

Weed Management Strategy



Contents	Page Number
Introduction	3
Shire of Broome	6
Strategy Boundaries	7
Legislation and Policy - Federal	8
Legislation and Policy - State	10
Legislation and Policy - Local	11
Roles and Responsibilities in Weed Management	12
Impacts of Environmental Weeds	13
Weed Species Introduction and Establishment	18
Importance of Weed Management	20
Environmental Weed Presence in Shire of Broome	23
Weed Control	27
Intergrated Weed Management Approach	28
Implementation	33
Appendices	35

INTRODUCTION

The Shire of Broome (the Shire) Weed Management Strategy provides the framework for best practice weed management within the Shire. The Strategy aims to protect the environment, economy, community and industry from the adverse impacts of weeds. The strategy will guide weed management funding, planning, monitoring and control.

The strategy focuses on the eradication of weeds whilst outlining a Shire wide approach to achieving the following objectives:

- Providing leadership and resourcing to prevent the introduction, spread and establishment of weeds.
- Reviewing, and promoting current best practice methods for ongoing weed control.
- Reviewing responsibilities of stakeholders in weed management.
- Increasing community awareness and education.
- Facilitating community involvement in weed management.

For the purpose of this Strategy a weed is defined as - *A plant that requires some form of action to reduce its harmful effects on the environment, the economy, human health, and amenity. Weeds are commonly plants that grow in natural ecosystems where they are not naturally occurring and proceed to modify natural processes resulting in the decline of the ecosystem they have invaded.*

The Weed Management Strategy follows the recommendations of the Shire's State of the Environment Report (2015) which provides both a strategic and operational response to the topic of "Managing Invasive Species".

The Report lists the strategic response as, *"To develop a comprehensive Weed Management Strategy to guide the Shire's weed management activities on land under care and control."* The operational responses as, *"To review the Shire's project management plan template for engineering works to include consideration of weed management when undertaking specific projects"* and *"Ensure that areas cleared of native vegetation are managed and mulched to prevent soil erosion and the establishment of weeds."* The State of Environment Report further guides our listed priority weed species based on weeds of national significance.

INTRODUCTION

The Shire's Weed Management Strategy will be guided by these weed management principles:

- Weed management is an integral part to all land management and for maintaining sustainability and natural resources.
- Prevention and early intervention are the most cost-effective techniques of weed management.
- Weed management requires a continuous, long-term commitment that must be prioritised.
- Integrated weed management is the key to achieving successful weed management.
- Combating weeds is a shared responsibility that requires clear understanding of roles and responsibility.
- Co-operation amongst government, land and water managers, industry and community is fundamental for effective weed management
- Successful weed management requires co-ordination of all stakeholders to establish and share legislative frameworks, research, funding and educational outcomes.

As weeds are not bound by land tenure, jurisdictional, legal or legislation boundaries, weed management is a shared responsibility between individuals and landholder/ land user organisations.

Local government's role and responsibility for weed management is the provision of information, education, support and coordination of community groups in addressing weed issues, and the implementation of weed controls within managed areas.

However, the actions of the Shire alone will not be the solution to weed management within the Shire of Broome, a collective approach is necessary for the effective long-term control of target species.



INTRODUCTION



The weed infestations evident within the townsite of Broome indicate that immediate action is required. This strategy focuses predominantly on the Broome townsite, but the key principles are relevant to the Shire as a whole. Certain areas have been identified of increasing concern to the Shire, therefore requiring particular attention for the successful management of weeds.

Areas of increasing concern within the Shire of Broome include:

- Remnant Bushland
- Road Reserves outside of townsite boundaries Vacant Crown Land
- Stormwater Drainage Systems
- Private Land that supports significant weed populations

The Weed Management Strategy is particularly designed to provide the framework for the Weed Management Action Plan. The Action Plan will utilise the strategy to outline and annually specify actions and resources required for the implementation of successful weed management within the Shire.

SHIRE OF BROOME

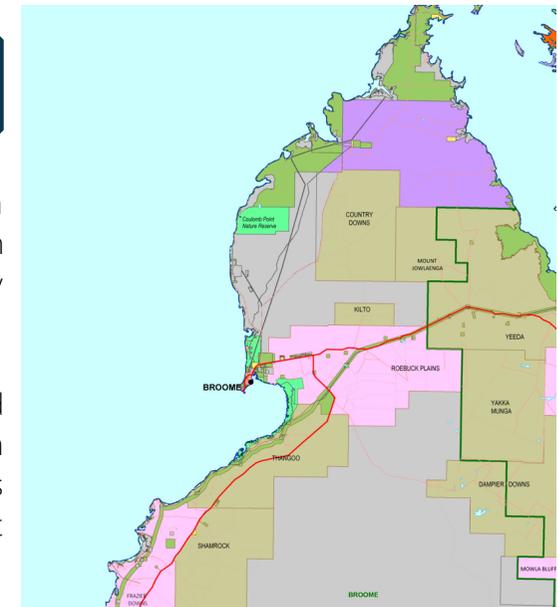
The town of Broome is positioned at the south-west extremity of the Dampier Peninsula, in a transition zone between the inland desert and tropics. Broome has a tropical climate with a distinct “wet” season from November to March, which experiences summer monsoon and tropical cyclones providing heavy rainfall and high humidity.

The “dry” season is from April to October and is typically without rain, lower humidity, cooler nights, and some foggy days. This mix of climatic factors as well as early multicultural development has resulted in an array of exotic tropic plants being introduced for shade, food, and ornamental values. Such species originating in tropics around the world are often devoid of natural control mechanisms and are resilient survivors becoming weeds.

Spatially, Broome’s Peninsula is surrounded and dissected by large areas of both environmentally and culturally significant endemic bushland, experiencing varied levels of urban disturbance. A vast area is foreshore reserve, while green corridors protrude through the town site and peninsula, joining ocean to bay.

The Broome townsite's urban fabric has a unique green infrastructure system that responds to its unique context. The open space includes a network of formalised and informal bush parks, often wide road reserves and a significant large urban drainage system.

The open trapezoidal shaped drains remove the high volumes of overland wet season rainfall to the surrounding bushland reserves, foreshore dunes, tidal creek, and the marine habitats beyond. The urban drainage system provides a significant challenge for weed management as it creates an extensive weed distribution network.



**KIMBERLEY REGION
LAND TENURE**

- Pastoral Lease
- General & Special Lease
- Commonwealth Land
- Pastoral Lease owned by mining company
- Indigenous Reserve
- Pastoral Lease owned by indigenous interests
- Department of Biodiversity Conservation and Attractions Estate
- Vacant Crown Land
- Other Reserves
- Forest
- Freehold
- Agricultural Region
- Shire Boundary
- YALGOO Shire Name
- Highway
- Major Road
- Minor Road
- Track

Figure 1. Land tenure mapping within the Shire of Broome.

STRATEGY BOUNDARIES

This strategy involves all Shire vested land within the boundary shown in *Figure 1*. Weed issues traverse all administrative and land tenure boundaries and as such, effective weed management will require a high degree of coordination and integration between stakeholders.

Increasing public awareness of the causes and appropriate responses to the problems is part of the solution. It is important to identify stakeholder groups and effectively engage with them to optimise responses to weeds across the prevention, eradication, and control spectrums of the strategy.

