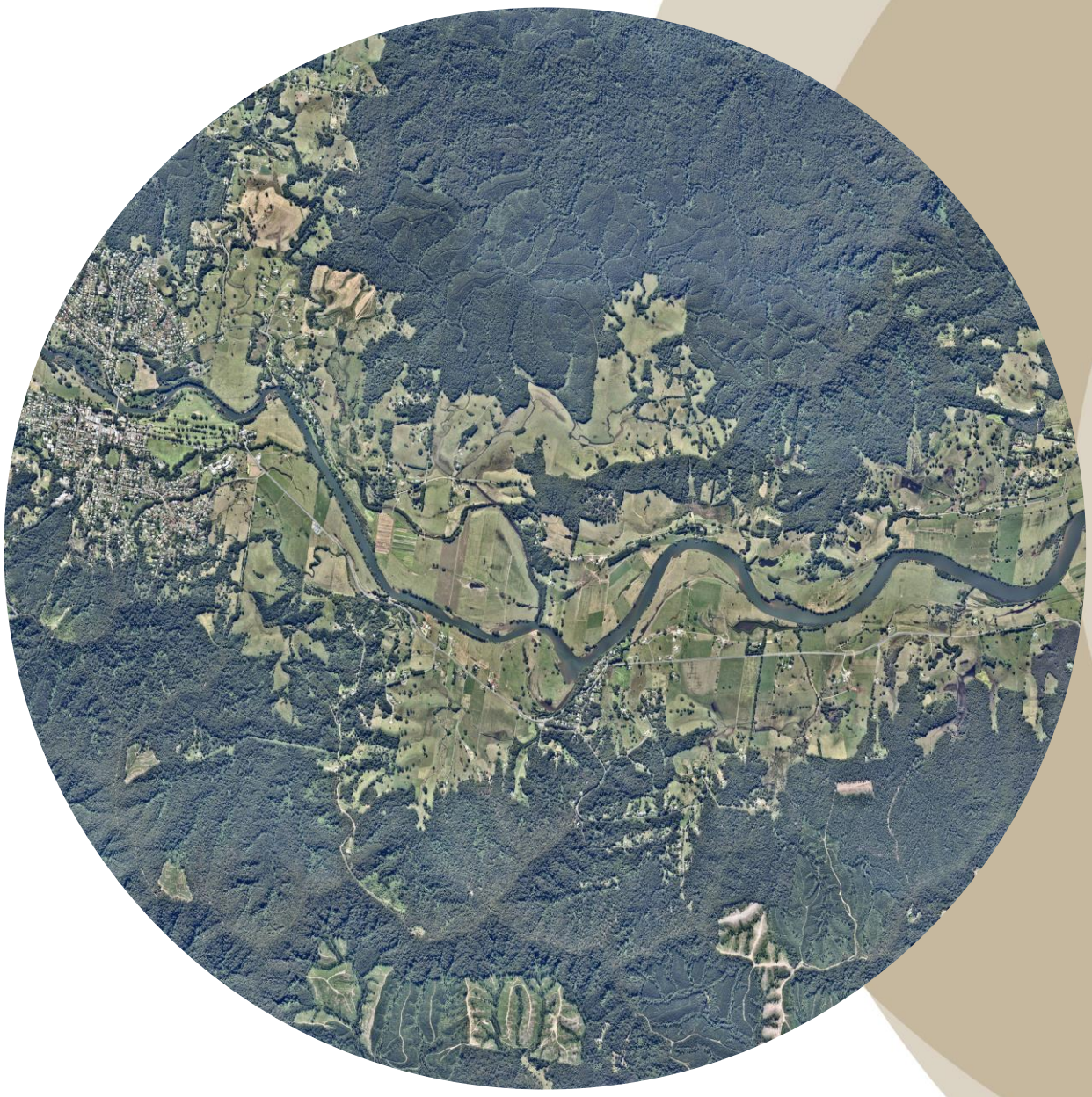

Bellingen Shire Herbicide Review

Rev 0

Bellingen Shire Council

16 May 2022

311012-01068

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Worley Group

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PROJECT 311012-01068 – Rev D: Bellingen Shire Herbicide Review

