Within a couple of years without effective fires, suckering plants reach the canopy, shading out the grasses, and converting grassland to woodland. Once they grow beyond the top-kill zone (about 2 m tall), the only way to restore an open vegetation structure is with mechanical intervention and herbicides (see An integrated approach to managing woody thickening, Page 22).

Very hot fires can kill trees, but fires across most of Cape York Peninsula are rarely hot enough to do so. Even late dry season fires rarely breach the bark layer of tea-trees and eucalypts, and if they manage to singe the canopy, the trees soon recover. The species most at risk of damage from late dry season fires are those along the rainforest boundary, where fuel loads are really high. So late dry season fires are unlikely to be useful for controlling woody thickening. A study from the Top End of the Northern Territory, which has hotter fires than occur on Cape York Peninsula, showed that tree saplings are more likely to die in early dry season fires than in late dry season fires.

At first this seems to contradict what is seen in the field, with a mass of suckers in areas burnt in the early dry season. This is because of the effect of grazing on areas burnt by early dry season fires (see Grazing under Causes of woody thickening, Page 12).

Plants responsible for woody thickening on Cape York Peninsula are mostly unpalatable to stock, and some are toxic. So, while the cattle will happily graze the grasses recovering after a fire, they will carefully avoid eating the suckers. Any grazing at all tips the balance in favour of the woody plants, so reduces the fuel load, and affects the fire regime. The heavier the grazing, the more severe is this effect. Very heavy grazing can eliminate perennial grasses that provide the best fuel loads on the peninsula. This lets the suckers get away, and shade out any remaining grass cover. Once that happens, only mechanical intervention can reverse the process.

"I see some of the land from on top and it's bare underneath, you've got all the young suckers coming up and the ground is sand. Some of the wildfires did come through and burn most of the saplings out, but most of the places don't get a fire in at all until late December and the storm burn time."
Michael Ross, Traditional Owner at Kalpowar Station, Laura Rangers

Figure 6. Broad-leaved tea-tree regrowth following fire, Coleman River catchment. *(Cape York NRM)*

How do I know if woody thickening is occurring?

The best way to know if woody thickening is occurring on your land is through monitoring.

Woody thickening can be confirmed by showing that there has been an increase of the number of woody stems in a given area over several years. This can be simply done by taking photos in places where you think woody thickening is occurring at the same time each year (see Measuring and monitoring woody thickening, Page 23).

Not all increases in woody stem density are considered to be woody thickening. Changes in woody plant density are either:

- long-term and consistent (woody thickening), or
- short-term cyclical and episodic events, as the vegetation responds to fire and changes in rainfall (not woody thickening)

Short-term thickening due to fire: Some plants (including many wattles, cocky apple and golden grevillea) germinate after fire, grow into shrubs or small trees, and then die off within a couple of years. The distribution of these plants is patchy across the landscape as a result, and ever-changing. This is particularly the case in heathy vegetation in which obligate seeding plants are common (non-sprouting plants that can only regenerate from seed).

Short-term thickening due to rainfall: Species like ironbarks are particularly prone to being killed by drought, and then re-establishing after wet years. This may also be the case for other long-lived plants that appear to have episodic recruitment events. For example, it is not clear whether uniform growth of quinine bush is natural or the result of thickening.

Figure 7. Quinine bush. *(Steve Murphy)*

Cyclical or episodic forms of shrubland and woodland change are a natural progression of vegetation communities, and should not be seen as problematic.

Monitoring woody stem density over time is important as it reveals key information such as whether the change is short-term or long-term, which can guide how it is managed. Counting stems in permanent monitoring plots may also be required.

"We've certainly seen an expansion of the number of dry rainforest species under our canopy species... But, I don't know whether that's what people would refer to as woody thickening.

To me, that's just a return of whatever shrub layer ought to be there - and I say "ought", but what ought to be there might not necessarily be what you want to have there now, because of whatever variety of other problems you're dealing with.

So if you're looking at loss of particular species, then you're going to want to look at what could advantage them in particular."
Janet Carson, Conservation Property Manager, South Endeavour Trust

Figure 8. An example of woody thickening at Artemis Station on Cape York Peninsula.
These photographs were taken at the same place 20 years apart (left 2001, right 2021). The green-leaf box tree in the centre of the left photograph can just be seen in the righthand photograph amidst the thicket of broad-leaved tea-trees that have grown up to surround it. (Gabriel Crowley - left; Steve Murphy - right).

CAUSES OF WOODY THICKENING

There are several factors that cause woody thickening, and sometimes it's difficult to know the exact cause for a particular area. Generally, woody thickening is caused by one or more of four drivers that disrupt the environment – fire, grazing, rainfall cycles and atmospheric carbon dioxide levels – however changed fire regimes and livestock grazing are the key drivers in tropical savannas such as on Cape York Peninsula. The disruptions include: grazing, lack of fire, infrequent fire, not burning when woody plants are actively growing, and – in particular - the combination of early season burns with grazing. Woody thickening is recognised by Queensland Herbarium as a fire management issue in all grassland and tea-tree woodland Regional Ecosystems in the Cape York bioregion.

These disruptive shifts to fire regime favour woody species, causing a competitive shift between grasses, trees and shrubs.

> ***"...when you change the competitive balance between grasses, trees and shrubs, to favour the trees and shrubs, such as burning at a time when grasses can't come back vigorously, or flogging a recently burnt area with cattle, then the shrubs will thicken and take over, and it won't be long before you lose your grass. If you burn at a time when the grasses can bounce back vigorously you haven't got a woody thickening problem, provided at the same time you don't graze heavily."***
> Peter Stanton, Landscape and Fire Ecologist, Australian Wildlife Conservancy

Some land managers believe that neither fire nor grazing are solely responsible for woody thickening.

> ***"My opinion is that regrowth [woody thickening] is not solely due to burning. I've seen early fires and late fires go through in a hot time of year in November/December, two weeks later the [woody thickening] trees that are as thick as your finger, they've got new leaves on them, it hasn't burnt them. And that's in unfenced places, definitely not overstocked. The whole of Bamboo can carry 5000 head, and has 1000 head on it, and the bigger majority of them are behind wire. So it's not stocking that has caused the regrowth. I believe it's got something to do with mother nature... it's easy to blame everything, but my view is there's not enough fuel on the ground to burn the new suckers, and that's Mother nature's call - fires have been around since Adam and Eve were created, so cold or hot burning are not just a new thing, it doesn't seem to change the regrowth in my view. I'm not saying it can't, but you've got to have everything in your favour - you've got to have a good season for lots of grass, and a fire at the right time, to burn any [woody thickening]"***
> Astrea & Bamboo Station

Disruption to the fire regime

A disruption to the fire regime has in part led to woody thickening. This has been due to Indigenous fire management being removed from Country, resulting in the wrong type of fires or no fire occurring for long periods of time.

> ***"The fire regime is the main determinant as to whether you have a healthy open grassland or woody thickening happening."***
> Julien Gastaldi, CEO Maki Planet Systems, a subsidiary of Corporate Carbon Group

Indigenous fire management removed from Country

First Nations people on Cape York Peninsula burnt Country to maintain its health for thousands of years.

Fires were lit throughout the year, with different habitats being burnt in different seasons, depending on the local conditions. These purposely lit fires were used in conjunction with storm season lightning burns to help manage the landscape for hunting and bush foods and to suppress wildfires.

Grasslands were kept open with fire for hunting purposes. Lama Lama people kept the grasslands open by using storm-burns to control broad-leaved tea-tree.

Lama Lama Elders Paddy Bassani and Albert Lakefield explained (and reinforced by Lama Lama Land Trust Board member Sharelle Spratt below):

In the old days the Old People kept the country clean and open
Now, too much ti-tree and suckers coming up
Our country is closing up now
Come wild
That's no good
You gotta use fire to keep country open like the Old People did.
(Bassani et al. 2006, p 30)

"Only now they're looking at how to manage bushfire, what season to do it. Our old people did it a long time ago - they knew they burn it for food source, when rain come they make all that tree ready for dinner, taking for gathering food. It's a cycle. It's got to be for their hunting grounds."
Sharelle Spratt, Traditional Owner, Lama Lama Land Trust Board

Journals from Europeans exploring Cape York Peninsula prior to 1881 recorded Aboriginal people burning grass and fires being lit primarily in the "mid-dry season (June to September)". This fire management practice essentially ceased with the removal of Aboriginal people from their Country.

Land use changes disrupted the ecological balance of the landscape. In many places this has allowed woody vegetation to encroach into once-open grasslands. In the subsequent pastoral period (post-1881) fires were typically lit between May and August by pastoralists to create firebreaks and encourage new growth for grazing (green-pick). This period was marked by fire-avoidance and suppression strategies. However, much of the peninsula was still burnt by wildfires in the late dry season. In recent decades, active burning (current fire management practices) in Cape York Peninsula typically occur in the early dry season and at the onset of the wet season, with wildfires still being widespread.

With each of these changes in the fire regime, woody thickening was likely to have occurred, primarily because fires were not occurring when woody plants are most sensitive to fire which is when they are actively growing.

"The landscape was one that we inherited from 10,000's of years of Aboriginal management and that included meticulous, constant use of fire. But all that changed dramatically - in a couple of hundred years, the landscape has seen more dramatic change than it might have seen in 10,000's years beforehand, and suddenly we went from an ancient regime to the present regime. Because each generation assumes the landscape they were born into is the way it's always been, we're not aware of (and in many cases refuse to believe) just how dramatic the landscape has changed in decades or even in our lifetimes. We're not talking about a natural landscape in that sense—it's already an altered landscape—so re-establishing fire as part of the landscape is a critical first step in managing healthy country."
Peter Stanton, Landscape and Fire Ecologist, Australian Wildlife Conservancy

Wrong fire or not enough fire

Burning the wrong type of fire at the wrong time, not burning often enough, or not burning at all, can cause woody thickening. Burning that does not consider landscape, weather conditions and vegetation type can also be harmful and may cause woody thickening.

Wrong fire, wrong time

As described earlier, for fires to prevent suckers growing to the canopy, they must damage the plant. This is most likely to happen when the plant is actively growing, so after the first decent storms or in the early dry season. Fires later

than this may seem to remove the leaves, but these will regrow rapidly once the rains come. Fires in dry conditions will often favour woody species over grasses. Hot fires can be useful for controlling fire sensitive species, such as some wattles, but most plants responsible for thickening on Cape York Peninsula are likely to escape hot fires with little damage (see *How do woody plants grow and respond to fire and grazing?*).

"The wrong kind of fire, and the wrong time of fire, is occurring."
Mark Parsons, Senior Conservation Officer, QPWS

Burning at the same place, with the same type of fire, at the same time of year can also cause woody thickening, as it weakens perennial grasses. Repeated burning could lead to a loss of grasses or a change in grass composition, and is most likely to occur if the grasses are lit when they are still growing, especially in the middle of the wet season.

"Too much fire on country, year after year is a problem - if you're burning the same country, it kills all your annual grasses and it thickens the country."
Anne Raymond, Kimba Station

Not enough fire

Most suckers will eventually regrow after a fire, and within a couple of years start poking above the grass layer. Follow-up fire may be required within the next year or two to top-kill these new suckers before they grow tall enough to be able to escape most fires. Follow-up fire can also be used to control wattles, such as soap bush, before they set seed.

"In a normal season with a normal fire regime, I can anticipate that probably 95% of seed that's dry and started to grow are probably killed by fire, and 5% continue on to keep the community vibrant.

But in the lack of proper management and fire… you're probably getting 95% of strike rate surviving and as a result you're getting the thickening occurring. And it's not just with the melaleucas. I've seen it occurring in places where even when there's been a lot of fire, a lot of cool burns, you start to get woody thickening as well because you're not getting the really hot fires to knock things out."
Michael Blackman, Fire Craftsman, Friendly Fire Ecological Consultants

Not burning

Woody thickening occurs where fire has been long-absent or infrequent. This absence of fire over long periods causes woody trees to mature and thicken, to an extent where they cannot be curbed by fire management.

"The worst option of all is not to burn. Any fire is better than no fire. That's of course for a landscape that evolved with fire, but it doesn't apply to a rainforest or swamp."
Peter Stanton, Landscape and Fire Ecologist, Australian Wildlife Conservancy

Recent shift to early dry season fires

Fire regimes on Cape York Peninsula have shifted in recent decades towards more early dry season fires, to reduce the number of late dry season fires, for carbon farming projects, and due to the reinvigoration of Indigenous burning practices.

Since carbon farming was introduced to Cape York Peninsula in 2013, the extent of early dry season fires has nearly doubled, and the extent of late dry season fires has nearly halved. This has consequently led to more land left unburnt. In the last decade, this transition has been greatest on Indigenous managed land, followed by conservation land, followed by non-Indigenous pastoral properties.

In the 7 years I've been involved in [carbon farming], I've seen more biomass in more places than there used to be. In balancing carbon farming in woodland areas with grassland management, recognising the two ecosystems need a different fire regime, is essential."
Julien Gastaldi, CEO Maki Planet Systems, a subsidiary of Corporate Carbon Group

Grazing

Grazing removes grass, and so provides woody plants with a competitive advantage. It also reduces fuel loads, so reduces the frequency and effectiveness of fires, again benefiting woody plants. The heavier the grazing, the stronger this effect.

Grasses on Cape York Peninsula have two main strategies for surviving the long dry season. They are either perennial or annual. Just like woody plants, perennial grasses (such as sorghum, spear grass and cockatoo grass) go dormant as the dry season progresses and store their nutrients in underground tubers or corms. They rarely regenerate from seed. When heavily grazed, these species lose vigour, and can disappear altogether. Annual grasses (such as fire grass and silkytop) survive through the dry season by producing lots of seeds.