The success of environmental weed management should be measured by:

- Mapping and monitoring of weed infestations, including emerging invasions and established populations
- Number of weed species present not increasing but being maintained or decreasing.
- New weed species being identified and eliminated quickly
- Number of weed infestations; new infestations are prevented, emerging weed infestations identified and controlled quickly, the reduction in weed density and weed spread; number of species and affected area
- The protection of and active threat abatement for priority environmental and cultural areas
- The degree of community and stakeholder engagement and participation in the process of preventing and controlling weeds.

LEGISLATION & POLICY **FEDERAL**

This section of the strategy outlines various acts and policies from a federal to state level that influence the management of weeds in Broome. **Appendix 1** provides a condensed version of the Context for the hierarchy of roles and responsibilities of weed management from a national to local level.

Environment Protection & Biodiversity Conservation Act (1999)

The Environment Protection and Biodiversity Conservation Act 1999 (the EPBC Act) is the Australian Government's central piece of environmental legislation. It provides a legal framework to protect and manage nationally and internationally important flora, fauna, ecological communities, and heritage places as matters of national environmental significance.

A protected matters search identifies that the following terrestrial areas, flora, fauna and ecosystems are protected under the Act, occurring within the Broome shire area:

- The West Kimberley National Heritage-listed area (Cultural, geological, historical values, ecological values including biological richness) Roebuck Bay, Wetlands of international importance) (Ramsar)
- Nationally important wetlands: Roebuck Bay and Willie Creek wetlands
- Endangered ecosystem: Monsoon vine thickets on the coastal sand dunes of the Dampier Peninsula
- Weeds are identified as a key threat to this ecosystem, particularly as many occurring in the region are highly invasive, smother plants and promote hazard changes to the fire regime. High threat weeds occurring in Broome and noted in the conservation advice as threats include coffee bush (*Leucaena leucocephala*), neem tree (*Azadirachta indica*), siratro (*Macroptilium atropurpureum*), hairy morning glory (*Distimake dissectus*), passionfruit vine (*Passiflora foetida*), buffel grass (*Cenchrus ciliaris*), and mint bush (*Mesosphaerum suaveolens*)
- Critically endangered plant; Fringed fire bush (*Seringia exastia*)

LEGISLATION & POLICY **FEDERAL**

Weeds of National Significance (WoNS)

The Weeds of National Significance (WoNS) is a Federal system to prioritise weed problems for national action as developed in 1999 by a joint Commonwealth Government taskforce. It is regulated by the Biodiversity and Agriculture Management Act 2007. Thirty-two Weeds of National Significance (WoNS) have been agreed by Australian governments based on an assessment process that prioritised these weeds based on their invasiveness, potential for spread and environmental, social, and economic impacts. Consideration was also given to their ability to be successfully managed. The current list of WoNS can be found in **Appendix 2**.

National Environmental Alert List

The National Environmental Alert List for environmental weeds identifies 28 plant species that are in the early stages of establishment and have the potential to become a significant threat to biodiversity if they are not managed.



LEGISLATION & POLICY STATE

Biodiversity Conservation Act (2016)

This Act provides for the statutory listing of Threatened Ecological Communities (TECs). It provides statutory processes for preparing TEC recovery plans, registering critical habitat and penalties for disturbance.

Ecosystems are listed as a Priority Ecological Community (PEC) when there is insufficient information to determine it as a TEC, i.e., not all criteria for a TEC are able to be confirmed due to insufficient documentation OR where the ecosystem is identified as rare but not currently threatened.

The following TEC is known in the Broome Shire

- Monsoon (vine) thickets on coastal sand dunes of Dampier Peninsula, which is also listed under the EPBC Act (1999) with weed threats described as above.

The following PECs are identified in Broome Shire are:

- Dwarf pindan heath community of Broome coast
- *Corymbia paractia* dominated community on dunes
- Relict dune system dominated by extensive stands of *Minyjuru* (*Mangarr* - *Sersalisia sericea*)

Biosecurity and Agriculture Management Act (2007)

The Western Australian Organisms List (WAOL) provides the legal status and control categories of weeds (and other organisms) under the BAM Act (2007).

See: www.legislation.wa.gov.au/legislation/statutes.nsf/law_a146629.html

LEGISLATION & POLICY LOCAL



Kimberley Region Priority Alert Weed List

The Department of Biodiversity Conservation and Attractions (DBCA), has undertaken a species-led prioritisation process to assess the weeds of each region based on ecological impact, invasiveness, current distribution, potential distribution and feasibility and control.

In the Kimberley 13 species were identified as priority alerts of which none are known to occur in Broome.

Local Government

The Shire's Weed Brochure has been developed to educate residents and contractors in Broome of significant weed species.

See: www.broome.wa.gov.au/Community/Parks-and-Gardens/Weed-Control

Other useful weed information can be found through

- Environs Kimberley - weed cards and other identification tools
- Society for Kimberley Indigenous Plants and Animals, and Roebuck Bay Working Group - garden guides to encourage the use of native plants and reduce the opportunity for weed introduction and spread.

ROLES AND RESPONSIBILITIES IN WEED MANAGEMENT

Weed management is a shared responsibility, involving individuals, and all levels of government organisations. The coordination and involvement of all stakeholders, landholders, and community members in the Shire of Broome towards the collective approach of weed management is necessary for the effective long-term control of target species. Clear understanding of the roles and responsibilities of different stakeholders in environmental weed management and control is provided below.



IMPACTS OF ENVIRONMENTAL WEEDS

What are Environmental Weeds?

Environmental weeds are highly invasive and create competition with native plants for light, water, space, moisture, and nutrients. A plant's status as a weed is dependent upon its location and the land use of that place, for example native plants may be weeds in farm and forage lands. Similarly, non-native plants may become useful in the control of erosion, provision of habitat and shade where a native equivalent cannot be identified.

Invasive characteristics of environmental weeds include:

- Abundant seed production
- Rapid population establishment
- Seed dormancy
- Long term survival of buried seed
- Adaptation for spread
- Presence of vegetative reproductive structures
- The ability to release self-protecting toxins that interfere with the growth of surrounding plants
- Ability to occupy sites disturbed by human activities.

Beneficial characteristics of environmental weeds include:

- Soil stabilisation
- Habitat and resources for wildlife
- Aesthetic qualities
- Added organic matter for soils
- Nectar for insects and bird species
- Food resource for agricultural livestock



IMPACTS OF ENVIRONMENTAL WEEDS

Like most plants, weeds can be divided into Annuals and Perennials. Knowing a plant's lifecycle is important in aiding identification and deciding the best forms of control required. Annuals and Perennials can be described as:

Annuals: plants which flower, produce seeds and die in 1 year or less. Annual weeds are mostly opportunists that germinate after the first rains when the soil is at least partially bare through seasonal conditions following, mowing, cultivation, burning or other site disturbances.

Control - should aim to prevent further seeding. Roots are usually shallow, and plants easily hoed, hand pulled or controlled with herbicide.

Perennials live for 3 years or more and may be herbaceous or woody species. Plants have rhizomes, corms, lignotubers, deep roots, or similar structures so can regrow year after year. Most also reproduce through seed.