Rev	Description	Author	Review	Advisian approval	Revision date	Client approval	Approval date
A	Report Tasks i-iii Issued for internal review	M Priestley	K Newton		13/10/21	Justine Elder	
B	Report Tasks i-iii Issued for client review	M. Priestley		K Newton	15/10/21	Justine Elder J. Elder	
C	Draft Report Issued for internal review	M. Priestley	K Newton		20/4/22	Justine Elder	
D	Draft Report Issued for client review	M. Priestley		K Newton	20/4/2022	Justine Elder J. Elder	
0	Final Report	M. Priestley			16/05/2022	Justine Elder	

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Executive summary

Bellingen Shire Council (BSC) has an integrated approach to weed management, using herbicides alongside other methods including mechanical and manual removal techniques, biological controls and other bush regeneration activities. Following increasing community concern regarding impacts on human health and the residual environmental impacts of herbicides used for weed management, BSC has resolved to review its use of herbicides.

Advisian were engaged by Bellingen Shire Council (BSC) in late 2021 to undertake a review of herbicide use in the BSC Local Government Area (LGA) as well as design and assess the results of an alternatives herbicide trial for the LGA.

The Scope of Works included:

1. A literature review on international and Australian considerations of herbicides in use and trials of alternative herbicide products and methods.
2. Assessment of BSC's current herbicide use including type of product, quantity used, cost, labour time and areas of application.
3. Stakeholder engagement to identify areas in the LGA of greatest concern regarding herbicide use.
4. A 6-month trial period of herbicide alternative/s at sites identified through stakeholder engagement.
5. A comparison between BSC's current herbicide practices ((i) above) and the adoption of herbicide alternative practices ((iv) above); and
6. A review of the BSC Pesticide Use Notification Plan (2014) in accordance with findings of (i)-(v) above.

A review was undertaken of herbicide usage within the three main weed management areas of urban, roadsides and bush regeneration within a 12-month period (generally between July 2020- August 2020). Herbicides used by BSC during this period included glyphosate, metsulfuron methyl, triclopyr, picloram and aminopyralid. Methods of application were targeted using cut and paint (metsulfuron methyl) or multipurpose targeted sprays using a backpack, hand spray or powered units.

Within urban areas, most weed management was undertaken using mechanical methods with very low volumes of glyphosate applied with a targeted spot spraying application. Similarly, within bush regeneration sites there were minimal herbicides used and only when required. Roadside maintenance had the highest volume of herbicide usage, given the challenges of applying integrated methods over large and often steep roadside areas. There are also currently few viable alternative methods or products available for woody weeds.

A review of herbicide alternatives or alternative methods was undertaken based on case studies undertaken in Australia. Alternative methods that have been previously trialed include organic (acid or oil based) herbicides, alternative synthetic herbicides, other mechanical methods, sodium chloride, flame weeding, steam weeding or alternative application methods (such as wick wiping). A considerable amount of work has already been undertaken to trial and investigate these alternative methods within BSC. While many methods have been integrated into the BSC toolbox approach, there

are no alternative herbicide products which have met the four criteria of cost (labour and product), effectiveness, environmental and human health risks. Alternative approaches have also tended to be more suitable for urban type areas and multipurpose treatment of more fragile (non-woody) species.

Stakeholder consultation was undertaken through a survey and workshop to gather feedback on all areas of weed management and also to inform the design of the herbicide alternative trial. The outcome of the consultation was an overview of community concerns which ranged from inappropriate use of herbicides, human health impacts, environment impacts, difficulties in logistics of using alternative methods, risks of glyphosate, lack of effective weed management and applying the lessons learnt from previous trials. The consultation also guided the methods for the herbicide alternative trial.

The herbicide alternative trial was undertaken during Summer of 2021/22 over 12 weeks at Bellingen Waste Depot, Dorrigo Sewage Treatment Plant and Mylestom Tennis Courts, to represent the variety of climate conditions within BSC LGA. The effectiveness of weed treatments (including glyphosate, imazapyr, acetic acid and steam weeding) were assessed on fixed transects and fixed photoquadrats (n=5 per location) with measurements of weed species and percentage cover (%Cover) taken at 0, 3, 6, 9 and 12 weeks. A total of 300 photoquadrats were measured in the trial (three locations x four treatments x five photoquadrats). The photoquadrats were used in SamplePoint© software to calculate the %Cover of the main weed categories of grasses, herbs, bulbs, woody and sedges. Multivariate analysis was then used to determine if there was significant effectiveness of the treatments at each location and how long this lasted.