Both grass types are sensitive to grazing in the early dry season when the nutrients of perennial grasses are stored in the leaves, and before annual grasses have produced seed. They are also both relatively insensitive to grazing in the late dry season because perennial grasses are dormant, with their nutrient stores protected underground, and annual grasses are dead.

However, on Cape York Peninsula, the perennial grasses are mostly more nutritious than the dominant annual grasses, which have poor forage value. Grazing can cause a shift in dominance from perennial grasses to annual grasses. Perennial grasses also produce more biomass than annual grasses, so any shift to annual grasses reduces fire effectiveness.

Figure 9. Schizachyrium fragile (fire grass), an annual grass species. *(Gay Crowley)*

Intense livestock grazing

Woody thickening in tropical savannas has been linked to intense livestock grazing. By thinning out the grass layer, cattle grazing reduces the competition from grasses, giving woody plants a growth advantage. Many of the trees that cause woody thickening, including broad-leaved tea-tree, are unpalatable – or even poisonous – to cattle. So the cattle eat the grass, but not the woody seedlings and suckers in the grass layer, again allowing the woody plants to get away. However, some pastoralists believe that cattle may be eating the suckers:

> ***"Cattle seem to be able to control it, because on one side of the fence you'll have the suckers coming up on the road, and on the other side the suckers aren't there, the cattle are obviously eating them."***
> John Ahlers, Maitland Downs Station

Grazing animals may also cause the germination of woody plants. One hypothesis is that hoofs of cattle and pigs disturb the ground, and seeds deposit in shallow depressions, leading to woody thickening.

> ***"Pigs look for worms, they've got to dig under the grass to get worms, and the horse and cattle eat the grass on top, you don't know what's under their hoof, they might be carrying seeds and dropping it there you don't know, just like birds fly and drop seeds."***
> Sharelle Spratt, Traditional Owner, Lama Lama Land Trust Board

Some pastoralists also believe that paddock fences contribute to overgrazing as cattle are restricted to certain areas and will eat grasses from the best available area, contributing to woody thickening:

> ***"That causes thickening when you've got paddocks. Because if [cattle] are eating out somewhere or they think they can't shift to the other place, they're gonna go back and eat it again. And then the suckers come up because there's no big grass there."***
> Susan Shephard, Artemis Station

Intensive livestock grazing can worsen woody thickening, as there is less grass available to enable management burns at the intensity needed to reduce woody thickening:

> ***"So long as your stocking rate is in line with your country. So long as your country can support your cattle. Don't overstock, if you overstock it's going to crash. If you overstock it, you don't have the fuel load, and you can't burn and the trees take over."***
> John Ahlers, Maitland Downs Station

> ***"In the savanna you can't separate the impacts of fire and grazing from each other, they interact. If you have intensive livestock grazing then the frequency and intensity of fires will likely reduce as there is less grass available to burn. I'd argue woody thickening is due to a combination of intensive grazing and changed fire patterns."***
> Jarrad Holmes, Carbon Consultant, PEC Consultants

Impacts of grazing after early dry season fires

Early dry season fires can worsen the effects of grazing on perennial grasses. When they are burnt in the early dry season, perennial grasses resprout by drawing on soil moisture to reshoot using the stores that were meant to help them get through to the wet season. The green pick (nutritious new-growth grass) that emerges after fire attracts cattle, wallabies and kangaroos, which can result in overgrazing. Without spelling paddocks after burns, this grazing weakens the grasses by forcing them to draw on their underground reserves to survive and reduces the competitive pressure on the woody plants. Also, heavy grazing prior to burns reduces grassy fuel loads, and therefore reduces fire intensity, which can further enable woody thickening. A good body of grass is also needed if fire is to be used to manage woody thickening. Woody thickening can be exacerbated by a combination of early dry season fires and grazing, rather than early dry season fires on their own.

> ***"Woody thickening becomes much more severe where stock grazing is combined with repeated early season burns. Stock grazing reduces fuel loads preventing fires of a sufficient severity to manage overabundant seedlings/saplings. This is further***

compounded by concentrated feeding on regrowth grasses in the recently burnt areas which allows woody species the competitive advantage."
Planned Burn Guidelines - Cape York Peninsula Bioregion of Queensland, 2013

"The worst situation would be to burn right at the start of the dry season, patch burn, and then allow cattle to graze it - if you want to create a situation where there is explosive tree thickening, that'd be the best way to do it. And I think that's been the history of a lot of Cape York when you look at the structure of the vegetation."
Peter Stanton, Landscape and Fire Ecologist, Australian Wildlife Conservancy

Other causes

There are also linkages between woody thickening and rainfall cycles, shifting seasons and increasing atmospheric carbon dioxide levels.

Rainfall cycles are a natural phenomenon that can also change woody plant density, which increases in wet years (with seed germination) and decreases in dry years. This also means that not all changes in woody vegetation are permanent, so a thickened area can also thin out naturally and vice versa. This is not the case for plants like broad-leaved tea-trees, which persist through dry periods.

Shifting seasons have been noted by Traditional Owners and long-term grazing families on Cape York Peninsula. Seasonal changes noted include changes to temperatures and rainfall, changes to when flowering, seeding and fruiting occurs in native flora, and shifts in windy times. These changes affect land management in general and have significant impacts for fire management, sometimes impeding efforts to manage woody thickening.

"Our Lama Lama Rangers have noticed that the wet season is starting earlier in November and finishing later around May. Because of the longer wet season it has hampered our projects on the ground, limiting access to areas because of excessive water over access tracks."
Gavin Bassani, Traditional Owner, Lama Lama Land Trust Board

"The seasons are changing quite dramatically. One time you could rely on your first storms in late October or November, and you'd always start burning like early December before the next lot of storms, or even in January you could always get those first storms the first couple of weeks of January, it'd always be dry, and then you'd burn in January. But you can't do that anymore because it's so wet in January or December, and it's so green you can't burn."
John Ahlers, Maitland Downs Station

Increased atmospheric carbon dioxide levels may also be contributing to woody thickening. Researchers across Northern Australia have investigated whether increased carbon dioxide in the atmosphere favoured the growth of woody plants, and whether they have a better ability to absorb excess carbon dioxide compared to savanna grasses. However, they found that excess carbon-dioxide benefited some trees but not others, and some grasses, but not others. So, there is no clear link with vegetation thickening. Moreover, a recent study showed that even though excess carbon-dioxide levels in the atmosphere may be causing an increase in foliage cover across Cape York Peninsula, there is no evidence that it has caused an increase in the number of trees in the dominant eucalypt woodlands.

"Woody thickening may be because of environmental changes - so climate change. So the theory is (and I'm not an expert on it) but now with more carbon in the atmosphere in a changed environment and climate, we're actually getting an ecological response, which is that we're having more woody thickening because of climate change. Because there's an overabundance of carbon, the environment is responding to that by putting out more plants, lots more saplings, and the forests are thickening up to try and absorb that... it's an emerging science... but this could potentially be a long-term trend."
Ben Jones, Ecologist and Fire Scientist, Ecologistics

WHAT ARE THE GENERAL TRENDS IN VEGETATION CHANGE?

Woody thickening has been increasing in Cape York Peninsula and will continue into the future, depending on a combination of climate change and land management.

Older history

The grasslands of Cape York Peninsula have been kept open by fires that were lit by the Traditional Owners – or by lightning – which would have suppressed the growth of tea-tree suckers. When the first Europeans traversed the peninsula in the 1860s, they described tea-tree suckers in the grass layer. Evidence of woody thickening on Cape York Peninsula has been formally recorded since the early 1960s. It was first noted on Rinyirru National Park (then named Lakefield National Park) after it was purchased by the Queensland National Parks and Wildlife Service. But it had probably begun with the arrival of cattle grazing and removal of Aboriginal land management.

When pastoralists first arrived on the peninsula, they were met with the vast heavily grassed plains on the coastal lowlands. They gave them evocative names like Silver Plains, and Nifold Plains and Breeza Plains on Lakefield. These areas were the first to be developed as cattle stations. They were also the first to be hindered by woody thickening, and among the first to be surrendered as cattle stations. Lakefield station was sold to Queensland National Parks in the 1970s, and Silver Plains was returned to its Traditional Owners in the 2000s. Smaller properties on less productive country, with narrower stretches of grassland along drainage flats were developed later, but eventually also suffered the same fate.

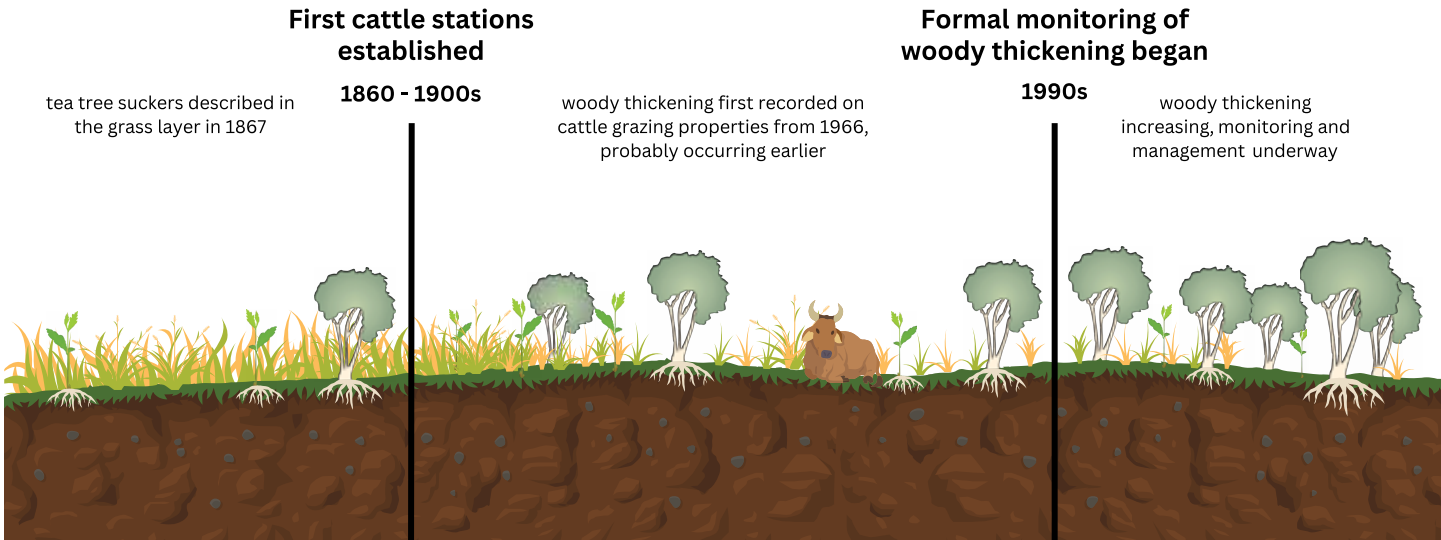
Recent decades

Landholders have observed an increase in woody thickening in recent decades. Woody encroachment on grasslands and thickening of associated tea-tree woodlands is supported by scientific studies, including the analysis of Autumn Persistent Green imagery (Figure 16, Page 24). Woody encroachment on grasslands varies. In some places, the entire grassland patch has been converted to woodland, in others woody thickening has occurred as isolated clumps of new trees.

On Artemis station, woody encroachment on grasslands has been monitored since 1969, showing an increase over the last 55 years (see Loss of grasslands and open woodlands under Artemis Case Study, Page 39). In the Normanby catchment, 14% of grassland sites recorded by CSIRO had converted to woodland, mostly from encroachment from Broad-leaved tea-tree between 1966 and 1995.

In contrast, scientific studies have shown there is no increase in the density of trees in eucalypt woodlands or rainforests. Despite this, between 1966 and 1995, woody plants such as wattles, nonda plum, quinine bush and matchwood had appeared in places where they had not originally been recorded and disappeared from others. Similar changes in composition were observed in the last 20 years on Artemis station and may be mistaken for thickening. It is important to distinguish between these short-lived changes and woody thickening.

Since the 1990s, there has been a focus on using fire to control woody thickening, particularly storm-burning. However, as storm-burning is difficult to achieve, its use has been limited (see Managing woody thickening using fire, Page 25).



Future

The long-term trends in overall vegetation condition on Cape York Peninsula will depend on a combination of climate change and land management. Opposing trends in woody thickening on Cape York Peninsula are likely. Woodland encroachment on grasslands is expected to continue on grazed properties, but slow or stop altogether on non-grazed properties, especially on those that are managed for carbon farming. Grasslands at the start of the encroachment process may be recovered using destocking and fire. However, where woody thickening already exists, it is unlikely to be reversed without serious intervention, such as mechanical management and herbicide use.

Cattle grazing has declined in the Cape York NRM region, with cattle numbers reduced from about 146,000 head in 2011 to about 104,000 head in 2020. Changed ownership has seen the transition of cattle properties to Indigenous land ownership, conservation estates and carbon farming projects, with further removal of cattle. Destocking may slow the loss of grasslands and thickening of tea-tree woodlands and may have already contributed to the levelling-off of thickening in grasslands in the region since 2012.

Hotter conditions are expected to increase fire intensity and frequency, and fuel loads are unlikely to change as natural rainfall variability is expected to continue – however, there is uncertainty about rainfall trends for Cape York Peninsula. Carbon dioxide levels in the atmosphere may keep increasing the vegetation cover of woodland, but – so far – carbon dioxide levels have had little effect on stem density. So currently, climate change and increasing carbon emissions are expected to have little influence on woody thickening.