Control - is difficult due to their underground vegetative structures. Most roots grow as deep as 45cm below ground sometimes as deep as 3-4 meters. Control aims to deplete root reserves so that no new shoots can develop. Those with shallow roots and not prone to sucker can be dug out. Systemic herbicide application may be required for control of deep roots, bulbs, and other underground structures.

Even if not currently present within the Shire they are still relevant to the strategy as they are legislated and under regulation, therefore the Shire should be alert for prompt identification. The categories of environmental weeds include the following:

Target Weeds (Weeds not yet in Australia): is a list of 41 species regarded as serious threats to Australia's productivity, export markets and the environment. It focusses on the potential for weeds to enter Australia from South-East Asian countries through natural or non-conventional pathways including wind currents, migratory animals, traditional vessel movements and illegal fishing activity.

Emerging or Sleeper Weeds(Weeds already in Australia): these are plant species in the early stages of establishment with the potential to become a significant threat to Australian Biodiversity. Sleeper weeds are plants that have not yet increased in their distribution significantly and could be controlled before numbers explode. None of the species identified on the National Environmental Alert List are found in the Shire of Broome.

IMPACTS OF ENVIRONMENTAL WEEDS

Noxious Weeds (Mostly agricultural/horticultural crop weeds): A noxious weed is a plant that has been legally declared under State/Territory legislation. These weeds have a negative impact on crop or animal production and are variously referred to as noxious or declared weeds. Some plants may be noxious in one State or Shire but not in another.

Western agricultural weeds are regulated under the Biosecurity and Agricultural Management Act (2007) and managed in the Kimberley by Department of Primary Industries and Regional Development (DPIRD).

Weeds of National Significance (WoNS): is a list of Australia's worst weeds which have been legally declared by the Federal government with restrictions on their propagation, trade or sale applying to all.

The Australian State and Territory Government have listed thirty-two weeds of National Significance (WoNS), based on weed species impacts, potential to spread, invasiveness, socio-economic and environmental value. **Appendix 2** identifies all species.



IMPACTS OF ENVIRONMENTAL WEEDS

Weeds on National Environmental Alert List: The National Environmental Alert List identifies 28 plant species that are in the early stages of establishment and have the potential to become a significant threat to biodiversity if they are not managed. The Praxelis, *Praxelis clematidea* is found in Broome.

Kimberley Region Priority Alert Weeds: Department of Biodiversity Conservation and Attractions, Parks and Wildlife, has undertaken a species-led prioritisation process to assess the weeds of each region based on ecological impact, invasiveness, current distribution, potential distribution and feasibility and control. This process identified 13 priority weed species for the Kimberley Region, none of which are found within the Shire of Broome.

If any of the Priority Alert Weed Species are identified, please notify the local Department Biodiversity Conservation and Attractions Office on (08) 9195 550

IMPACTS OF ENVIRONMENTAL WEEDS

Shire of Broome - Environmental Priority Weed Species:

Environmental weeds identified as significant within the Shire, are those that are rising in population and prevalent throughout the Shire's open space areas.

Weeds of concern and on the Shire's watch or alert list for their invasiveness, ecological impact, and health risks are listed in **Appendix 2**.



WEED SPECIES INTRODUCTION AND ESTABLISHMENT

Environmental weeds can be introduced and established through various pathways and have different characteristics for spread. Establishment of invasive species within a new area is dependent on the intrinsic characteristics of the weed species and the vulnerability or resilience of the community being invaded. The resilience or vulnerability of a location is determined by factors such as characteristics, dynamics, and history of the area. The biggest cause of weed introduction and spread is human activities and disturbance, the other cause of weed introduction is natural means.

Pathways for introduction and establishment of weed species in the Shire include:

- Transport corridors such as stormwater drain systems during and after rain.
- Accidental through tourism – camping, parking on the side of the road, rest areas and 4-wheel drive tourism.
- Vehicle transport – utility, service, construction, or civil contractors travelling between sites and transporting seed or fragments.
- Feral animals or native wildlife – seeds attached to fur or in faeces, fruit-eating birds and bats.
- Land use and development – construction and maintenance such as grading, land clearing, slashing, mowing, and vehicle/machinery movement.
- Fragmentation (Stem or root) – clearing areas, not fully removing stems and roots, and not properly disposing of weed material.
- Disturbing native vegetation – land clearing, use of vehicles or machinery in bushland and introducing mulch or foreign soil into the area.
- Dumping of garden waste – introduction of garden escapees and spread of common weeds into natural areas.
- Pastoral holdings – cattle, hay and contractors introducing weeds seeds.
- Production of new rhizomes, tubers, and other vegetative reproductive structures by perennial weeds.
- Wind-borne spores or light weight seeds – weeds can be spread over great distances.
- Post fire opportunities – over burning and hot fires can impact revegetation, create bare earth, and stimulate weed seed germination.
- Water distribution – corky, flattened or light weight seeds are transported through water systems and can establish in watercourse banks, coastal areas, and bottom of floodways.

WEED SPECIES INTRODUCTION AND ESTABLISHMENT

Once a weed species has established within an area they can create a seedbank of dormant weed seeds. Seed bank lifecycle is demonstrated in *Figure 2* below. Seeds are triggered to germinate through disturbance by fire, machinery/vehicles, water flow and moisture presence. Germination can be suppressed using a chemical pre-emergent, mechanical scraping/removal, forced germination and chemical control, hot fires, and smothering with mulch.

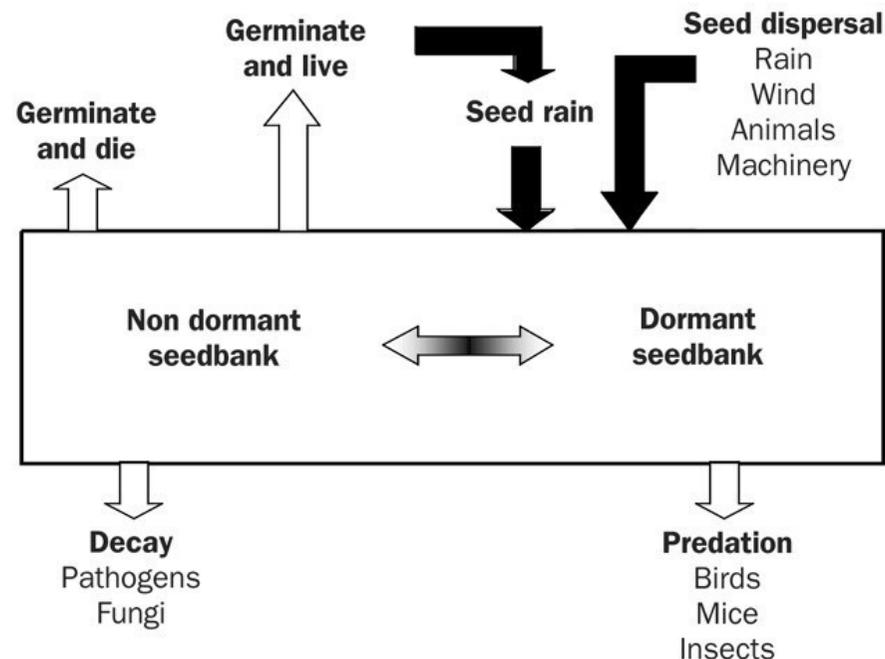


Figure 2. Weed seed bank lifecycle – with input to the seed bank depicted with black arrows and losses of seed to the seed bank with white arrows.