The results of the herbicide alternative trial found the following:

- Imazapyr had similar effectiveness to glyphosate in treating grass weeds at Dorrigo and Mylestom but was not very effective on herbaceous weeds. This herbicide has similar short-term toxicity as glyphosate but much lower long-term toxicity (based on review of available studies in mammals). This product is a viable alternative for grasses but more expensive (at least five times that of glyphosate based on chemical costs).
- Local Safe® (acetic acid) was more effective than glyphosate at reducing herbaceous weed cover at all locations but was not very effective on grass weeds. This product requires more product to be effective and more frequent applications. The costs of using this product (including labour) are at least 10 times that of glyphosate. This product is considered to be viable for herbaceous weeds but more expensive (at least ten times that of glyphosate based on chemical and labour costs).
- Steam weeding only provided effective reduction to 3 weeks at Bellingen and Mylestom but had no reduction in weed cover following a second application. The poor results are likely to be related to the higher soil moisture across all locations. Based on this trial, this method would be very labour intensive and may not be as suitable for the region (compared to other Australian locations) given the high rainfall within the Bellingen LGA.
- None of the trialed alternative products are considered suitable as a replacement of glyphosate usage in terms of meeting the criteria that are required for a long-term replacement. However, imazapyr and Local Safe® are recommended for inclusion as part of the toolbox approach, particularly in urban areas.

Based on the outcomes of this review, including stakeholder consultation and the alternative trial, the following recommendations are made to BSC:

1. Herbicide alternatives should continue to be considered where practical, especially in areas of high public use. There are currently no suitable alternatives to synthetic herbicides for large operational areas (such as roadsides) or for woody weeds.
2. Glyphosate should be continued to be used where required (where there are no suitable and practical alternatives).
3. Herbicide 'no spray' 20 m exclusion zones are recommended around urban sensitive areas.
4. Provision of education and training for all pesticide applicators including volunteers.
5. Maintain weed profile to assist with management.
6. Consistent pesticide application record keeping and training on how to fill out.
7. Continued review of pesticide usage and weed management options.
8. Revision of Pesticide Use Notification Plan (2014).

Acronyms and abbreviations

Acronym/abbreviation	Definition
AHAS	Acetohydroxyacid synthase
ALS	Acetolactate synthase
ANZG	Australian and New Zealand Guidelines
APVMA	Australian Pesticides and Veterinary Medicines Authority
BSC	Bellingen Shire Council
C&SEP	Community and Stakeholder Engagement Plan
EPA	Environment Protection Authority
ESD	Ecologically Sustainable Development
H	Henry's Law Constant
IARC	International Agency for Research on Cancer
K_{oc}	Soil Sorption Coefficient
K_{ow}	N-octanol/water Partition Coefficient
LGA	Local Government Area
LLS	Local Land Services
MCPA	2-methyl-4-chlorophenoxyacetic acid
NSW	New South Wales
NSW DPI	New South Wales Department of Primary Industries
OC	Organochlorine
OP	Organophosphate
PIRI	Pesticide Impact Rating Index
POEAs	Polyethoxylated tallow amines
QLD	Queensland
RMIT	Royal Melbourne Institute of Technology University
WHO	World Health Organisation
WoNS	Weeds of National Significance

1 Background

1.1 Bellingen Shire Council

Bellingen Shire Council (BSC) is located on the Mid North Coast of New South Wales (NSW), just south of Coffs Harbour. The BSC Local Government Area (LGA) covers an area of 1,605 km^2. Over half of this area is covered by State Forests and National Parks. The extent of the BSC LGA is shown in Figure 1-1.