Nearly half of the Cape York NRM region is now under Savanna Burning projects (see Woody thickening and carbon farming, Page 42). The resultant shift from late to early dry season fires may have slowed the rate of grassland loss since 2012. There is also an ongoing interest in storm-burning, but as storm-burns require specific conditions, application will be limited. Many landholders are reluctant to storm-burn after end-of-year rain storms as they are unsure if this is permitted under carbon projects.

"A lot of the places in the Cape – places where we used to pull up and have lunch, you'd pull up 500-600 head of cattle, two helicopters and you can't even land, you can't even see the place anymore. The big wet running flats are not meant to have timber, because you've got the natural water course. The tea-tree has taken over the water course and that is causing erosion, the tea tree comes from early burns."
"It will be a vicious cycle - in another 20 years, there'll be not a lot of [open country], and there'll be a lot of erosion."
Bret (Magoo) Little, Helicopter Pilot

"As the fire regimes changed from 200 to 250 years ago, there's been some massive changes... you see it in all areas - that whole fire management was taken away for a long period of time. Mind you, 200 to 250 years it's only a click of your fingers as far as time goes - so there's no doubt the opportunity to turn it all around, it's just going to require a bit of dedication. And we can't go back to what was there before, obviously, but surely, we can go back to a much better system than what we have in a lot of places now, which is nothing other than a wildfire regime."
Michael Blackman, Fire Craftsman, Friendly Fire Ecological Consultants

Into the future

2024

Woodland invasion of grasslands is expected to continue on grazed properties, and slow or stop on non-grazed properties, while many vast areas of woody thickening are beyond fire management

Tea tree sapling symbol courtesy of the Diana Kleine from Marine Botany UQ ian.umces.edu/media-library

Figure 10. Normanby catchment. *(Cape York NRM)*

WHAT ARE THE IMPACTS OF WOODY THICKENING?

Woody thickening has implications for stream flow, soil health, cattle grazing businesses, conservation values, and cultural land management.

Impacts on stream flow

Trees use far more water than most grasses. A small tea-tree transpires around 4 litres of water a day, and a mature one can transpire up to 200 litres of water a day. While some of this water will be obtained from the groundwater, much of it will come from the soil profile.

Runoff may increase or decrease with woody thickening. Increases in transpiration are likely to reduce runoff, while loss of ground cover is likely to increase it. Woody thickening has been shown to reduce stream flow, as it draws on both soil water storage and groundwater.

> ***"Tea-trees are basically big water pumps. So we can't expect an invasion of tree trees not to have impacts on the way water behaves in the landscape."***
> Steve Murphy, Conservation Partners

Impacts on soil health

Woody thickening is not good for soil health, as it is often associated with nutrient depletion and increased acidity. Woody plants compete with other plants for light and nutrients, especially grasses which are an important part of the ecosystem as they provide fuel loads needed for restorative planned fires or wildfires, as well as grass feed for cattle grazing and food and habitat for native animals.

Woody thickening is also thought to cause erosion, as it reduces the grasses that help to stabilise the soil:

> ***"It causes more breakaways and erosion because they haven't got a hold in the soil... [and] there's no big grasses to hold the ground."***
> Susan Shephard, Artemis Station

> ***"Once it gets more and more timber, you get less and less grass, so less and less cattle, and then eventually [no sunlight], no grass because it's all trees. ...and there'll be a lot of erosion, because there's nothing to hold the ground when the tree roots come out, bust the ground open, the water comes down and washes the dirt away. I can show you a lot of places where that's happened already. I can show you trees sticking out of the ground 20 ft just on a patch of dirt."***
> Bret (Magoo) Little, Helicopter Pilot

> ***"The more taller timber you get, the less grass you get, so any woody thickening threatens grass. Once you [lose] grass, you get erosion, and you get less seed for your cattle - well, for animals full stop. Wildlife don't like woody thickening either because they prefer to be out in the open where they can see what's coming at them."***
> Anne Raymond, Kimba Station

Figure 11. Ten Mile nest site at Artemis Station, May 2005. *(Gabriel Crowley)*

Impacts on cattle grazing businesses

As tree cover increases, pasture productivity generally decreases. Productivity of the pasture is reduced through increased competition from trees for light and moisture. It may also be affected by the nutrient depletion of the soil and increased soil acidity that is often associated with woody thickening. Loss of grasslands or the shading out of grasses in grassy woodlands therefore reduces the recommended carrying capacity. As woody thickening increases, grazing land condition deteriorates, as does the long-term stocking rate (Table 2). So woody thickening reduces the number of cattle that can be sustainably grazed on a property, and ultimately, the cattle that are produced and sold.

"There's no spear grass, sorghum or any native perennials like that. And every year I can see it worse and worse. All the annual grasses take a while to come up and they're eaten off straight away."
Susan Shephard, Artemis Station

"Cattle, woody thickening, unless they can eat the bush it's useless - it stops growth underneath, it shades the ground, the grass dies out and you've got no pasture."
Anne Raymond, Kimba Station

Woody thickening also makes it difficult to move through the country, particularly for mustering, and reduces the availability of open country for helicopters to land in emergencies. Helicopters may be needed to flush cattle out of dense vegetation, but even then, the cattle may be hard to find. It has been estimated that woody thickening can increase mustering costs by up to 30%.

Woody cover	Condition	Carrying capacity %
No sign of woody thickening	A	100
Some thickening in density of woody plants	B	75
General thickening in density of woody plants	C	45
Thickets of woody plants cover most of area	D	20

Table 2. Impact of woody thickening on carrying capacity.

Impacts on conservation values

Figure 12. Golden-shouldered parrots have been impacted by woody thickening encroaching on their habitat. *(Conservation Partners)*

Woody thickening degrades habitats. It changes the nature of grasslands and makes them unsuitable habitat for grassland-dependent species. Woody thickening can reduce species and habitat diversity, particularly when it involves domination by a single woody species (a 'monoculture'). Woody thickening has been identified as an issue for many vegetation communities on Cape York Peninsula. However, no community has been classified as being either 'Endangered' or 'Of concern' as a result.

On Cape York Peninsula, a transition from an open to a closed habitat (such as from woody thickening) brings with it different predators, including brown goshawks, collared sparrowhawks, black-backed butcherbirds, black-headed monitors and brown tree snakes, which are all species of wooded habitats. Species adapted to feeding and breeding in open habitats are therefore likely to suffer more from predators as the vegetation thickens.

In recent decades, this transition to more closed habitats because of woody thickening has been observed on Cape York Peninsula:

"…in the 15-20 years I've been up on the Cape – where I've come in – thickening is pretty well entrenched. Now it's more the infilling, so the more secondary stages of that thickening process, causing the canopy to become captured, transitioning to more of a forest state as we lose woodlands and open plains."
Mark Parsons, Senior Conservation Officer, QPWS

Loss of grasslands is adversely affecting several species on Cape York Peninsula. The species most at risk are the golden-shouldered parrot, and the antbed parrot moth which breeds in the parrots' nests. Both species are classified as endangered, largely because of the woody encroachment on grasslands, which has decreased the parrot's nesting success. See Artemis Case Study: Example of a long-term woody thickening management and monitoring program (Page 38) for more information on efforts to restore the golden-shouldered parrot habitat by reducing woody thickening.

Some people don't see woody thickening as harmful, especially in smaller amounts, and say it can be beneficial for some species:

"I don't necessarily see woody thickening as a bad thing, if it's not to a large extent."
Ben Jones, Ecologist and Fire Scientist, Ecologistics

"No, we don't tend to think of [woody thickening] as necessarily a problem - we've still got tonnes of grasses (and tonnes of grass weeds)… But that's from a certain point of view, and it very much depends on what you're trying to do on a specific piece of land. So from a conservation point of view, there's a lot of data that suggests that thicker understory means better outcomes for many fauna species, particularly critical weight range mammals, but also many birds and reptiles, particularly those who utilise the forest floor. It's to do with protection from cat predation.

I would say that woody thickening can actually be beneficial to certain species... I would also say that quite often the improvements for fauna outweigh the detriment. It depends on which species you are interested in advantaging and also which species are doing the thickening. For example, following a repeat fauna survey after 9 years we are now seeing black-footed tree rats along with some woody thickening on one of our properties. Cattle have been removed and widespread fire events avoided in favour of smaller area planned burns wherever possible. Our results suggest that this has perhaps disadvantaged some bird species, but apparently suits the vulnerable and declining rat."
Janet Carson, Conservation Property Manager, South Endeavour Trust

Golden-shouldered parrot
Antbed parrot moth
Crimson finch
Star finch
Black-faced woodswallow
Red goshawk
Buff-breasted button-quail

Table 3. Species likely to be adversely affected by woody thickening.

Impacts on cultural land management

Many First Nations people see long-unburnt Country as sick and neglected. Using fire to keep Country healthy is part of the reciprocal relationship people have with the land.

First Nations people on Cape York Peninsula burn Country to maintain its health, something they have been doing for tens of thousands of years. Traditionally, fires were lit throughout the year, with different habitats being burnt in different seasons, depending on the local conditions.

For grasslands and tea-tree flats, keeping Country healthy means keeping it free of suckers and woody thickening. Lama Lama people keep the grasslands open by using storm-burns to control broad-leaved tea-tree. Woody thickening can impact continued traditional practices such as hunting, as open grasslands are favoured by kangaroos and wallabies.

Lama Lama Elders Paddy Bassani and Albert Lakefield explained:

You can clean up the scrubby country with fire
You can clear the country so you can see them minya better
Keep the country clean
Too much country come wild now.
(Bassani et al. 2006, p 30)

Individual plants and animals affected by woody thickening are also important to the Traditional Owners, such as the golden-shouldered parrot.

Wik Mungkan Traditional Owner, Marilyn Kepple, says that fish species are being impacted by woody thickening around a creek on Meripah Station:

"At Scrubby Creek where there is thickening… it connects up to the area where we go fishing… the fish were dying… there were fish on the surface trying to get to the air."

"The grass is non-existent, the vegetation is eroded, the creeks are clogged up, so the water doesn't get through. When the water does get in there it's not a healthy environment for cattle."
Marilyn Kepple, Wik Mungkan Traditional Owner, Meripah Station

There are also spiritual considerations around sites of woody thickening, as Sharelle Pratt, a Lama Lama Ranger, explains below. This may also have implications for any management of woody thickening.

"People don't use that area [where there's woody thickening], we say it's a boundary, the boundary belongs to other family clan groups. We can't say it's untouched, it's probably a story place for them, sacred, that's why it's wild because you can't go there and interrupt the place if it's got a story place. Then if you go that way now, where the dingo story is, you get sick."
Sharelle Pratt, Traditional Owner, Lama Lama Land Trust Board

Figure 13. Traditional burn at Steve Irwin Wildlife Reserve, Taepathiggi Country *(Cape York NRM)*

AN INTEGRATED APPROACH TO MANAGING WOODY THICKENING

The best approach to managing woody thickening will depend on how advanced it is, and whether spelling and burning are practical options. In many cases, multiple management tools will be needed.

Fire management can be an effective tool, especially for early-stage woody thickening. In some cases, woody thickening has gone so far that more intensive management such as mechanical removal and herbicide treatments will be required (see Intensive management of woody thickening, Page 35). These intensive methods may only be suitable for small areas (a few hectares), and are unlikely to have application at a broader scale because they are expensive and time-consuming. Effective methods include mechanical removal and herbicides but these must be used carefully and only with the right permissions. Bull-dozing or chaining to remove suckers is counter-productive because it usually stimulates more suckers to emerge where roots were broken. More extreme measures, such as blade-ploughing, cause too much environmental damage, and are unlikely to be approved.

Storm-burning or burning early in the dry season, combined with spelling, are considered the most effective fire management method for reducing early-stage woody thickening. At storm-time, trees are most vulnerable to fire and grasses will grow back strongly afterwards to compete with any remaining or new woody plants. In the early dry season, the suckers are still growing, so are also sensitive to fire.

As long as ground cover is maintained, controlling woody thickening should have minimal adverse effects on biodiversity or water quality, and may improve pasture quality and soil health. Managing woody thickening isn't a once-off solution – even after mechanical removal – it may require regular burning every 2 to 3 years.

This document does not provide advice or guidance on undertaking vegetation management activities in accordance with relevant legal requirements. Before conducting any woody thickening management activities, please contact any relevant authorities to understand, and ensure you comply with, all legislative and other requirements.

Clearing of native vegetation in Queensland is regulated under the ***Vegetation Management Act 1999*** **(VMA).** The Queensland Government provides resources and guidance to assist landholders in undertaking their vegetation management activities in accordance with the VMA. To find out more about vegetation clearing requirements go to www.qld.gov.au (search 'vegetation management') or contact the VEG HUB on 135 VEG (135 834).

In addition to the vegetation management framework, clearing activities may also be regulated under other Queensland Government legislation, Australian Government legislation and local government requirements. Landholders are encouraged to familiarise themselves with the Acts and regulations relevant to their operations, and to seek advice from the relevant agency if required.

Land managers should also consider their responsibilities under the ***Aboriginal Cultural Heritage Act 2003*** before clearing any land.