IMPORTANCE OF WEED MANAGEMENT

Weeds are one of the most significant and costly threats to Australia's natural environment and biodiversity. With Australian wide Commonwealth, State and Local Governments spending millions each year on costs for weed monitoring, control, management, and research. Environmental weeds also impact on tourist amenity, agricultural production, public and private infrastructure, as well as economic and social impacts.

As visible through *Figure 3* the greater the weed infestation based on area occupation, the greater the economic impact. It is evident that there are various ways weed species can be introduced or established and due to the invasive nature of weeds; prevention of spread through pathways is a necessary and cost-effective approach to weed management.

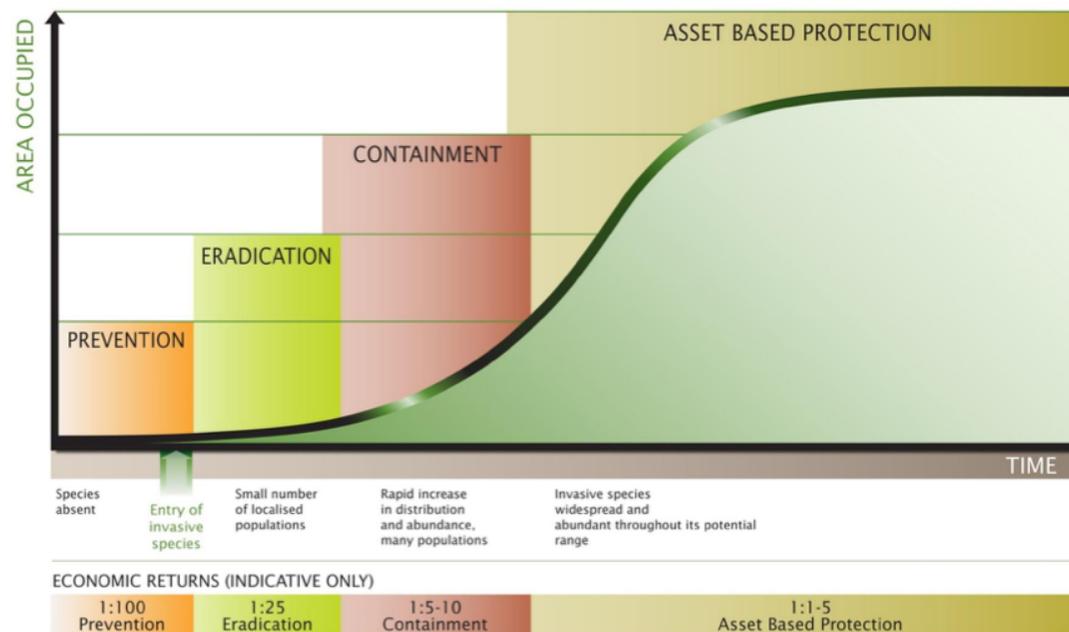


Figure 3. The generalised invasion curve – with the four stages of weed management: prevention, eradication, containment, and asset-based protection (Bailey, 2019).

IMPORTANCE OF WEED MANAGEMENT

In weed management there is an action threshold, which are set levels a weed population must reach before control can begin. These are driven by economic, seasonality and legislative factors. From an economic perspective the action threshold is when the weed density is at a point which some control should be exerted to prevent a weed population from increasing further causing economic loss.

The action threshold for seasonal weeds is based on the time of year and the corresponding temperatures, these aid in predicting the emergence of the first generation of an adult weed. With legislative action the threshold for control is whether the weed is declared therefore by law must be controlled. Action thresholds are important as it assists in resource allocation.

When controlling weeds, timing is a key factor to effectively prevent and manage weed populations establishing. From the weed lifecycle standpoint: control prior to fruiting or seeding and/or control prior to spread pathways – tourism season and wet season. From a weather standpoint: it is important to control weeds whilst the plant is actively growing and prior to it setting seed It is important to consider weather when choosing your control – use of chemicals in fine weather, conducting prescribed burns in the cooler months, and spraying chemicals on calm days.



IMPORTANCE OF WEED MANAGEMENT

Potential impacts from the introduction and spread of environmental weeds within our public open spaces/reserves:

- Reducing the viability, health and biodiversity of native flora species by competing vigorously for space, water and nutrients.
- Causing human health problems causing asthma, skin irritation, other respiratory issues, and poisoning.
- Water contamination affecting the quality of waters when infestations become prominent in wetlands.
- Social impacts on communities through degradation of parks, verges and public access ways which are impacted by lowering the amenity, functionality and aesthetic appeal.
- Alteration of fire regimes through additional fuel loads through the abundant nature of weeds and ability to spread extensively within a landscape.
- Altering soil nutrients by either removing nutrients from soils impacting intentionally planted flora or nitrogen fixing which can impact on native plant species. Some weeds release self-protecting toxins that interfere with the growth of surrounding plants
- Introduction of pests and diseases from different regions that native species or intentionally planted flora may not have been in contact with.
- Alteration of geomorphological processes with weeds causing increased erosion. When annual weeds die off after outcompeting an ecosystem, leaving the soil exposed and susceptible to being washed away from rains or wind.
- Cultural heritage impacts include alterations of cultural heritage or sacred sites and lowering the availability of bush tucker and native medicines available to indigenous communities.

ENVIRONMENTAL WEED PRESENCE IN SHIRE OF BROOME

Weed Distribution

Monitoring weed distribution is important when attempting to control weeds. Monitoring should be ongoing and must be a collaborative effort between the Shire, industry groups, landholders, community groups and our National Resource Management body

Key observations relating to the distribution of weeds in Broome and surrounds:

- Weeds have been mapped more often along (fence lines, road verges, informal vehicle, and human tracks). More mapping needs to be undertaken to decide the extent of many species from these edge areas.
- Weeds readily invade and establish in disturbed sites (due to livestock, human disturbance, fire, construction, illegal rubbish dumping)
- Weeds establish more easily in wet areas (swales, drains, monsoon vine thicket, back of dunes, near sewer treatment plant)
- Garden escapees contribute to the spread of weeds, including the introduction of new weeds.
- Weeds promote hotter fires which in turn promote the establishment of more weeds.
- Distribution is aided by humans and vehicles, animals which eat seeds or have them become stuck in their fur, inflow from the stormwater drainage system

ENVIRONMENTAL WEED PRESENCE IN SHIRE OF BROOME

Weed Management Prioritisation

Weed prioritisation is assessed and broken down within the Shire of Broome's different managed land categories including stormwater drainage systems, parks and gardens, road reserves and natural bushlands. Current and potential weed distribution, ecological impact, and level of invasiveness (at a landscape and site scale) are important factors in prioritising weed management.

To ensure weeds are managed on a priority basis resources should be allocated based on the following three considerations:

- Priority weeds
- Priority landscape areas
- Priority pathways of spread



ENVIRONMENTAL WEED PRESENCE IN SHIRE OF BROOME

Alert Weeds

For the context of the weed management strategy the Shire defines 'alert' weeds as a species that:

- Not yet naturalised in the shire area
- Has the potential to have a high level of impact if it became established
- Has a reasonable likelihood to arrive in the shire area

The 'weed risk ratings' are based on the following criteria:

- **Invasiveness:** Ability to invade bushland in good or excellent condition or ability to invade waterways.
- **Distribution:** Wide current or potential distribution including consideration of known history of widespread distribution elsewhere in the world.
- **Environmental Impacts:** Ability to change the structure, composition, and function of ecosystems. Particularly the ability to form a monoculture in a vegetation community.