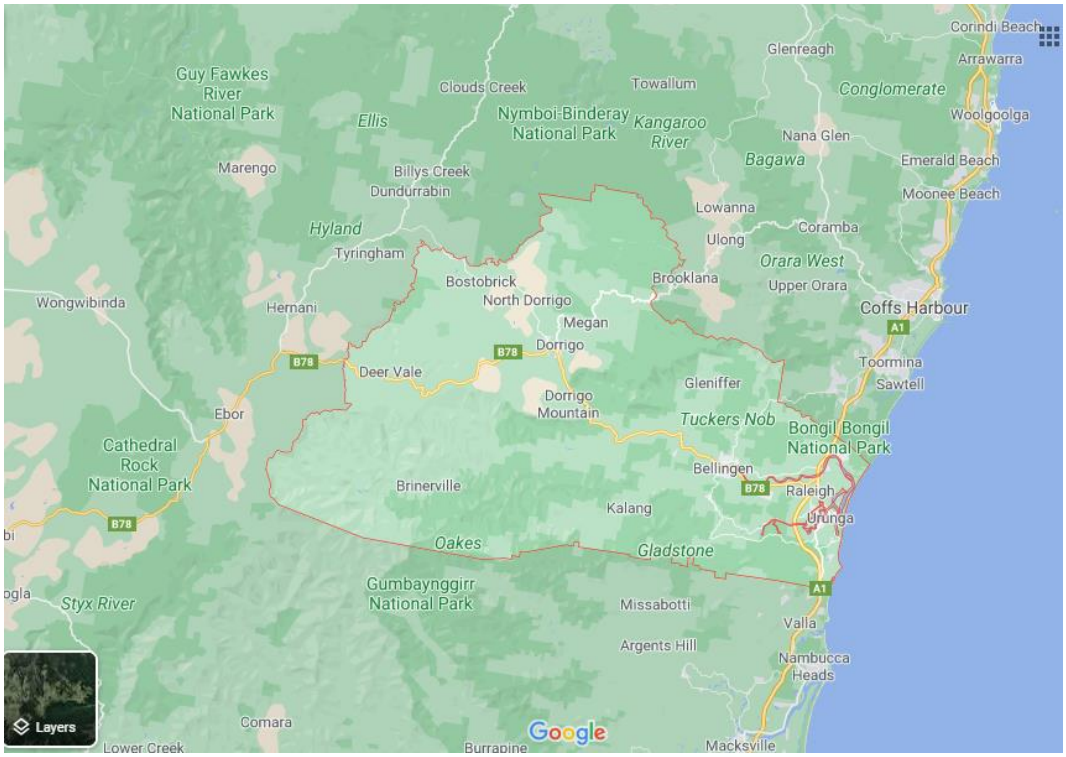

Figure 1-1 Bellingen Shire Council Local Government Area.

1.2 Project Drivers

Local Councils have the responsibility to maintain public open spaces and roadsides. This maintenance includes a requirement for pest and weed control. BSC has an integrated approach to weed management, using herbicides alongside other methods including mechanical and manual removal techniques, biological controls and other bush regeneration activities.

Community concerns are important drivers in decision making around weed management and the use of herbicides in public areas. Following increasing community concern regarding impacts on human health and the residual environmental impacts of herbicides used for weed management, BSC has resolved to review its use of herbicides.

At a national and international level, the use of the common herbicide glyphosate (predominantly used in Monsanto's multipurpose herbicide product known as Roundup®) has already been restricted or banned in cities, states or counties of numerous countries (Baum and Hedlund 2021). Within Australia, some councils have already ceased use of, or are currently reviewing or phasing out, the use of glyphosate (AIHs 2019).

The drivers for this project are understood to be:

1. Community concerns regarding impacts on human health and the residual environmental impacts of herbicide use.
2. BSC's commitment to the community and ecologically sustainable development (ESD) (through minimisation of chemical pollution by minimising the use of herbicide based weed control and to use alternatives where practicable and feasible).
3. To control the growth of weeds in road reserves, nature strips, parks and other public places to an acceptable level.
4. To contribute to Bellingen Shire's biosecurity.
5. To protect natural assets, particularly waterways and wetlands, from invasive weeds.
6. To protect staff and community members from health impacts of herbicide use.

1.3 Objective and Scope

The main objective of this project is to undertake a review of current herbicide usage by BSC.