"It's a matter of balance and making sure we do things the right way. Because if we go in and just clear one area there's consequences like our story... something comes back, or someone gets sick, or some weird thing happens... we've got to make sure, our culture and beliefs are very much still alive... That's why I was talking about the fish dying... so [we can't] take away too much [woody thickening]... But not forgetting the cultural beliefs and practices. You might see me dressed in modern attire and I grew up in the city... but I always carry those stories and cultural practices shared to me... and I make sure that we're doing things properly."

Marilyn Kepple, Wik Mungkan Traditional Owner, Meripah Station

Measuring and monitoring woody thickening

Monitoring should be done both before and after any management intervention. Monitoring beforehand allows you to assess if woody thickening is occurring, the extent of the thickening, which areas it's occurring in, the speed of thickening, and which species are thickening. This information will inform the best management approach. It's also important to monitor vegetation change to determine whether an increase in woody density is causing woody thickening (consistent and long-term) or is the result of short-term cyclical or episodic events (triggered by fire or changes in rainfall) as this is not considered to be woody thickening (see *How do I know if woody thickening is occurring?* earlier in this guide). After an intervention, monitoring of the same areas will show whether the management has been effective at reducing the woody thickening, and indicate how soon any follow-up planned burns or other treatments are required, as well as how a fire has impacted the groundcover and the regrowth of grasses.

There are three ways to monitor woody thickening by measuring changes in stem density:

- taking photographs at exactly the same place every year (Figure 14)
- counting the number of tree stems in a permanent plot over increments of several years, or by using a dendrometer such as a Haglöf factor gauge as a measure of basal area (Figure 15)
- changes in Autumn Persistent Green satellite imagery have been used to assess woody encroachment on grasslands (Figure 16)

Taking photographs is the easiest way to monitor woody thickening by observing changes from year to year. It's important that photographs are taken at exactly the same place every year, which can be done by setting up a permanent plot marked by star pickets. Ideally, set up a few different plots in different areas across the affected areas on your property. This will show how different vegetation communities and landscapes are affected by woody thickening (e.g. if different species are in different areas, or it is thickening faster in certain areas). This will also help determine if fire or other intervention methods are more effective in some areas compared to others.

Basal area measure tells us how much timber there is in a plot, and is also an approximate measure of woody plant or stem density. Basal area is measured by standing at a central point in a plot (marked by a star picket) and turning a full circle while holding a pocket dendrometer (such as a Haglöf factor gauge) at arm's length in front of you. You then count the number of trees that fill a window in the dendrometer as you turn (Figure 14).

Figure 14. Monitoring of progressive woody thickening.
Only a pair of photos is needed to convince us that the grassland photographed in 2001 (left), had been converted to woodland by 2021 (right). Metal pickets marked both a) the position of the camera and b) the direction in which the photograph was taken, so the same view could be captured. (Gabriel Crowley - left; Rigel Jensen - right).

Figure 15. Devices to measure woody stem density.
Examples of dendrometers used to manually measure basal area (stem density) as an indicator of woody thickening. The first device is the original Kramer's pocket dendrometer that was designed based on the Bitterlich method, and the second device is a modern equivalent (Haglöf factor gauge) that is available to purchase. A star picket is used to mark the point from which the measures are taken so that changes at the same site can be monitored over time. (AWF-Wiki, Georg-August-Universität Göttingen - left; Grube - right.).

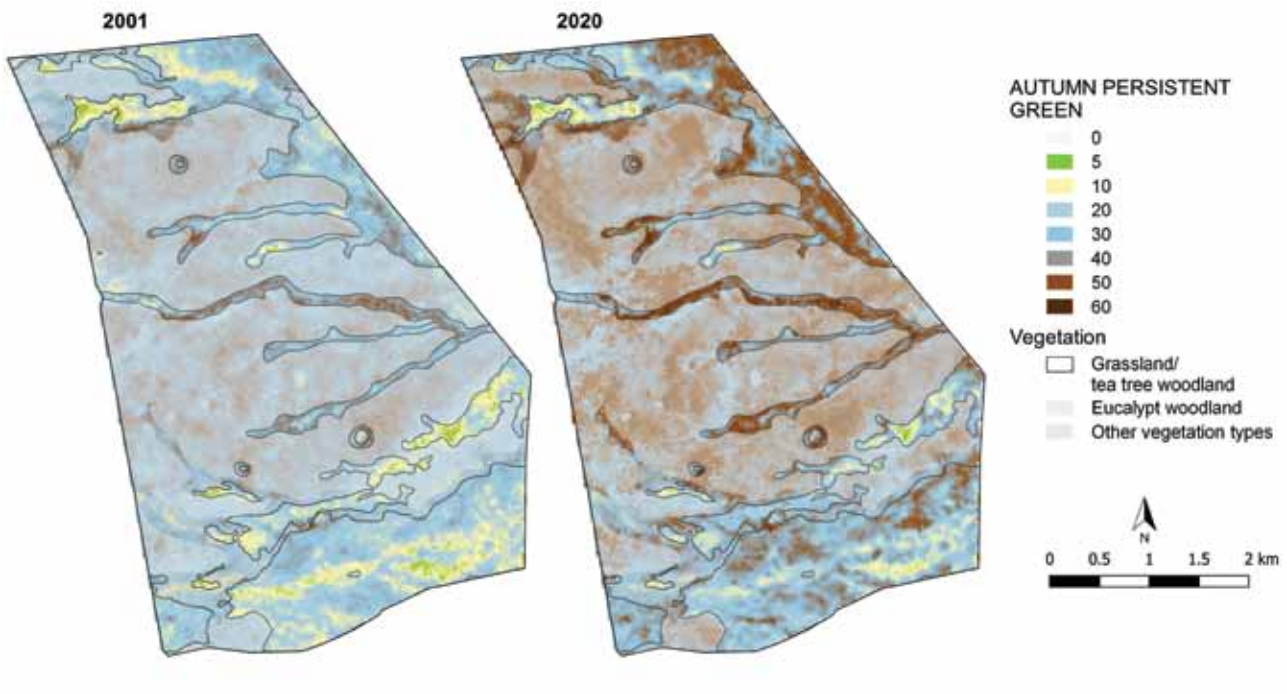


Figure 16. Changes in Autumn Persistent Green in the former Artemis Antbed Nature refuge show an increase in foliage cover between 2001 and 2020.
(Gabriel Crowley). Sources of data: Autumn Persistent Green, Department of Environment and Science (2023); Vegetation Types, Department of Environment and Science 2018.

"Every fire should inform the next fire event, because if you don't know the results of what we've done with fire, you're not going to see what's changing in the environment, and unfortunately people only see a very small portion of their land and generally that's out the window of a Toyota or a fire truck... it's a poor representation of what's happening… so I encourage people: go out, walk 100m (in from the track)."

Ben Jones, Ecologist and Fire Scientist, Ecologistics

"There's nearly 2 [monitoring points] in every paddock… but we've got about 10-12 all up that we use. We try to take photos every year after the growing season. Sometimes those areas get burnt before we get to do the monitoring... Over the years it shows the difference in country and vegetation… it shows when you've got to do a hot burn, it shows whether there's grasses in certain areas and what grasses were there beforehand."

Anne Raymond, Kimba Station

Managing woody thickening using fire

Fire is used to manage woody thickening because it top-kills the suckers emerging from the grass layer. It is a natural tool of management that has regenerative benefits to the surrounding environment when implemented properly. Fire is a key driver of woody vegetation structure. It can stop seedlings, suckers and saplings from reaching the canopy. Fires can help to maintain open country. However, while intense fire can kill trees or individual branches, and reduce tree growth, it rarely kills trees that are responsible for thickening.

Queensland Herbarium recommends fire management to control an overabundance of woody plants in 112 of the 192 Regional Ecosystems mapped in the Cape York bioregion. Fire regimes to manage woody thickening are recommended for all grasslands and tea-tree woodlands, as well as for the majority of eucalypt woodland Regional Ecosystems.

A single fire may be adequate to restore an open vegetation structure if the thickening is not too advanced. Where woody plants are starting to escape the top-kill zone, repeated fires, or more extreme treatments, are likely to be required. However, once an open structure is re-established, an ongoing management regime that involves regular spelling (or total cattle exclusion) and burning will be required for long-term maintenance. Storm-burns every 2-3 years are likely to be needed to maintain an open vegetation structure. The required periodicity of early dry season burns is unknown, but they must be accompanied by cattle exclusion to be effective at reducing the suckers.

Fire has its limitations, as once trees grow beyond the top-kill zone, canopy-scorch is hard to achieve, and the thick bark protects them against fire damage. Furthermore, a dense canopy shades out grasses needed for a sufficient fuel load, making fire difficult to reintroduce. That's when other means such as mechanical or herbicide methods will be required. Certain vegetation types may also not respond well to fire, so it's important to always burn according to the vegetation type, fuel load, season and weather conditions such as outlined by the Planned Burn Guidelines – Cape York Peninsula Bioregion of Queensland and adjoining bioregions.

> ***"If you had really big grass and hot fires you killed the little suckers. But once they get above 6 foot … you're not going to kill them."***
> Susan Shephard, Artemis Station

Any fire regime should be patchy so that animals can move easily from unburnt patches to recolonise burnt areas as they recover, and for the plants that escape the fires to shed their seed into burnt patches. Patchy fires also reduce the risk of the same places being burnt every year, which is important for allowing grasses and other plants to recover their vigour between fires. Patchy fires are easiest to achieve in the early dry season. Fortunately, these fires are likely to be effective at controlling woody thickening.

> ***"The only way you can manage it is through fire… depends on what year you burn… in the old days the old people did it at the right time of the burning season"***
> Christine Musgrave, Traditional Owner at Mary Valley Station, Laura Rangers

Benefits
• Is effective for early-stage woody thickening • Can be applied across extensive areas • Is a low cost option • Has been shown to have environmental benefits, and is recommended by government agencies
Disadvantages
• On cattle properties, spelling – required to allow fuel build up and to protect grass growth after fires – may be difficult to achieve • An effective burn can be difficult to achieve, as once canopy cover shades out grasses the fuel load is reduced • Fire will not be effective once trees mature and grow beyond the top-kill zone • The right conditions for storm-burning may not occur very often • Fires, particularly storm-burns, can get out of control and become a risk to people, property and the environment

Table 4. Benefits and disadvantages of using fire for managing woody thickening.

Figure 17. Early dry season fire, Normanby catchment. *(Lars Kazmeier, Cape York NRM)*

What type of burn and when to manage woody thickening?

Burns that can manage woody thickening if done properly include storm-burns and early dry season burns. Fires should not be lit in the middle of the wet season, as this will kill the grasses, expose the soil, and cause erosion. Just like the best time to use herbicide to control rubber vine is when the sap is flowing, the best time to burn suckering plants is when their sap is flowing. At these times, woody trees are growing and so are vulnerable to fire.

It is important that there is enough fuel for an effective fire that will reduce suckers and saplings in the top-kill zone (Figure 18). For pastoralists, this means reducing grazing pressure over the preceding period or destocking altogether. Destocking after the fire is also important to prevent cattle grazing on 'green pick' which would weaken the grasses and give the suckers a competitive advantage.

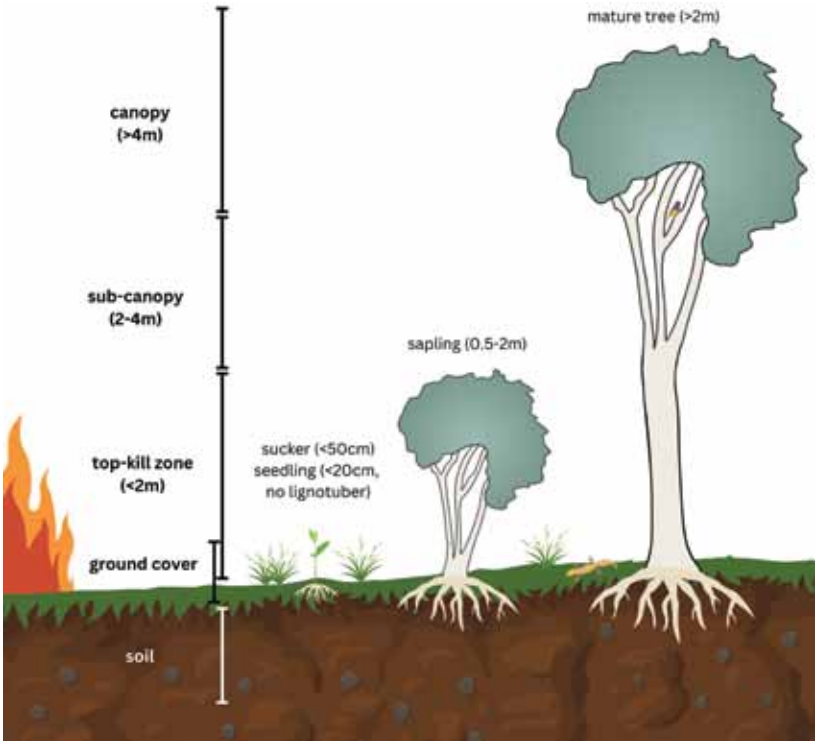


Figure 18. Vegetation zones and tree sizes. *(Cape York NRM)*

A mixture of early dry season burns and storm-burning is probably the best approach for reducing woody thickening in its early stages.