Priority Landscape areas

Landscape areas that require priority management attention within the Shire of Broome are determined using one or more of the following criteria:

- Low incursions of weeds
- Sites of significance for biodiversity conservation
- Significant commercial values
- Very high visitation areas
- Significant cultural and heritage values
- Susceptibility to invasion
- Weed source areas including top of streams and up wind areas
- High value assets

Consideration should be given to several other factors such as the weed species present within the natural area, the characteristics of individual sites such as soil type, proximity to water courses, quality of native vegetation and presence of sensitive species (ecological ranking).

ENVIRONMENTAL WEED PRESENCE IN SHIRE OF BROOME

Priority Pathways for Spread

The main pathways of spread for weeds within the Shire have been identified within *Figure 4*.

Considerations include:

- Physical characteristics of weeds that are likely to be transported by human or natural means
- Which weeds are most likely to be transported into or within the Shire of Broome
- Human activities most likely to spread weeds
- Presence of a physical corridor assisting weed spread



Cause	Pathway of Spread	Example mechanisms of spread along priority pathways
Physical processes	Stormwater drainage systems	Water, wind
	Tidal movement	
Native or feral animals	Native bushland	Feral or native animal movement
	Natural corridors	
	Watercourses	
Land use and development	Pastoral holdings	Cattle, hay, and contractors
	Roads	Construction and maintenance such as grading, slashing, livestock and fodder hauling, high traffic, rest areas and tourism
	Water pipeline	Maintenance activities
	Contractors	Maintenance activities and vehicle machinery movement
Tourism	Accidental	Camping, 4WD tourism, use of rest areas
Use by industry	Nursery industry	Deliberate planting, garden escapees, pastoral escapees, vehicle, and machinery movement
	Garden plants	
	Horticulture	
	Agriculture	

Figure 4: Priority Pathways of Spread within the Shire

WEED CONTROL

This section outlines the common methods used in the control of weeds. There are many aspects that need to be considered when determining the relevant weed control method or combination of methods to implement in parks, urban landscaping areas, natural bushland, and drainage systems. The correct selection and implementation of a control method will ensure that weed infestations are dealt with in a timely manner and have least environmental costs to the impacted site or surrounding areas.

Weed control methods used to reduce weed infestations to manageable levels or eradication includes:

- **Physical Weed Control:** the removal of weeds through manual or mechanical processes including slashing, mowing, mulching, tilling or by hand.
- **Chemical Weed Control:** the use of selective, non-selective and pre-emergent herbicides to affect the growth, development and germination of weeds which may result in death of the plant.
- **Thermal Weed Control:** the utilisation of burning with fire as a tool and the application of hot water or steam to cause death of the weed.
- **Biological Weed Control:** the introduction of pest, pathogens, or viruses to reduce weed spread and growth.
- **Land Management Control:** indirect control through good land management practices including hygiene protocols, fire management, quarantine protocols, feral animal controls and prevention of overgrazing.

An important recognition is that whilst the initial implementation of the above methods is an important control, it is ineffective unless follow up controls are programmed. For long term effectiveness of the control, weeds that are removed or reduced, should be replaced with desirable plants such as native species through natural recolonisation of an area or intentional planting to ensure there is less space for re-infestation. Monitoring and follow up control methods can aid in early identification of re-infestation and weeds can be addressed promptly, preserving the area.

A comprehensive list of weed control is outlined in **Appendix 3**.

INTERGRATED WEED MANAGEMENT APPROACH

Integrated weed management (IWM) is a long-term approach, using a combination of different management and control techniques to monitor, prevent and control weeds. The most effective weed management involves the implementation of an integrated approach, as a single control measure will not be effective over the long term. Using a variety of control methods, rather than just one, also ensures weeds are less able to adapt to a single control method. Integrated Weed Management addresses the underlying causes of weed infestations, rather than just focusing on controlling visible weed presence.

This is achieved through targeting the various stages of the weeds lifecycle and undertaking measures that will prevent weed reproduction, reduce weed emergence, promote seed bank depletion, and minimise weed competition with desirable vegetation. Weed management program development can be informed through the interpretation of individual sites, the native plant communities, distribution of weed species and patterns of disturbance.

An integrated approach within the Shire would include:

- Weed Monitoring: mapping, photo monitoring and observational monitoring.
- Weed Prevention: minimising access and disturbance, and hygiene protocols.
- Weed Control: physical, chemical and land management.

INTERGRATED WEED MANAGEMENT APPROACH

Weed Mapping

Weed mapping can be a useful tool in identifying the extent of the weed infestation, identify patterns in distribution and pathways of spread, assist in control and management planning, allocation of resources and effectiveness of control actions (Bailey, 2019). Weed mapping can also assist in defining control cells within priority reserves. Mapping is done in conjunction with monitoring, as weed monitoring provides the data and information required for mapping. Parameters of mapping need to be established whether it be priority species, certain percentage cover or established highly invasive species the use of continuous mapping can determine how successful a control in an area is going and can alert us of outbreaks or when the objective has been reached.

Current Management

Weed mapping has begun in the Shire with the data being collected regularly through observational monitoring and infestation identifications. The weed mapping will assist in informing on ground weed management programs and follow up protocols.

Previous mapping has been conducted by the Environs Kimberley around the Broome townsite, evident from *Figure 5*.

Department of Primary Industries and Regional Development have developed a reporting app "My Pest Guide Reporter" which aids in identification of new or established weed infestations and in the active mapping of an area.



Figure 5 - Environs Kimberley weed map (2013))

INTERGRATED WEED MANAGEMENT APPROACH

Weed Reporting

Weed reporting can be a valuable tool for gaining or confirming identification, sharing knowledge of infestations, weed management from the responsible stakeholder can occur. Reporting can be done locally - for area specific target weed infestations, regionally – for established weed threats, and nationally – for new incursion threats.

Current Management

Weed reporting is only currently conducted internally. Only weed infestations of a large scale are reported that need substantial control methods, smaller weed populations are dealt with by staff either through physical or chemical controls.

Observational Monitoring

Observational monitoring is a form of surveying and can be conducted through use of permanent transects or quadrats. This type of monitoring tracks new weeds and monitors the effectiveness of weed control programs. Transect surveying involves walking along a fixed pathway or single line whilst recording occurrences of the weed species, this method is applicable to storm water drainage systems.

Quadrat surveying involves random sampling of one square metre of habitat and recording the distribution of weed plant species within the quadrat.

INTERGRATED WEED MANAGEMENT APPROACH

Weed Prevention and Control

Preventing the introduction and spread is one of the key objectives of the weed management strategy, as control methods can be both costly and labour intensive. Weeds can be introduced to an area through transportation by both natural and human sourced mechanisms.

Transport pathways for weed spread and introduction were detailed previously. Through the identification of these pathways, a focused effort on specific methods of weed prevention can be implemented.

Weed prevention management processes can include:

- Minimising access and disturbance
- Weed hygiene protocols
- Drainage system rehabilitation
- Fire management and response
- Education

Community Education

Community education and training for contractors and practitioners in contact with weed infestations is integral to slowing the spread of weeds. Raising awareness, knowledge, motivations, and behaviour will assist in the prevention of weed spread and encourage participation in environmental activities.