The Scope of Works for this project includes:

1. A literature review on international and Australian considerations of herbicides in use and trials of alternative herbicide products and methods.
2. Assessment of BSC's current herbicide use including type of product, quantity used, cost, labour time and areas of application.
3. Stakeholder engagement to identify areas in the Shire of greatest concern regarding herbicide use.
4. A 12-week trial period of herbicide alternatives at sites identified through stakeholder engagement.
5. A comparison between BSC's current herbicide practices ((1) above) and the adoption of herbicide alternative practices ((4) above); and
6. A review of the BSC Pesticide Use Notification Plan (2014) in accordance with findings of (1)-(5) above.

2 Literature Review

2.1 Herbicides

A herbicide is a naturally or synthetically produced substance used to destroy, suppress or alter the life cycle of a weed species (Croplife 2021). Herbicide products are sold as a formulation. The biological activity and effectiveness of herbicides are determined by the active ingredient, which is formulated with other inert ingredients (such as water, oils and surfactants) and then sold as a product. This addition of inert ingredients improves the storage, application and often the safety of herbicide products. The term 'herbicide' refers to the active constituent of the product, as opposed to the formulation.

The main herbicide products used in Australia include active constituents of glyphosate, 2-methyl-4-chlorophenoxyacetic acid (MCPA), dicamba, bromoxynil, picloram, triclopyr, 2,4-Dichlorophenoxyacetic acid (2,4-D), aminopyralid, diflufenican, flupropanate, amitrole and metsulfuron methyl.

2.2 Different Classes

The various classes of herbicides are important to consider, as the mode of action, together with the formulation, determines the effectiveness of various herbicide products.

Herbicides may be derived from inorganic sources (copper, sulphur), natural organic sources (plants) or be organic compounds synthesised in a laboratory. Many of these synthesised products mimic the activity of natural organic compounds. There are a wide variety of chemicals with different chemical structures that determines their mode of action, uptake, biotransformation and persistence in the environment.

The major groups of herbicides are summarised in the following sections.

2.2.1 Phenoxy Herbicides

Phenoxy herbicides mimic the effect of natural plant growth hormones called auxins, which regulate the growth of plants. One of their functions is to make the plant grow towards the light. Phenoxies, or as they are commonly called today, phenoxy herbicides, are a class of pesticides related to the growth hormone indoleacetic acid. When sprayed on broad-leaf plants they induce rapid, uncontrolled growth, eventually killing them. Chemically they are acids and are typically applied in an ester or salt form. Two of the best known phenoxy herbicides are 2,4-dichlorophenoxyacetic acid (2,4-D) and 2,4,5-trichlorophenoxyacetic acid (2,4,5-T).

2.2.2 Triazine Herbicides

The 1950s saw the introduction of the triazine family of herbicides. Triazine herbicides are a group of pesticides that interfere with plant photosynthesis. Examples include atrazine, glyphosate, propazine and simazine. Triazine herbicides are currently the herbicide family of greatest concern with regard to groundwater contamination. Atrazine does not break down readily (i.e. within a few weeks) after being applied to soils of above neutral pH. Under alkaline soil conditions atrazine may be carried into the soil profile as far as the water table, especially following rainfall. Atrazine is thus said to have carryover, a generally undesirable property for herbicides. Due to its effectiveness on a large number of weeds and

under a broad range of conditions, atrazine is widely used. Many modern chemical herbicides used for agriculture are specifically formulated to decompose within a short period after application. This attribute is desirable as it allows crops, which may be affected by the herbicide, to be grown on the land in future seasons. However, herbicides with low residual activity (i.e. that decompose quickly) often do not provide season-long weed control.

Glyphosate is another widely used triazine herbicide and is the mostly widely used pesticide in Australia and globally (CropLife 2021). The most common glyphosate containing product is Roundup® by Monsanto. Its mode of action is to inhibit an enzyme involved in the synthesis of the aromatic amino acids: tyrosine, tryptophan and phenylalanine. It is absorbed through foliage and translocated to growing points. Because of this mode of action, it is only effective on actively growing plants and is not effective as a pre-emergence herbicide.