"I think our old people burnt early as they go through the country, but later in the year to get rid of woody thickening - burn late, with storm burns."
Gavin Bassani, Traditional Owner, Lama Lama Land Trust board

"My simplified method for fire management is: same fire, same place, same time - isn't good. That's what you want to avoid... If you burn at the same place every year, you're probably going to experience woody thickening. If you burn at the same time of year, you're going to have the same fire-type generally in terms of parameters. Say, if you burnt in May, it would be a very low intensity, patchy burn, which often people think is great - cool burning - and it is, but if you repeated that same fire every event and not mix it up with, say a storm-burn every few years, or different types of fire, you're going to have change in your habitat, your environment, because you're not going to have an intense fire."
Ben Jones, Ecologist and Fire Scientist, Ecologistics

"I would see an area if it was managed properly, over say a 10 year period, it might be burnt 3-4 times. It might have one really hot fire and several cooler fires go through it. One of the main problems, of course, is when you have a large part of your biomass of fuel removed by grazing or things like that - you are never going to get the intensity fires at probably the times of year you really need them to combat that woody thickening."

"When you do have grazing it seems to be that the only viable way of knocking it back is storm-burning, which is very difficult to time and to get right, and if follow-up rain doesn't happen fairly promptly, who knows where that fire is going to stop? Whereas I am beginning now over time to swing towards the belief that if you do have the fuel loads, you have a natural fuel load from your grasslands and everything like that, you can get the same result by burning at an earlier time of the year because you can get a hotter fire due to the fuel loads not being removed. Because I can't see how it could have all been maintained through storm-burning."
Michael Blackman, Fire Craftsman, Friendly Fire Ecological Consultants

"The safest way to avoid woody thickening, even in the presence of cattle, would be to have the bulk of your burning after the first storms or early wet season. But if you're managing a property, you can't lock all your grass up and burn it at one time, so you're inevitably going to have to do some early burning just to give the safety to be able to burn later in the year."
Peter Stanton, Landscape and Fire Ecologist, Australian Wildlife Conservancy

Fire does not respect boundaries, and country varies as well as people choosing to manage theirs differently, so it is important to ensure that there are adequate fire breaks between properties and to protect other areas that you do not intend to burn:

"What we're trying to achieve with fire and the landscape is taking very much a 'tenure-blind' approach... [which] is more of a general view of recognising that fire doesn't stop at boundaries, that we do need to work together, and understand obviously everyone has slightly different objectives and in how they manage lands, but trying to apply fire as it's going to move through a landscape rather than stopping at a fence."
Mark Parsons, Senior Conservation Officer, QPWS

"Every type of country is different, we know our country because we've been here long enough and where to burn and where not to burn. Someone else on the property next door will know more about their own just because of the type of country they're in."
Anne Raymond, Kimba Station

Key points:

- **Burn** when trees are actively growing, so vulnerable to fire, and grasses will grow back strong (at storm-time or in the early dry season).
- **Spell paddocks** before a burn if there is not enough grassy fuel load, and protect grass from unplanned fires.
- **As far as possible exclude cattle grazing** after a burn to ensure grasses grow back strongly and out-compete regenerating suckers. Exclude cattle until well into the dry season.
- **Monitor** to check whether the fire has been effective and how soon **follow-up burns** are required.

Figure 19. Burning at Maitland Downs Station. *(John Ahlers)*

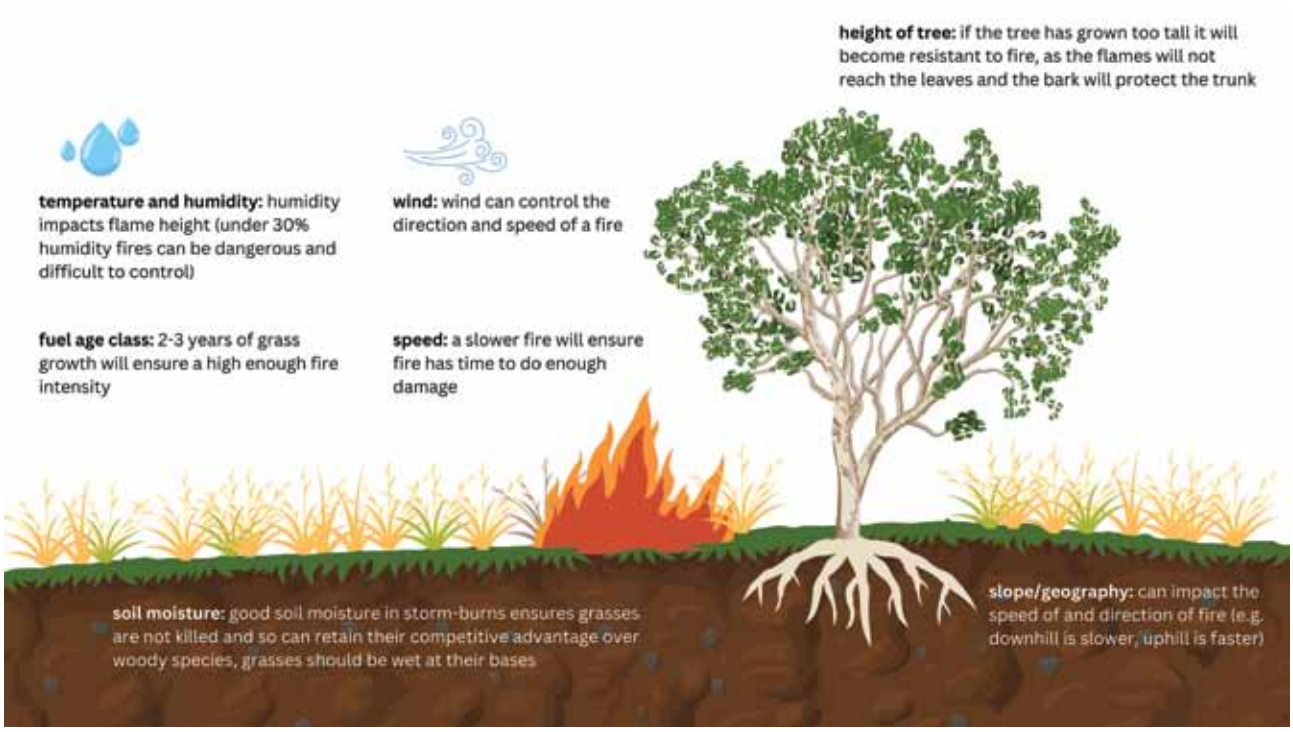


Figure 20. Fire parameters and conditions when managing woody thickening. *(Cape York NRM)*

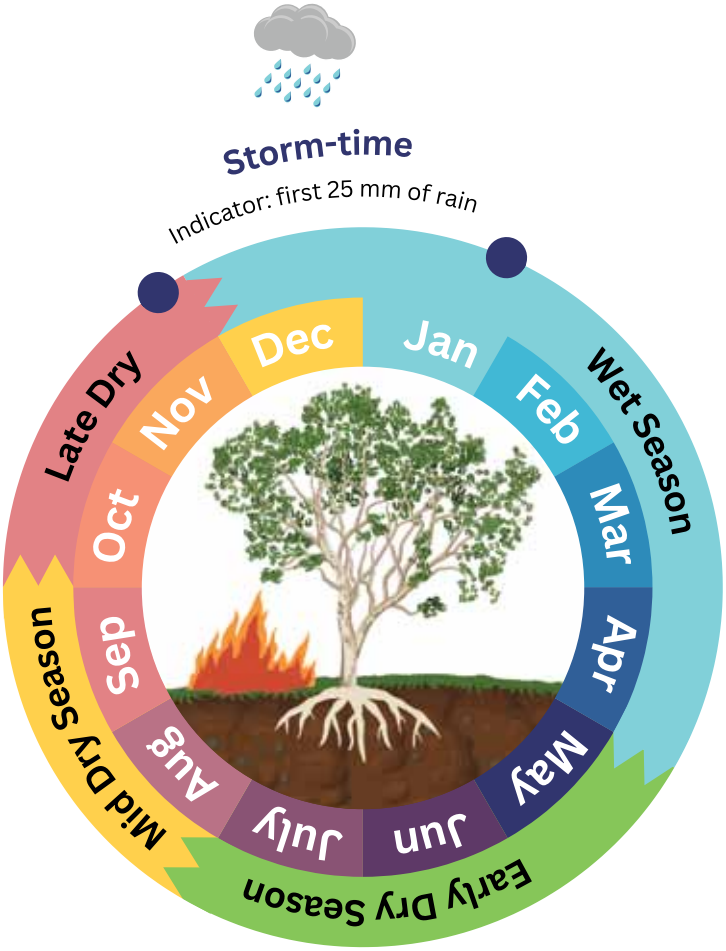
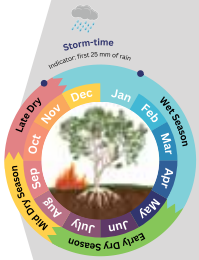


Figure 21. Seasonal fire calendar cycle for managing woody thickening. *(Cape York NRM)*



Storm-time	**Can burn** to manage woody thickening after the first storm (storm-burning) if you have fuel load and can ensure the fires will not get out of control because there are adequate fire breaks. **Cattle managers:** exclude cattle from areas that have been storm-burnt until the grasses recover. **Carbon managers:** can burn to manage woody thickening in ineligible vegetation (including grasslands and tea tree woodlands). You can also burn in eligible vegetation if the first storms are after 1st January, or if storm-burning is part of your fire management plan.
Wet Season	**Don't burn** to manage woody thickening in the middle of the wet season as this will kill the grasses, expose the soil and cause erosion. **Prepare** for early dry season burns. Ensure there are fire breaks around the areas you intend to burn. **Cattle managers:** exclude cattle from areas that are designated for early dry season burning to ensure an effective fuel load, and that the grasses are healthy enough to regrow well after the fire.
Early Dry Season	**Can burn** to manage woody thickening if you have enough grassy fuel load for an effective burn. Create a patchwork of fire scars leaving isolated patches for storm-burning. **Cattle managers:** exclude cattle after early dry season burns so as not to weaken the palatable grasses and promote woody thickening. Also exclude cattle from areas designated for storm-burning. **Carbon managers:** undertake early dry season burning to manage woody thickening at the same time as savanna burning in eligible woodland.
Mid Dry Season	**Don't burn** for woody thickening as fires will be ineffective at damaging woody plants as they are not actively growing, and fires may be difficult to contain. **Cattle managers:** can graze on areas burnt in the early dry season as dormant grasses will be insensitive to grazing, but exclude cattle from areas that you plan to storm-burn to ensure there will be adequate fuel for an effective fire.
Late Dry Season	**Don't burn** for woody thickening as fires will be ineffective at damaging woody plants as they are not actively growing, and fires may be difficult to contain. **Manage wildfires** using back-burns if necessary. **Prepare** for storm-burning. Ensure there are fire breaks around the areas you intend to burn. **Cattle managers:** can graze on areas burnt in the early dry season as dormant grasses will be insensitive to grazing, but exclude cattle from areas that you plan to storm-burn to ensure there will be adequate fuel for an effective fire.

Figure 22. Seasonal fire calendar table for managing woody thickening. *(Cape York NRM).*
Note: the above is a guide only - each year is different, and seasons can change timing against the calendar year from one year to the next, so be sure to burn according to conditions, seasons, fuel load and vegetation type. For more detailed guidance, refer to Planned Burn Guidelines: Cape York Peninsula Bioregion of Queensland in the Resources section.

Early dry season burns

For a long time, it was thought that early dry season fires caused woody thickening. Many now believe that this is only the case when cattle are allowed to graze the 'green pick'. Research has shown that early dry season fires can be effective at top-killing suckers – as long as the plants are still actively growing. However, areas that are grazed along with early dry season fires experience more grassland loss. So, the challenge is to not combine early dry season burning with grazing.

There are two reasons why grazing combined with early dry season fires are a problem for managing woody thickening:

- **Fuel load:** grazing before an early dry season fire reduces grass cover, making it hard to get an effective fire, or any fire at all
- **Weakens grass competition:** cattle like to graze the 'green pick' of new grass growth after fire, which weakens the grasses, which are needed to suppress sucker growth and to provide fuel for further fires.

For early dry season fires to be effective at managing woody thickening, grasslands or paddocks should be spelled through the preceding wet season to ensure there is enough grassy fuel to produce fires hot enough to top-kill suckers and saplings (see seasonal fire calendars in Figure 21 and 22). Paddocks and grasslands should remain spelled until the mid-dry season so that grasses can regrow in the following wet season and suppress resprouting suckers, without being weakened by grazing cattle or other animals.

> ***"What is needed to manage woody thickening for us is to get rid of the cattle, and let the grass all grow. I think the perennial grasses would come back… So if you could spell a paddock properly with nothing in it and let the grass grow. But it'd have to grow for a couple of years and then you burn it."***
> Susan Shephard, Artemis Station

Storm-burning

Storm-burning is the process of lighting fires within 2 to 3 days of the first fall of at least 25 mm of rain, after woody plants break their dormancy and become vulnerable to fire. Fire can also naturally occur at this time from lightning during the storm season (generally between late November and January) and is important ecologically for stimulating the growth of a diversity of ground layer plants, many of which are important for the survival of seed-eating birds. Storm-burning is different to wet season burning.

Storm-burns are generally done over small areas but can be difficult to achieve. They require careful preparation and leave little time for mobilising people and resources once the first rains begin. They must be lit within a short time frame after there has been enough rain to stimulate growth in the woody plants, but not so much as to prevent fire altogether. The effectiveness of burning in this window is highly dictated by weather and on-ground conditions. If rain has not been widespread, there is a risk that fires will get out of control. If rain has continued for too long, then there is a risk that fire will damage the grasses that are important for stabilising the soils, and providing food and habitat for native species, as well as fuel for future fires.