INTERGRATED WEED MANAGEMENT APPROACH

The community can prevent weed introductions and spread by:

- Correct disposal of green waste - not dumping garden waste into natural bushland areas, stormwater drain systems and roadsides.
- Minimising access and disturbance to natural areas or weed infestation sites – staying on tracks, not taking vehicles or recreational equipment into undisturbed areas, and not allowing dogs to run off-leash in natural areas.
- Undertaking appropriate hygiene practices when entering and leaving parks, natural bushlands, or stormwater drainage systems. This includes cleaning footwear, removing any seed from clothing, pet fur and recreational equipment such as bike tyres.
- Joining a community group to participate in planting and maintaining some of the stormwater drain systems and other areas.

As it is an offence to deposit litter on land or water, if you see anybody illegally dumping green waste - please contact the Shire via (08) 9191 3456 or shire@broome.wa.gov.au.

Current Management

The current approach to community education regarding weed management by the Shire of Broome includes education through the “Weeds of Broome” brochure and the “Weed Control” page on the Shire website.

There is existing local educational material offered by external sources including the “Kimberley Weeds” index cards, Roebuck Bay Working Group’s “Coastal Gardens: a planting guide for Broome on the Dampier Peninsula” booklet and Department of Primary Industry and Regional Development website and “Weeds to Watch” poster. Further educational information can be found on the Department of Biodiversity Conservation and Attractions “Weed” page on their website.. Weeds Australia provides identification and distribution information on weeds.org.au.

Training

Ongoing training is essential for the continued development of staff knowledge and expertise. Training in weed identification from germination to seeding, understanding of weed lifecycles and appropriate control methods for target species and hygiene protocols for use of machinery and equipment is vital for all staff working in the Broome habitat.

IMPLEMENTATION

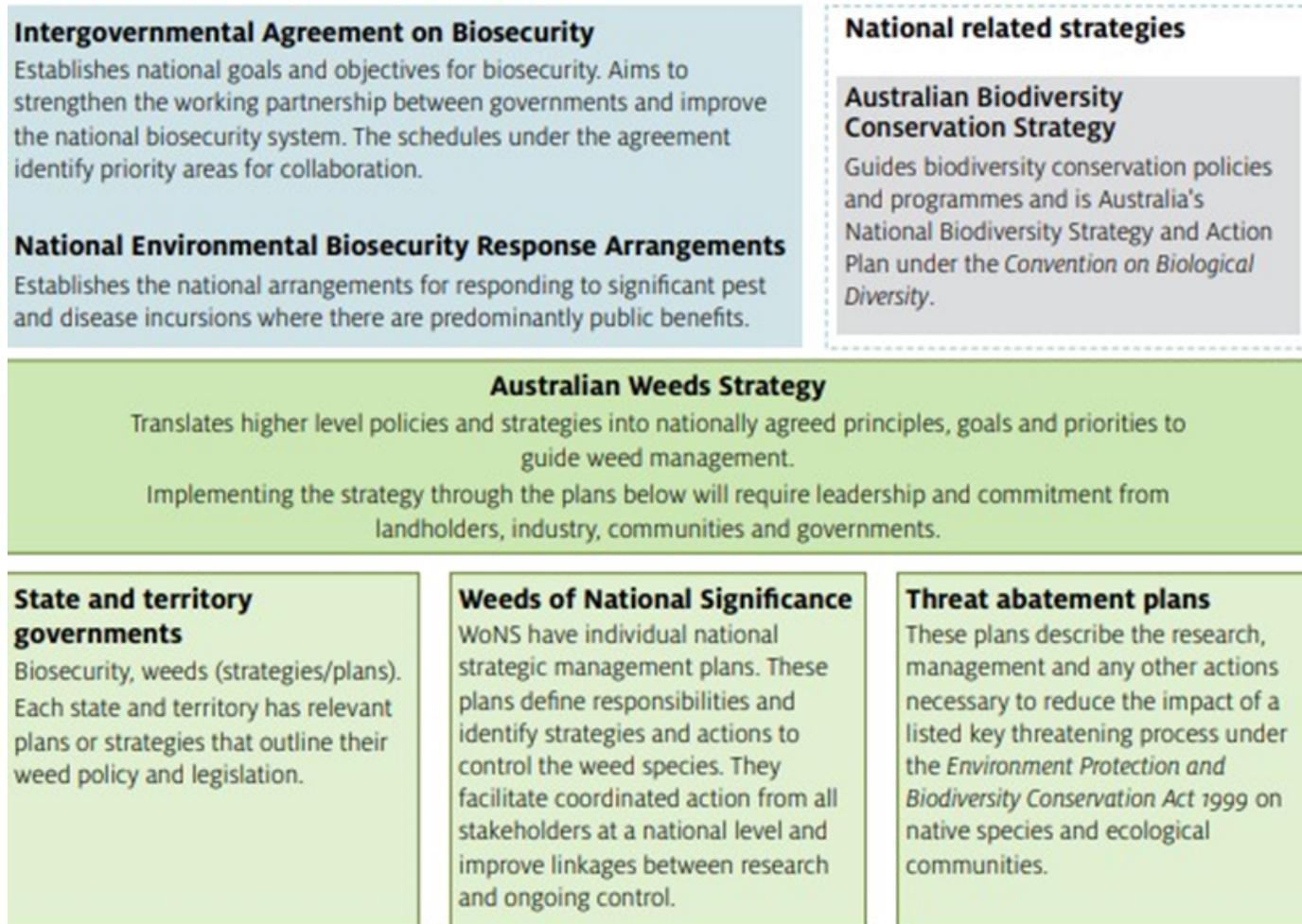
An Action plan is being developed to support the Broome Weed Strategy and provide a framework of actions for effective, efficient and sustainable management of weeds within the Shire.





Appendix 1 -

Context for the hierarchy of roles and responsibilities of weed management from a national to local level.



Appendix 1 - Cont.

Context for the hierarchy of roles and responsibilities of weed management from a national to local level.



Appendix 2- Weed Identification & Priority Listing

	WA Declared Class	Shire Priority Weeds for Eradication	Shire Watch/ Alert List	Declared/ Noxious Weeds	Weeds of National (WoNS) Significance	Weeds of National Significance (WoNS) - Watch List	Priority
Bellyache Bush, <i>Jatropha gossypifolia</i>	Declared S22(2) (C3 Management)	Y		Y	Y		High
Buffel Grass, <i>Cenchrus ciliaris</i>	Permitted S11	Y					High
Caltrop, <i>Tribulus occidentalis</i>	Permitted S11	Y					High
Candle Bush, <i>Senna alata</i>			Y	Y			High
Chinese Apple, <i>Zizyphus mauritiana</i>				Y			High
Coffee Bush, <i>Leucaena leucocephala</i>	Permitted S11	Y					High
Gallon's Curse, <i>Cenchrus biflorus</i>	Permitted S11	Y					High
Hairy Merremia, <i>Distimake aegyptius</i> (previously <i>Merremia aegyptia</i>)		Y					High
Khaki Weed, <i>Alternanthera pungens</i>	Permitted S11	Y					High
Mint Bush, <i>Mesosphaerum suaveolens</i> (previously <i>Hyptis suaveolens</i>)	Permitted S11	Y					High
Neem Tree, <i>Azadirachta indica</i>		Y		Y			High
Praxelis, <i>Praxelis clematidea</i>	Declared S12 Prohibited (C1 Exclusion)		Y	Y	Y		High
Rubber Bush, <i>Calotropis procera</i>		Y		Y			High
Rubber Vine, <i>Cryptostegia grandiflora</i>	Declared S12 Prohibited (C2 Eradication)			Y		Y	High
Siratro, <i>Macroptilium atropurpureum</i>	Permitted S11	Y					High
Snake Vine/White Creeper, <i>Distimake dissectus</i> (previously <i>Merremia dissecta</i>)		Y					High
Water Lettuce, <i>Pistia stratiotes</i>				Y			High
Wild Passionfruit, <i>Passiflora foetida</i>	Permitted S11	Y					High