Storm-burning has been undertaken by First Nations people for thousands of years. It is part of traditional land management undertaken by the Lama Lama People on Cape York Peninsula to keep Country open:

You gotta know when to burn the country
The best time is after first storm
You only burn a little patch
You don't make a big fire
You burn them dry grass rubbish.

The cattlemen they burn too hot, but too many suckers come up after that
They don't burn Aboriginal way
You gotta know the right time to burn
You gotta know the right time to do the burn
You gotta know how strong to make the fire
Hot enough to kill them sucker, but not too hot
You might burn up the whole country.
(Bassani et al. 2006, p 30)

> ***"I've seen most of the birdlife has come back on the open plains with woody thickening on it after doing storm burns, it brings all the birds back out on the plains."***
> Michael Ross, Traditional Owner at Kalpowar Station, Laura Rangers

Timing and conditions

Timing of storm-burns is key for maintaining a healthy ground cover. If they are lit too late or after too much rain, they may destroy the germinating grass seedlings and leave the ground scalded for the remainder of the year. Burning more than a couple of days after the first storm is not advisable, as it weakens perennial grasses, and some may never recover.

Falls of about 25 mm of rain are needed to ensure sugars have begun moving from the underground roots and lignotubers to the stems and leaves, and a moist fuel layer to keep fires from spreading too far. This needs to be followed up by a couple of dry, sunny days to ensure a fire can take hold.

Conditions suitable for storm-burning generally occur between November and January, but may occur any time from about late October through to early February. In some years, the first rain will be less than the amount required, and in around one-third of years, will be too heavy making storm-burning impossible. Even when conditions for lighting storm-burns occur, conditions for containing them to the target areas may not.

Once the rain stops, and the grass is dry enough to burn, there is the risk of burning well beyond the target areas unless effective breaks have been established. Even when all conditions are right, because storm-burns require close supervision, it may be physically impossible to attend more than a couple of burns before the right conditions have passed.

Soil moisture is important - grasses should be wet at their bases, so not get burnt to the ground, allowing them to compete with woody species after the fire. If undertaken properly, storm-burning should expose as little ground as possible to avoid causing erosion.

Protecting annual grasses by correct timing of storm-burning: Annual grasses are more sensitive to fire directly after the first rains, in comparison to perennial grasses, because their seed bank germinates once it starts raining. Where annual fire grass is the main grass cover, it is probably safe to burn after 25 mm of rain, as only a small percentage of its seed will have germinated, but dangerous to burn after 50 mm, as almost all of the viable seed will have germinated.

Protecting perennial grasses during storm-burning: In comparison to annual grasses, perennial grasses are less sensitive to fires that are lit directly after the first rains. Although resprouting of cockatoo grass is stimulated by as little as 40 mm of rain, it is still tolerant of fire at this stage because most of its sugars are still stored below ground. As the wet season progresses perennial grasses become more vulnerable to fire, so burning more than a couple of days after the first storm is not advisable, as it weakens perennial grasses and some may never recover. Keep in mind that while burning later in the wet season might help to shift the dominance from annual to perennial grasses, it is more likely to eliminate both and so cause soil scalding and erosion.

"To get good results, you have to know the type of country, your grasses and soil types. Some soils if you burn early it won't get grass back on it because it's the wrong type of country. You can burn it at the end of year and it'll come back really good, because it's got that rain to follow up and reactivate the seeds. Different soil types need different burning regimes."
Anne Raymond, Kimba Station

"Storm-burns and lightning fires control woody thickening. The Old [Aboriginal] fellas taught me about seasonal calendar burning. They said to never just storm-burn when there is lightning and thunder, as there needs to be soil moisture underground up to the length of your middle finger first [9-10 cm, 3.5-4 inch]."
Barry Lyon, Cape York Ecologist and former Ranger

"We usually wait until it's close to the next storms before we burn so the cattle can forage in the old grass for green shoot as it holds in the moisture better. Burn too soon and the fresh green shoot of grass on the burnt ground could scour the cattle and they will die.

We like to have at least 5-7 inches of rain on our country before we storm-burn because it puts water in the gullies and creeks to help act as natural fire breaks. Then we can get good clean burns in, and that stops the woody thickening trees coming back. The cattle will also come to that area, graze it a bit, keep it down a bit low, and then we've got a good break for the following year as well."
John and Tanya Ahlers, Maitland Downs Station

Intensity

Storm-burns should not be of high intensity. They should be hot enough to damage the rising sap in suckers and saplings, but do not need to scorch the canopy or turn whole trees to cinders (see Fire parameters and conditions in Figure 20). They should also leave the bases of perennial grasses undamaged so that they can resprout again as soon as the fire passes. Burning when the soil is still moist will help prevent fires getting too hot.

Preparation, burn patterns and containment

Storm-burning requires much preparation throughout the year, including isolating areas that are designated for storm-burning to prevent them being burnt out prematurely by late dry season wildfires. It is only possible to storm-burn in areas that have enough grassy fuel load and that have not already been burnt in the most recent dry season. A field inspection should be done prior to storm season to determine which areas to burn, ideally recording observations through monitoring or surveys. Isolating the areas to be storm-burnt is essential to ensure that the storm-burns do not spread beyond the target areas. First Nations people would achieve this by lighting a networked-mosaic of burns throughout the year, with each fire forming a break that prevents the spread of subsequent fires. However, this type of burning requires many people being on Country all the time, and may mean burning more pasture than is desirable on a cattle station. Instead, on cattle stations it is more common to protect the areas that are designated for storm-burning by burning or grading fire breaks around them in the early dry season.

Frequency

As with any management for woody thickening, storm-burning isn't a once-off solution. Storm-burns (or early dry season fires) may be required every 2 to 3 years to keep an open grassy structure.

"Some of the prescriptions for the [Queensland Herbarium] Regional Ecosystem planned burn guidelines say if you're doing 1-2 early mosaic burns every 2-3 cycles, then maybe one cycle you can do a storm-burn and then return to early season burns, and that mixes things up."
Ben Jones, Ecologist and Fire Scientist, Ecologistics

"[I recommend] they put a 5 or 10 year program in where they storm-burn - sometimes it starts in November, sometimes it starts in December, you can't put a date on it. Poisoning is out because it's too thick now, so they'd have to go back to a 10 year program with storm-burns. I honestly think it's the most cost effective - that and grass seed, put some of your natural grasses back out."
Bret (Magoo) Little, Helicopter Pilot

Figure 23. Storm-burns should be of low to moderate intensity, trickle though moist grass, and not damage the bases of perennial grasses. *(Gabriel Crowley)*

Challenges of storm-burning

Storm-burning is a difficult activity to do well, and often people will not have the confidence or resources to do it in the way they want to. Challenges of storm-burning include:

- getting the **timing and weather conditions** right (enough rain and moisture but not too much, favourable wind, temperature, humidity etc)
- **destocking** to ensure enough grassy fuel load for a moderate intensity fire
- **acting quickly** to coordinate burns and mobilising resources within days once the rains begin and completing it within the short period of suitable conditions
- getting **permits** from Queensland Fire and Emergency Services
- getting **access to country** that needs to be burnt, especially if rivers have come up or the ground is boggy
- getting **support** (people on the ground) to undertake the burning – such as from staff, neighbours, community members or firefighters
- getting **resources** required, especially for smaller property owners and Indigenous land managers (e.g. any equipment)
- **training** people up who are undertaking the burning, and planning where to burn
- **keeping cattle off** the resprouting grasses until the mid-late wet season
- **preventing unwanted fires** by keeping wildfires out of the designated storm-burn area
- **managing storm-burns** if it gets out of hand in the absence of follow-up rain
- **understanding** how storm-burning affects carbon farming projects.

"The bad part about fire management is trying to manage outsiders starting unauthorised burns... and staff not having the right qualifications."
Mikayla Down, Lama Lama person

"We have a very similar challenge [to pastoralists] with trying to set aside those pockets of woody thickening that we're targeting, by securing with early season burning so that we can come in later in the year and specifically target those for storm-burns. But the challenge there is if we get a wildfire or something that leaks through, it undoes all the work that you've put in to trying to set that area aside."
Mark Parsons, Senior Conservation Officer, QPWS

"We need a program to support storm-burning - you're not going to achieve it just expecting properties to do it on their own... I think everyone wants to do storm-burning but it's very difficult to achieve, because we don't have the resources set up to support people to do it. There's a lot of support around doing early burning, but not so much around storm-burns, and storm-burns are incredibly difficult to do well."
Daryl Killin, Carbon and Fire Consultant

"An improperly executed storm burn can lead to catastrophic consequences. Experienced fire practitioners must thoroughly plan and understand the techniques involved to successfully carry out a storm burn."
Jason Carroll, South Cape York Catchments / Cooktown District Rural Fire Service

INTENSIVE MANAGEMENT OF WOODY THICKENING

Once woody thickening is advanced to the point of large diameter and tall stems, or a closed canopy that shades out the grass layer, mechanical clearance is typically the only option.

It is most effective to cut stems using chainsaws or clearing saws as close to the ground as possible, with immediate herbicide application. With limited soil disturbance, this cut-stump method minimises erosion risk and so has the least adverse impacts on soil health and biodiversity (see *Artemis Case Study,* Page 38).

A proportion of cut stems will resprout and seedlings will establish, and these need to be treated, or else rapid re-thickening will occur. Spelling or light grazing will allow grassy fuels to accumulate for subsequent burning. This leads to some resprout mortality, or razes thin stems to ground layer, where they are outcompeted by a vigorous grass layer. Foliar herbicide application to kill resprouts is typically required even with burning. Follow-up treatment should be done annually and ongoing, especially if the area is grazed.

Broad-leaf specific residual herbicides, such as tebuthiuron, should be used with caution because it's easy to over-apply and inadvertently kill grasses. The issue occurs when there is concentrated application in small patches, even when the total application over a hectare is accurate. Being residual, this effect can persist for many years. Pellets can be applied using backpack blowers or UTV mounted spreading equipment if access permits. Careful calibration of delivery equipment is required, and it is best to consult with a herbicide extension officer for advice. It is important to note that tebuthiuron kills all broad-leaved plants out to approximately twice their height. Larger trees are often more susceptible because of their more extensive root system. For these reasons, tebuthiuron cannot be used in settings where the objective is thinning, but it can be used, with caution, where the objective is the removal of all stems.

Chaining or dozing are not recommended, as these will cause too much environmental damage, so should be avoided on the highly erodible soils found on the floodplains of Cape York Peninsula. Also, clearing without simultaneous herbicide application is likely to lead to rampant and potentially unmanageable regrowth. The above-ground foliage regrowth from an un-sprayed plant typically does not provide enough surface area for foliar herbicides to kill the underground parts of the plant (which are proportionally larger). The opportunity for herbicide application is when the main, larger stem is first cut, with a dose of triclopyr, picloram and diesel. If this doesn't kill the plant entirely, it will cause enough tissue mortality in the underground structures so that the remaining live tissue can be killed by subsequent spraying through the re-sprouted foliage.

"It's a waste of time clearing because you only had 10 trees before, you clear it, now you've got 1,000 trees."
John Ahlers, Maitland Downs Station

Benefits	Disadvantages
• Has been shown to have environmental benefits on Artemis (see Artemis Case Study) • Is effective for advanced woody thickening	• Difficult to achieve at scale • Expensive • Time consuming • May leave herbicide residue (depending on chemical and application rate) • Results in large piles of timber that need burning or moving to enable access

Table 5. Benefits and disadvantages of intensive management of woody thickening.

Figure 24. Grassland restoration over a 7-month period at a site on Artemis Station. Treatment was cut-stump and immediate application of Access herbicide followed by burning. Notably, most fallen timber remained on the ground after the high intensity October fire. *(Patrick Webster/Conservation Partners)*

Initial treatment:	
	1. Sever stems using clearing saws or chainsaws (1 hectare site typically takes 15 hours to clear to zero stems)
	2. Stumps sprayed immediately with 240 g/L triclopyr + 120 g/L picloram (e.g. Access) mixed with diesel according to product label
	3. Consider how to manage felled timber such as dragging into piles for burning, or burning in situ (which may require several fires)
	4. Monitor to check what type of follow-up treatment is required:
Follow-up treatment (for regrowth):	
	5. a) Storm-burning (if enough grassy fuel load) using temporary destocking or conservative grazing prior to promote fuel load for intense enough fire; otherwise (or in conjunction with):
	6. b) Spray new suckers/seedlings with high concentration-low volume foliar herbicide application using 300 g/L triclopyr + 100 g/L picloram + 8 g/L aminopyralid (e.g. Grazon Extra), or 300 g/L triclopyr + 100 g/L picloram (e.g. Conqueror) mixed with water according to product label

Figure 25. Intensive management to control woody thickening used on Artemis Station.