Appendix 2- Weed Identification & Priority Listing

	WA Declared Class	Shire Priority Weeds for Eradication	Shire Watch/ Alert List	Declared/ Noxious Weeds	Weeds of National (WoNS) Significance	Weeds of National Significance (WoNS) - Watch List	Priority
Athel Pine, <i>Tamarix aphylla</i>					Y		Medium
Coffee Senna, <i>Senna occidentalis</i>			Y				Medium
Coral Vine, <i>Antigonon leptopus</i>	Permitted S11		Y				Medium
Indian Devil Tree/Cheesewood, <i>Alstonia scholaris</i>	Permitted S11		Y				Medium
Ivy Gourd, <i>Coccinia grandis</i>	Declared S22(2) (C3 Management)		Y				Medium
Kapok Bush, <i>Aerva javanica</i>	Permitted S11		Y				Medium
Lantana, <i>Lantana camara</i>					Y		Medium
Madagascar Rubbervine, <i>Cryptostegia madagascariensis</i>	Declared S22(2)		Y				Medium
Mossman River Grass, <i>Cenchrus echinatus</i>	Permitted S11		Y				Medium
Parkinsonia, <i>Parkinsonia aculeata</i>					Y		Medium
Taylor Fruit, <i>Ziziphus mauritiana</i>	Declared S22(2) (C3 Management)		Y				Medium
Tiger Paw, <i>Ipomoea pes-tigridis</i>	Permitted S11		Y				Medium
Birdwood Grass, <i>Cenchrus setiger</i>	Permitted S11		Y				Low
Butterfly Pea, <i>Clitoria ternatea</i>	Permitted S11		Y				Low
Cabomba, <i>Cabomba caroliniana</i>	Declared S12 Prohibited (C2 Eradication)					Y	Low
Cats Claw Vine, <i>Dolichandra unguis-cati</i>					Y		Low
Gamba Grass, <i>Andropogon gayanus</i>	Declared S12 Prohibited (C2 Eradication)					Y	Low
Hymenachne, <i>Hymenachne amplexicaulis</i>	Declared S12 Prohibited (C1 Exclusion)					Y	Low

Appendix 2- Weed Identification & Priority Listing

	WA Declared Class	Shire Priority Weeds for Eradication	Shire Watch/ Alert List	Declaired/ Noxious Weeds	Weeds of National (WoNS) Significance	Weeds of National Significance (WoNS) - Watch List	Priority
Leaf Cactus, <i>Pereskia aculeata</i>	Permitted S11					Y	Low
Madeira Vine, <i>Anredera cordifolia</i>	Permitted S11					Y	Low
Mesquite, <i>Prosopis spp.</i>						Y	Low
Mimosa, <i>Mimosa pigra</i>	Declared S12 Prohibited (C2 Eradication)					Y	Low
Parthenium, <i>Parthenium hysterophorus</i>	Declared S12 Prohibited (C1 Exclusion)					Y	Low
Pond Apple, <i>Annona glabra</i>	Declared S12 Prohibited (C1 Exclusion)					Y	Low
Prickly Pear, <i>Opuntia spp</i>	Declared S12 Prohibited (C2 Eradication)				Y		Low
Salvinia, <i>Salvinia molesta</i>	Declared S12 Prohibited (C2 Eradication)					Y	Low
Water Hyacinth, <i>Eichhornia crassipes</i>	Declared S12 Prohibited (C2 Eradication)					Y	Low

Appendix 3- Weed Control Methods

Physical Weed Control

Manual or physical control involves the physical removal of the weed by human or mechanical effort. Although, physical control is the most appropriate weed control in certain circumstances, it is also the most expensive, as it is the most time consuming and labour-intensive process. Physical control allows for selective removal of weeds and avoids the use of herbicides.

This control method follows the three general principles:

- Work outwards from good bush areas toward areas of weed.
- Make minimal disturbance to the environment.
- Let native plant regeneration dictate rate of weed removal.

This method, however, would not be recommended for species that reproduce by rhizomes, tubers, corms, or areas where soil disturbance would have implications. Gross soil disturbance can lead to weed replacement, which is why revegetation actions are recommended in conjunction with weed removal.

The method also needs adjusting for drainage weeding, where it is recommended to commence where water enters a drain.

Hand removal is commonly prescribed for the control of individual plants, small populations, ecologically sensitive areas, and species that are seeding or flowering. Care must be taken to remove all root matter to ensure regrowth does not occur from remaining roots. All removed weeds should be disposed of appropriately off site.

Mechanical Slashing is a favourable method for control of fast-growing annuals and is a standard control measure for grassweeds. This method can be used on a small scale to de-flower weeds and remove vegetative growth. Mechanical slashing is a relevant method for weeds that have not gone to seed – slashing whilst a weed is in seed will only further contribute to the spread of weed seeds. Mechanical control must be done in conjunction with the relevant hygiene protocols to ensure weed seed is not spread from weed sites to different areas.

Appendix 3- Weed Control Methods

Ploughing or Tilling turns over the soil and buries the weed beneath the soil. This provides a barrier to the sun, therefore killing the weeds. Tilling is a form of physical control that can be easily undertaken over a wide area, using agricultural machinery. Strategic tilling can lower the subsequent weed emergence; however, it can lead to damage in soil structure and exposes the soil to erosion and further invasion by weeds. This is not generally an urban application.

Mulching or smothering is the use of materials such as wood chips, newspaper, black plastic, or organic matter to cover disturbed soils, smothering of weeds or stopping the emergence of plants in the area. The suitability of smothering and mulching needs to be considered in natural areas as it can cause soil disturbance from machinery use preventing native seedling regeneration

Chemical Weed Control

Chemical weed control through use of herbicide application is often the most cost-effective and practical method of weed control in various situations. Herbicides are defined as a 'chemical substance used to destroy or inhibit the growth of plants, especially weeds.' Herbicides can be classified into three categories:

- pre-emergent (residual) – inhibit the germination of pest plants.
- non-selective – broad spectrum and work on wide variety of plants; and
- selective – working on a specific range of plants.

Herbicide application is an effective component in integrated weed management, having higher success rates than other forms of weed control. Herbicide application is carefully considered and should be used in conjunction with a variety of control methods. The best practice for herbicide application involves knowing the target weed, understanding the site conditions, choosing the correct herbicide, choosing the correct application method, ensuring operators are trained and ensuring all regulations and label instructions are followed. The correct percentages of low toxicity herbicides at key points, especially in the proximity of waterways and water catchment sites can have lesser of environmental impact and more success in the management of weeds than other control methods.