Figure 26. Herbicide treatment of woody trees was part of attempts to restore grasslands and woodlands at Artemis Station. *(Steve Murphy)*

ARTEMIS CASE STUDY:
Example of a long-term woody thickening management and monitoring program

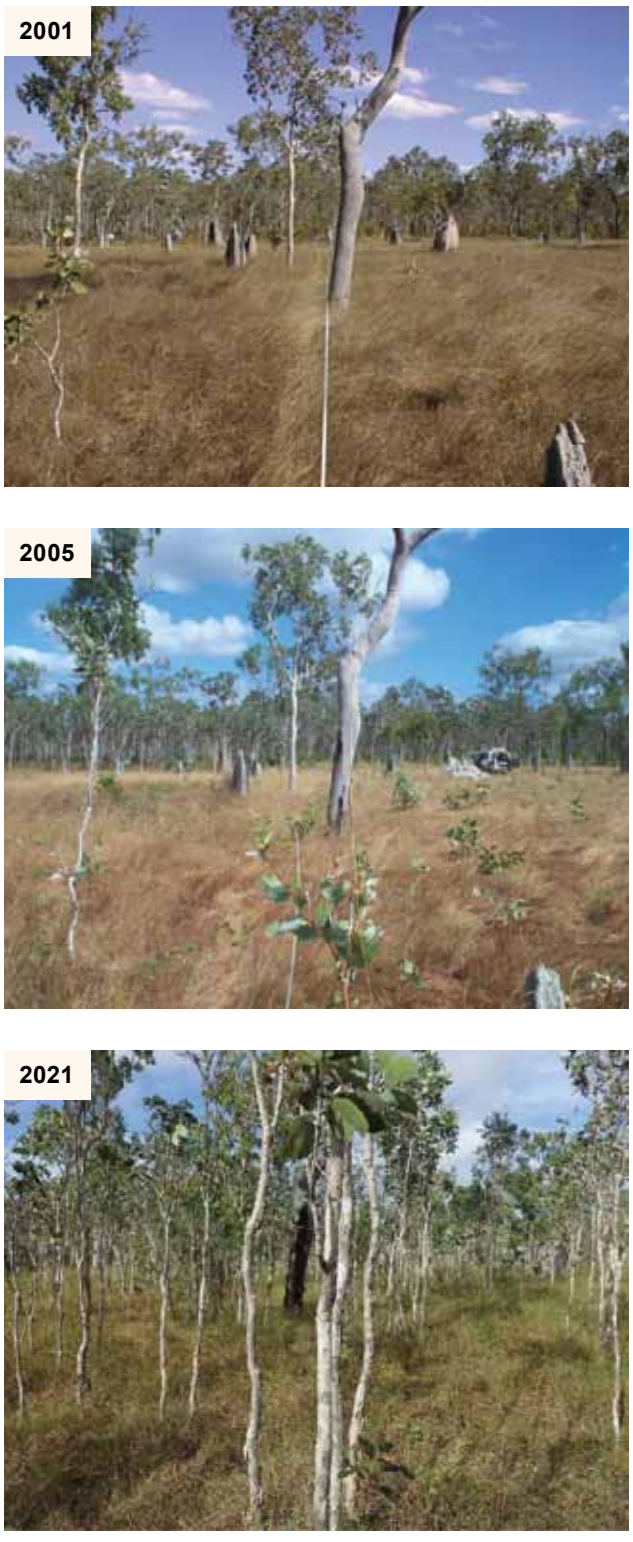


Figure 27. Broad-leaved tea-tree encroachment on a grassland on Artemis Station. *(Gabriel Crowley - 2001 & 2005; Steve Murphy - 2021).*

At Artemis cattle station on Cape York Peninsula, woody thickening is threatening the habitat of the endangered golden-shouldered parrot. The golden-shouldered parrot not only has ecological value, but is significant to traditional owners on the peninsula. There are benefits to local tourism with several commercial tour groups visiting Artemis each year, with flow-on economic benefits for roadhouses and other services on Cape York Peninsula. Globally, many people value golden-shouldered parrots intrinsically for their beauty and other unique traits.

Artemis is a 125,000 hectare cattle property midway between Coen and Laura. The property has been in the Shephard family for 4 generations and is run by Tom and Sue Shephard. It currently has 3,500 head of cattle, a carbon farming project, and an active program to save golden-shouldered parrots through managing woody thickening.

Woody thickening has invaded the open grassland and woodland habitats of the golden-shouldered parrot, reducing the number of termite mounds for nesting and bringing with it predators such as goannas, butcherbirds, snakes and feral cats. These predators take both adults and chicks, and are more effective hunters in woody vegetation than in grassland. In 2019, the estimated population of the golden-shouldered parrot on Artemis dropped to about 50 birds, including only about 15 adult pairs. Detailed monitoring has been conducted since the late 1990s and storm-burning to return invaded areas back to grasslands / open woodlands occurred in 1997-2001. Habitat restoration resumed in 2021, first experimenting with different methods on small sites to test effectiveness of different methods, and then scaling up to larger areas.

Figure 28. Woody thickening management and monitoring at Artemis Station is gradually restoring the habitat of the endangered golden-shouldered parrot, seeing their numbers increase. *(Conservation Partners)*

Loss of grasslands and open woodlands

Grasslands and open woodlands are the main habitat for the golden-shouldered parrot and grass seeds are their main food. The seed of annual fire grass is abundant through the dry season.

> ***"The golden-shouldered parrots love fire. They love it because the grass has all burned, and the seeds just left behind, the seed doesn't burn in the early fire - well some of it does, but most of it's left on the ground so they can feed on the ground."***
> Susan Shephard, Artemis Station

However, the key food that they need for surviving through the wet season is cockatoo grass. It is reduced by cattle grazing and wet season burning, but seed production can be improved by storm-burning. Under the right fire and light or no grazing, it will flourish through the wet season and produce abundant seeds for the parrots to eat.

Woody thickening is threatening the parrot's nesting and wet season feeding habitats. Analysis of aerial photographs showed that 10% of grassland on Artemis Station had been lost to woody encroachment in the 20 years between 1969 and 1988. Monitoring plots established in the late 1990s and early 2000s show an ongoing encroachment by broad-leaved tea-tree into golden-shouldered parrot habitat.

> ***"Sometimes in a little foot square plot measuring you could have 1,000 tea-trees come up if you count them. Just little trees anyway. They don't all live, only 1 or 2 will live, but they're there all the time, they're ready to go."***
> Susan Shephard, Artemis Station

Work to restore grasslands and woodlands

Work began to use storm-burning to restore grasslands and woodlands on Artemis Station in the late 1990s, and monitoring plots were established for assessing these efforts.

> Over a three-year period, storm-burning initially maintained an open vegetation structure by substantially reducing recruitment of broad-leaved tea-tree suckers to the sapling layer, and reducing the abundance of all invasive woody species in the top-kill zone.

Monitoring showed that a mass tea-tree germination event occurred on Artemis in the 2000-2001 wet season, which was a particularly wet year (124% average annual rainfall) and involved 7 consecutive months with more than 20 mm of rain. However, given the right fire and grazing regimes, the resultant seedlings should have been killed before they could establish as suckers in the grass layer.

Figure 29. Early-stage woody thickening on Artemis Station in 1999 (top) and in 2001 after two storm-burns (bottom). *(Gabriel Crowley)*

Soon after, storm-burning efforts decreased and woody encroachment on grasslands and woodlands returned to the detriment of the golden-shouldered parrot. Monitoring of 14 sites in 2021 showed a fivefold increase in woody plants less than 3 m high, and a fourfold increase in the number of taller plants in just 20 years. In some sites, the increase has been much greater - at one site the number of trees taller than 3 m increased from 3 to 70.

The increase in woody plants occurred because the grass layer was suppressed due to interactions between grazing and fire. The interaction was especially powerful during the dry season when soil moisture is lowest. The parrot's habitat on Artemis was burnt no more than 3 times in 21 years, if at all. Further south, where the parrot's population remained healthy, fires continued to occur every second or third year.

So, in 2021, work to restore their habitat resumed. This has involved combinations of mechanical removal of woody plants, herbicide treatment, grazing management and storm-burning. Ongoing studies show that mechanical stem removal is necessary for advanced thickening. The best methods depend on the setting, but on Artemis – where soils are erodible and the protection of termite mounds is important – stem removal to ground level with clearing saws and chainsaws has been most effective. Every cut stump was sprayed with 240 g/L triclopyr + 120 g/L picloram and diesel. The typical site took about 15 hours to clear 1 hectare to zero stems.

Dealing with the fallen timber has been a significant issue for subsequent access. Dragging it into piles has been the most effective, but is labour intensive and only suited to relatively small areas. Pushing up debris with machinery has also been trialled on Artemis over larger areas with some success. The initial treatment was always followed by some level of re-shooting and new seedling establishment. Where fuel loads could be maintained by wet-season spelling, regrowth was managed with fire. Otherwise, high concentration-low volume foliar herbicide application using 300 g/L triclopyr + 100 g/L picloram + 8 g/L aminopyralid was required. Even then, results have been better where conservative grazing allowed fuels to accumulate to produce hot fires.

Experiments were undertaken during the process, including using blow torches to see how hot a fire would need to be to kill trees with lignotubers:

"I think we carried a gas bottle around and I don't know how many tea trees for nearly 12 months and burnt them with unreal heat from a blow torch and I think one died accidentally. They all shoot up from the root somewhere else."
Sue Shephard, Artemis Station

Impact of grassland and woodland restoration on biodiversity

As of 2024, approximately 60 hectares of golden-shouldered parrot habitat has been treated with one or more restoration methods. This comprised multiple distinct areas, chosen because they contained critical nesting or feeding habitats. Most of this was done in 2022 and 2023, so it's early days in terms of the recovery of those ecosystems, but there are already encouraging results.

First, to assess how parrot predators respond to restoration, the Artemis team fitted small GPS trackers to Black-backed Butcherbirds and found that they did not enter the treated areas. This showed that predation pressure reduced in the open habitats created once woody thickening is reversed. Secondly, parrot nests were more likely to succeed where the surrounding vegetation was removed. This is because parrots have more time to see predators coming and take evasive actions. Thirdly, perennial native grasses (such as cockatoo grass) have made a significant come-back in a large area on Artemis that has been destocked since 2019 and was storm-burnt in 2022. In addition to grass recovery, a small ground dwelling bird called the painted button-quail is also now far more common in this area.

To find out more, go to:

- Conservation partners website on Saving Golden-shouldered Parrots
- Managing vegetation thickening in the Cape York Peninsula Bioregion: Lessons from Artemis Station

"Restoring the open structure of country takes time and effort, but we've shown it can be done. One of the main things we learned is that managing grazing pressure after initial treatment is important, because it tends to dictate how much follow-up work is needed to control regrowth."
Steve Murphy, Ecologist, Conservation Partners

Figure 30. Mechanical removal of woody trees was part of attempts to restore grasslands and woodlands at Artemis Station. *(Steve Murphy)*

WOODY THICKENING AND CARBON FARMING

What is carbon farming in the context of Cape York Peninsula?

Carbon farming involves managing the land to increase carbon storage in the vegetation and soil and reduce the emission of the potent greenhouse gases nitrous oxide and methane. There are currently two main ways that land managers can achieve this – through emissions reduction (also called 'abatement' or 'avoidance') or sequestration (the removal of atmospheric carbon, also called 'carbon capture and storage'). See below for the different carbon farming methods in Australia that provide details on the different approaches. In 2023, carbon farming projects in the Cape York NRM region covered an area of 68,000 km2, or approximately one-half of the land area of the region. At the time of writing, the only carbon-farming method used in the region is Savanna Burning. The proposed Integrated Farm Land Management may also apply to the region.

The **Savanna Burning method** was the first government-regulated carbon farming framework in Australia, and began in 2012. The first projects in Cape York Peninsula followed in 2013. Savanna Burning methods involve accounting for either emission reduction alone, or both emission reduction and carbon storage in woody biomass (sequestration). However, currently only 3 of the 36 projects in the Cape York NRM region include sequestration.

Each project has a designated project area in which vegetation types eligible for carbon accounting are mapped by a qualified botanist. Both emission reduction and sequestration involve using a strategic early dry season burning regime to reduce the extent of late dry season wildfires in eligible vegetation types. Because the fuel still has some moisture in it in the early dry season – and the weather is relatively cool – fires at this time of the year are more patchy and less intense than those of the late dry season, hence, they emit less greenhouse gas.

The use of patchwork or mosaic burning reduces fuel loads and creates a network of burnt fire breaks in the landscape, reducing the spread of later wildfires. Greenhouse gas abatement (reduction) and associated income is determined by comparing fire extent and annual emissions with a baseline period (the 10 years prior to the project) using vegetation and fire maps.

> The information in all other sections of this guide applies only to the Savanna Burning method that was current at the beginning of 2024. This method is being revised, and a new version is expected to be released in 2024. It is not clear whether existing projects will have to transfer to the new method. Any changes to the methods may include a requirement to update the vegetation map, and could have different implications for managing woody thickening than are described in this guide.

Human-induced Regeneration (HIR) is a revoked method that allowed vegetation to regain forest cover and recover from disturbance by removing or moderating grazing and other forms of disturbance. This included an undertaking 'to permanently cease the mechanical or chemical destruction, or suppression, of regrowth'. At the time of writing, there were no HIR projects within the Cape York NRM region. As it was revoked on 1 October 2023, no new HIR projects can be undertaken on Cape York Peninsula for the foreseeable future. However, the proposed ILFM method may include elements of the HIR method. If so, management of woody thickening would conflict with IFLM's project obligations.

Integrated Farm Land Management (IFLM) is a newly proposed 'umbrella' method being developed that combines the activities of several existing soil and vegetation sequestration methods, including the revoked HIR method, into a single method. It will probably work alongside the Savanna Burning method, and should facilitate the adoption of multiple carbon abatement methods across a single property. It aims to reduce participation costs, streamline reporting, and reduce the administration and auditing requirements. If IFLM incorporates the sequestration requirements of the revoked HIR method, it may prohibit management of woody thickening, as it operates at a property scale.

The IFLM method is also proposed to include a new approach to estimating carbon storage in woody biomass and soil to avoid over-estimation. This is likely to have implications for managing woody thickening. Unlike Savanna Burning, the method will apply to the whole property, so it will not be possible to exclude grasslands and tea-tree woodlands. This means that management of woody thickening will affect carbon credits. By June 2024, it is expected that a decision will be made about whether the proposed IFLM method will go ahead.