Appendix 3- Weed Control Methods

A multi-faceted selection of herbicides and application techniques is recommended. Some chemical weed control methods include:

Broad Acre Spraying is a primary level of control within open areas of little or no native vegetation. This can be undertaken by hand in small areas and by vehicle to cover larger areas. It involves spraying a weak herbicide solution over the foliage of weeds.

Spot Spraying is like broad acre spraying though targets weed infestations amongst germinant rehabilitation or revegetated areas. Care must be taken when spot spraying to avoid off-target spray affecting native vegetation. Careful attention to environmental conditions, particularly wind direction and speed, and strengths of chemical solutions must be taken when spot and broad acre spraying.

Wicker Wiping is a method used to minimise off target damage often caused by spraying of herbicide. This method involves wiping a herbicide-soaked rope or cloth implement against weed foliage. Whilst this is a more targeted treatment, it is also more labour intensive and should be prescribed for areas of highest specific usage only e.g. sport ovals and high amenity areas.

Cut Stump Control is a specific method used for treating large and woody weeds from sensitive bushland areas. Trees and shrubs have foliage cut and often trunks cut to the stump and a herbicide applied by spray or brush to the cut stumps and stems. Weeds can remain intact onsite without requiring further removal if preferred.

Stem Injection/Drill and Pill involves drilling or cutting through the bark into the sapwood tissue in the trunks of woody weeds and trees. Herbicide is immediately placed into the hole or cut, in liquid or pill form. The aim is to reach the sapwood layer just under the bark (the cambium growth layer), which will transport the chemical throughout the plant.

Basal Bark involves mixing an oil-soluble herbicide in diesel and spraying or painting the full circumference of the trunk or stem of the plant. This method is suitable for thin-barked woody weeds and undesirable trees. Basal bark spraying is also an effective way to treat saplings, regrowth and multi stemmed shrubs and trees. This method allows the herbicide to enter underground storage organs and slowly kill the targeted weed.

Appendix 3- Weed Control Methods

Thermal Weed Control

Burning Fire management can be utilised as a tool in weed control. Burning removes the above soil weed body and can be a good control method for wide areas and large infestations of grasses and woody weeds. Prescribed burns can be planned appropriately either before the weed is seeding or in dry soils for maximum intensity leading to destruction of seed bank stores. An integrated approach of herbicide spraying before burning, can assist by increasing the weeds flammability, broadening the burning opportunity. Follow up weed control is recommended after burning activity, as fire can result in vegetation cover loss, expose soil surface to erosion and reduce competition for resources, providing weed species with the opportunity to grow.

Fire is an important and necessary natural feature of the Australian environment and can have negative and positive impacts on weed management. The increased disturbance from hot fires and/or regular fires within a region is destructive and can kill native species leaving an area exposed. This provides opportunities for weed species to establish in these newly disturbed areas. Therefore, quick fire responses and fire prevention activities such as maintaining fire breaks and access ways, reducing fuel loads of nearby natural bushland, and reducing access and disturbance post fire will avoid introduction of weeds into the area.

The Shire operates an annual Bushfire Mitigation Program from May through to the end of December, designed to encourage residents to take action to help minimise the threat of bushfires. Through the participation of Shire of Broome residents within this program can help prevent the impacts of fire and as a by-product the impact of weeds within the shire.

The Shire works in collaboration with the Department of Fire and Emergency Services and local Broome Volunteer Bush Fire Brigade and the Volunteer Fire and Emergency Services, to conduct planned burns to reduce large weed infestations.

If you see fires within the Shire of Broome please call Triple zero (000). To report knowledge of suspicious fires or acts of arson to the police or ring crime stoppers on 1800 333000.

Hot Water involves the application of hot water under pressure on to a weed species, which can result in the breakdown of the plants cellular structure. Hot water application is most relevant to urban environments (eg. footpaths and kerbsides), where herbicide concerns are at highest proportion. This form of thermal control can be fast-acting and a safer alternative to herbicide use; however, has been found to be less effective than chemical controls, greater in cost, non-selective and is impractical for natural areas.

Appendix 3- Weed Control Methods

Biological Weed Control

Biological weed control is the management of weed populations through the introduction and use of natural parasites, predators, and viruses.

Biological control does not eliminate weeds, but aids in the reduction of target populations, lowering their impact. This can be an efficient form of weed management, particularly useful for widespread introduced species where manual control is uneconomical. Biological control can further be advantageous over other methods as it is cost-effective in the long term, reduces requirement for herbicide application and is generally an environmentally friendly option. However, not all weed species have identified biological controls and cannot be used in all circumstances. Limitations of biological controls are recognised within the Shire of Broome, as the seasonal and environmental conditions may impact the effectiveness of biological control agents.

Land Management Control

Land management control focuses on how the modification of land use practices can prevent the spread of weeds. Good land management practices are critical in reducing the incidence and impact of weeds. This control type is most relevant to Indigenous ranger groups, large tenure land managers, grazers, and station owners. The initial increased costs associated with improved land management are counteracted by the reduced weed control required.

Minimising access and disturbance to weed infestations or weed controlled sites will significantly reduce the spread of weeds. Human disturbance is a vector for weed spread, through seeds being attached to clothing, footwear, recreational equipment, machinery or tools and pets. Through preventing or controlling access to infested areas through fencing or blocking of illegal entrances site hygiene can be maintained. The use of external soils or mulch imported into natural bushland areas will only further disturb the area, introducing potential weed spread. The use of wide buffer zones between infestation sites and undisturbed adjoining areas or roadsides can also minimise the disturbance of areas.

Appendix 3- Weed Control Methods

Hygiene Protocol:

Weed hygiene is an important weed prevention tool to ensure weeds, pathogens and pests are not spread from or in parks and urban landscaping areas. Weed seeds and pathogens can be spread through materials such as soil, sand, gravel, and water, captured in footwear, lodged in machinery, vehicles, and other equipment. The appropriate cleaning of all transport mechanisms will reduce the spread of weed seeds between sites. Producing a biosecurity protocol to be used throughout the Shire of Broome by both staff members and independent contractors will be the best prevention method.

A biosecurity/hygiene protocol will target:

- Vehicles, machinery, and equipment
- Materials such as soil, gravel, or sand
- Clothing, boots, or recreational equipment such as bike tires.
- Best practice design and maintenance of all wash down and decontamination areas

Revegetation: Broome townsite has extensive open space areas, which experience heavy wet season monsoonal rains in combination with occasional cyclones and regular fires. The combination of these factors promotes weed incursion. Rehabilitation of the landscape through replanting, mulching, weed control and monitoring reduces weed incursion.

Feral Animal Control: appropriate feral animal control reduces seed distribution that can attach to fur and hooves, also reduces disturbance to soil and native vegetation therefore lowering weed invasion susceptibility.

Quarantine protocols: isolate a weed prone area and limits further weed dispersion and monitoring for early weed identification of neighbouring areas. Quarantine of stock may also be used to limit seed dispersion.

Prevention of overgrazing: maintenance of pastures and or desirable ground covers and grazing management through the prevention of stock will lessen the soil disturbance/deterioration which would allow for weed growth.