For more information, go to Proposed Integrated Farm and Land Management method - Issues Paper by Department of Climate Change, Energy, the Environment and Water (2023) www.dcceew.gov.au/climate-change/publications/proposed-integrated-farm-and-land-management-method-issues-paper

Figure 31. Aerial prescribed burning. *(Cape York NRM)*

Managing woody thickening alongside carbon farming

Many landholders are confused about whether they can manage woody thickening if they have a Savanna Burning project. As long as grassland and tea-tree woodlands have been mapped as ineligible vegetation, it should be okay to manage woody thickening in these communities, as they will not be considered in carbon accounting. The people who developed this method recognised the need to keep these communities open. Just remember that vegetation communities can change over time which can affect how they are categorised, so it is worth keeping maps up to date.

This means that having a Savanna Burning project generally does not prevent fire or other means from being used to control woody thickening in grasslands and tea-tree woodlands at any time of the year, including at storm-time. So, managing woody thickening in these communities should not result in lost carbon credits.

> Grasslands and tea-tree woodlands are excluded from eligible vegetation communities in Savanna Burning Method carbon accounting as it is recognised that these communities should naturally remain open. Storm-burns and intensive management can be used to manage woody thickening in grasslands and tea-tree woodlands without impacting carbon credits, so long as fires do not escape into eligible vegetation types. Check your carbon project's eligible vegetation fuel type map closely.

It is a different story for the eligible vegetation types, which include eucalypt forest and woodland, and heath. Any fires in these communities are considered in the emission accounting, and so will influence the calculation of carbon credits. Storm-burns lit in early January will be counted as early dry season fires, and so will contribute to the obligation to burn strategically in the early dry season. They should have little impact on carbon credits, especially if they are targeted to small areas as is recommended in this guide.

However, storm-burns lit towards the end of the year will be classified as late dry season fires, and therefore they will be counted as producing high levels of emissions. This will affect carbon credits, especially if they spread out of control.

It should not be necessary to storm-burn eligible vegetation types, as there is currently no scientific evidence that these communities are thickening. However, if you do believe that storm-burning is necessary, then it may be possible to include this in your annual fire management plan. You will still be penalised for the emissions, but there is nothing in the method that prevents strategic use of late dry season fires. The main thing to remember is that any fires that cover large areas will probably cause a large loss of credits, whichever season the fires occur in.

The early dry season burning required in Savanna Burning projects should help prevent woody thickening, except where cattle cannot be excluded.

The timing restrictions of carbon projects can be challenging to manage land properly:

"That's what that bloke said to us… 'Sometimes you just have to sacrifice your credits to manage your property.'"
John Ahlers, Maitland Downs Station

"With carbon projects, people are really reluctant to burn outside of their window, but in certain years you can have a [storm-burn] window in January so you'll still be within your carbon project timelines and not impact your carbon credits too much... Also, you can burn outside your 1st August deadline - you can burn into September - as long as you contain it and it's not going to continue to burn... and in some years you'll probably need to burn later in September. But how do you contain that to small areas? That's very hard to do, particularly if you're a landowner with a small carbon project as you're not going to have a lot of money to reinvest in fire management."
Ben Jones, Ecologist and Fire Scientist, Ecologistics

"Carbon projects should be redesigned to allow storm-burns, as the lack of storm-burns being lit are having an impact on biodiversity on the Cape. The idea that you can't burn after 31 July is not how nature works. Old people won't burn after July until the storms start.

The older generation of cattlemen storm-burn - through first storms, lightning - it's Mother Nature, that's the way it's supposed to happen. Now with carbon credits you burn early, and if you burn late then they think they'll lose their carbon credits. But if they late burn / storm-burn, it helps with the weeds, timber, woody thickening, all of that."
Barry Lyon, Cape York Ecologist and former Ranger

It's helpful to be aware of what is considered ineligible and eligible vegetation, and discuss your project's needs with your carbon adviser.

Carbon projects often tend to facilitate the growth of biomass, but we want to do that in the right place, not in the wrong places. Many ecosystems – including tea-tree country, grasslands, and closed forests – are ineligible for carbon farming. This is because these are areas where we say early dry season burns have no place… you should use the fire regime that's appropriate for the place."

"When it comes to the grasslands, where we absolutely agree that woody thickening shouldn't happen, we've found that there's been more hesitation in putting healthy hot burns through because of the surrounding carbon projects— no one wants to be responsible for starting a fire that negatively impacts your neighbour's property. We've seen a lot less of those hot burns on grasslands that need them (especially around native species areas, like the golden-shouldered parrot), however, we understand this as an unintended consequence of the carbon project. Landowners can continue to manage those grasslands and seek support in doing so if needed."

Julien Gastaldi, CEO Maki Planet Systems, a subsidiary of Corporate Carbon Group

Figure 32. Grasslands are generally mapped as ineligible vegetation. A fire restrained within such a grassland should therefore not negatively impact carbon credits, at any time of year. *(Cape York NRM)*

FAQS: Frequently Asked Questions

How do I obtain a fire permit?

Any fire lit outdoors in Queensland requires a permit, with few exceptions including smaller fires for cooking or heating. The ***Fire and Emergency Services Act 1990*** is the main legislation that deals with lighting fires in the open.

In rural Queensland, the use of fire is controlled through the volunteer Fire Warden network. An application for a fire permit must be submitted to, and approved by, your local Fire Warden. Your local Fire Warden will grant or reject applications for a permit to light fire, advise on conditions under which fires can be lit, advise on the need for fuel and hazard reduction, and recommend any safety precautions to reduce risk to people, property or the environment.

Steps to apply for a fire permit:

1. **Contact your local council** to see if you can have a fire and if so, do you require written permission from the council.
2. **Contact your neighbours**—the owners/occupiers of the land adjoining the property where you wish to light a fire—and advise them of your intention to apply for a permit.
   - 72 hours notification may be seen as a reasonable amount of time in populated areas, however this timeframe may not be appropriate in rural primary production areas. The timeframe is at the discretion of the Fire Warden.
   - Record the time you contact them on the application form and also note if they have or have not objected.
   - If the neighbours do have an objection, they should contact the local Fire Warden.
   - If you cannot contact the owners/occupiers, note this in the application form.
3. **Complete the application form**, ensuring both sides are completed.
   a. Purpose of the fire: ensure you specify the purpose in this section. This may include hazard reduction, land management, pasture management, weed control or ecological outcomes.
   b. Material to be burnt: it is important to also fill out this section. Note: no toxic or hazardous materials are allowed to be used.
4. **Contact your local Fire Warden** to submit your application.

Important Links:

Fire Bans: Check the Current Fire Bans for any fire restrictions imposed by Queensland Fire and Emergency Services: qfes.qld.gov.au/safety-education/using-fire-outdoors/fire-bans-and-restrictions

Local Fire Warden: To find your local Fire Warden, go to the QFES website and use their interactive map: qfes.qld.gov.au/safety-education/using-fire-outdoors/fire-wardens

How to apply: Download this brochure for information on how to apply for a Permit to Light a Fire: qfes.qld.gov.au/sites/default/files/2022-06/Applying-Light-Fires.pdf

Apply: Download and complete the Application for Permit to Light Fire: qfes.qld.gov.au/sites/default/files/2021-04/CSO_010-FORM.pdf

Check fire permits: To check what fire permits have been obtained in the last 30 days, go to the QFES Permit to Burn map: qfes.qld.gov.au/prepare/bushfire/permit-to-burn-map

For more information on lighting fires in Queensland, go to the QFES website: qfes.qld.gov.au/safety-education/using-fire-outdoors/lighting-fires-in-queensland

Local Governments may have rules or by laws prohibiting the lighting of fires. Check with your local council before lighting any fires.

How do I obtain a vegetation clearing permit for managing woody thickening?

Clearing of native vegetation in Queensland is regulated under the *Vegetation Management Act 1999* (VMA). The Queensland Government provides resources and guidance to assist landholders in undertaking their vegetation management activities in accordance with the VMA. To find out more about vegetation clearing requirements go to www.qld.gov.au (search 'vegetation management') or contact the VEG HUB on 135 VEG (135 834).

In addition to the vegetation management framework, clearing activities may also be regulated under other Queensland Government legislation, Australian Government legislation and local government requirements. Landholders are encouraged to familiarise themselves with the Acts and regulations relevant to their operations, and to seek advice from the relevant agency if required.

FINAL WORDS

This booklet has been produced as a guide for land managers to manage woody thickening on Cape York Peninsula. The tools that are most useful for preventing woody thickening include combinations of spelling or destocking, storm-burning and early dry season burning. Application of these methods will vary from property to property. Where woody thickening is more advanced, more intensive methods of management may be required, including a combination of mechanical removal and herbicide treatment alongside fire. Any interventions to address woody thickening should follow government legislation and any local council requirements around fire, vegetation removal and use of chemicals.

The way land is managed on Cape York Peninsula is constantly changing as new tools are introduced and new research and management initiatives provide insights into better ways to look after land and water. These changes, along with changing legislation, and the ever-changing climatic environment, mean land managers will need to continuously update knowledge and practices.

Get in touch with Cape York NRM for further information and support with land management, including around woody thickening.

"Land managers should have local and cultural knowledge of your own Country, other TO's on the Cape should already know how to burn their part of the country, so I think that's important."
Tyrone Spratt, Traditional Owner, Lama Lama Land Trust Board

"This is not a complex subject, we shouldn't try to make it complex. It comes down to some very simple principles, and there's a way of working in many different directions around management of woody thickening while still following those principles."
Peter Stanton, Landscape and Fire Ecologist, Australian Wildlife Conservancy

"I have seen the change in country - where it has gone from a grazing regime to a natural management regime with fire, and the positive changes you see occurring. It can be done if people are willing to sacrifice a paddock or an area of land. I suppose it comes back to reducing stock numbers and managing it for a combination of fire and grazing and not just one dominating."
Michael Blackman, Fire Craftsman, Friendly Fire Ecological Consultants

RESOURCES AND MORE INFORMATION

Resources

These are some relevant resources in the public domain for more information.

Planned Burn Guidelines: Cape York Peninsula Bioregion of Queensland *QPWS and QDNPRSR* (2013) https://parks.desi.qld.gov.au/__data/assets/pdf_file/0019/151480/pbg-cape-york.pdf	Guidance on fire management by Queensland Parks and Wildlife Service, divided into 9 categories of vegetation communities at a bioregional level.
Fire on Cape York Peninsula *Cape York Peninsula Land Use Strategy, Office of the Co-ordinator General of Queensland, Brisbane, and Department of the Environment, Sport and Territories (1995)* capeyorknrm.com.au/sites/default/files/2020-07/fire_on_cape_york_peninsula.pdf	A Stage 1 report of the Cape York Peninsula Land Use Strategy, which includes impacts of fire on vegetation types and the historic and recent use of fire in land management on Cape York Peninsula.
Vegetation Management Queensland Government qld.gov.au/environment/land/management/vegetation	Learn about native vegetation clearing laws, request property reports, and view vegetation mapping, clearing codes and approvals and guides, and vegetation types (Regional Ecosystem database - VM REDD).
Queensland Globe Queensland Government qldglobe.information.qld.gov.au	Interactive maps that show Regional Ecosystems, property boundaries and more.
North Australia and Rangelands Fire Information (NAFI) firenorth.org.au	Data and interactive maps that show fire management from satellites for northern Australia, such as current fires and historic fire scars. Also available as a phone app.
Forage Queensland Government longpaddock.qld.gov.au/forage/about	Online system that produces property reports based on lot numbers. The reports include climate, pasture, rainfall, fire scars, drought, soils, ground cover and more.
Future Beef futurebeef.com.au/?s=woody+thickening	FutureBeef provides tools, information and advice to the northern Australia beef industry, with blogs and resources on woody thickening.
Saving Golden-shouldered Parrots Conservation Partners conservationpartners.org.au/artemis/golden-shouldered-parrots	Webpage on the work to restore habitat of the golden-shouldered parrot at Artemis Station, including links to videos and monitoring reports.
Managing vegetation thickening in the Cape York Peninsula Bioregion: Lessons from Artemis Station	Report on techniques trialled to manage woody thickening on Artemis Station.

Disclaimer: Cape York NRM does not endorse these resources. Some resources may be useful for some situations but not others, so it's important to do your own research and make your own decisions.

Contacts for more information

Cape York Natural Resource Management

Andrew Drenen, Fire Coordinator
Phone: 0419 148 426
Email: andrew.drenen@capeyorknrm.com.au
Website: capeyorknrm.com.au

Queensland Department of Resources, Vegetation Management Hub

Phone: 135VEG (135 834)
Email: vegetation@resources.qld.gov.au
Website: qld.gov.au/environment/land/management/vegetation

Queensland Department of Environment, Science and Innovation

Protected plants and protected areas
Phone: 1300 130 372
Email: wildlife@des.qld.gov.au
Website: www.desi.qld.gov.au

Queensland Parks & Wildlife Service

Phone: 1300 130 372 (Option 4)
Email: wildlife@des.qld.gov.au
Website: parks.des.qld.gov.au

Contact Queensland Rural Fire Service and your local Fire Warden

Fire Warden finder: qfes.qld.gov.au/safety-education/using-fire-outdoors/fire-wardens
Online inquiry: qfes.qld.gov.au/contact-us/online-enquiry
Phone: 13 QGOV (13 74 68)

Contact your local fire practitioner and local government council

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