2.2.3 Phenyl Urea Herbicides

Phenyl urea herbicides inhibit plant photosynthesis. One of their main uses is for selective control of annual weeds in fruit and field crops and non-crop areas. The Bayer Chemical Company introduced DCMU (3, 4- dichlorophenyl)-1, 1-dimethylurea) in 1954 under the trade name of diuron. Similar to atrazine, diuron is effective on a large number of weeds and under a broad range of conditions. The Australian federal government pesticide regulator, the Australian Pesticides and Veterinary Medicines Authority (APVMA), recently issued a suspension on the use and sale of many products containing diuron due to environmental concerns. Other phenylurea herbicides include linuron and chlorotoluron.

2.2.4 Sufonylurea Herbicides

Sulfonylureas are a family of environmentally compatible herbicides that were discovered by DuPont Crop Protection in 1975 and first commercialised for wheat and barley crops in 1982. They are now sold worldwide for use in all major agronomic crops and for many specialty uses (e.g. rangeland/pasture, forestry, vegetation management). Sulfonylureas represent a major advance in global crop protection technology and have revolutionised weed control by introducing a unique mode of action. Specifically, these compounds interfere with a key enzyme required for weed cell growth, acetolactate synthase. Furthermore, sulfonylureas are compatible with the global trend toward post emergence weed control and integrated pest management (http://news.agropages.com).

2.2.5 Quaternary Ammonium Herbicides (Dipyridyls)

Quaternary ammonium herbicides fall into the class of herbicides that are classified as disinfectants. Examples are paraquat and diquat, which are non-selective contact herbicides that are widely used in agriculture and by government agencies and industry for weed control.

2.3 Environmental Fate and Transport of Herbicides

One of the main principles governing the fate of herbicides in the environment is a process known as partitioning, which determines the chemical's ability to move (or partition) into different phases. There are four potential phases in which herbicides can move: sediment or soil (mineral matter or particulate organic carbon), liquid (water phase), gas (volatile phase) and biota. There are also four factors that govern this partitioning: soil sorption coefficient (K_{oc}), solubility, Henry's Law Constant (H) and the n-octanol/water partition coefficient (K_{ow}). These parameters have been well defined for herbicides and are used to predict the environmental fate of the herbicide.

For herbicides with high soil sorption coefficients (K_{oc}), their movement in the environment may be reduced if the herbicide binds to the organic matter in the soil. This is why the sorption behaviour of an herbicide can be described by its organic carbon normalised sorption coefficient. Movement is decreased by sorption and this can cause increased persistence because the herbicide is protected from degradation.

Another factor influencing herbicide fate in the environment is the DT50 or half-life, which is the time required to decrease the initial quantity or concentration of the herbicide to one half.

Henry's Law Constant (H) states that the solubility of a gas in a liquid is directly proportional to the pressure of the gas. Henry's law has since been shown to apply for a wide range of dilute solutions, not merely those of gases.

The K_{ow} is the chemical's solubility in each of the phases at steady state and is usually expressed as log K_{ow}. It is used as an indicator of whether the chemical has the ability to bioaccumulate in aquatic organisms. If a chemical has a log K_{ow} of >3 this is usually an indicator that these chemicals will bioaccumulate.

Biomagnification is another fate of herbicides in the environment. Some of the older deregulated herbicides can persist for long periods in the environment. This is related to a higher affinity to bioaccumulate in fat tissue of organisms, as they are consumed by higher trophic levels organisms the concentrations increase, or biomagnify, higher up the food chain, generally through a series of prey-predator relationships. One of the most well-known cases of biomagnification occurred for the organochlorine herbicide, DDT which was documented by Carson in 1962 in the book Silent Spring (Carson, 2000). This work described ecosystem collapse as a result of synthetic pesticide usage, in particular DDT, which was directly linked to thinning eggshell of raptor birds in North America. This cascaded into the deregulation of many organochlorine and organophosphate pesticides with high bioaccumulation potential, which are no longer used. Current market and commonly used herbicides have a lower risk for transfer through the food chain and environmental breakdown is generally within days to months (in comparison to decades for some deregulated organochlorine and organophosphate pesticides).

2.4 Australian Pesticides Regulation and Management

Pesticides management is evolving in nature, in regard to the market, usage, community concerns, regulation and scientific literature.

2.4.1 Legislation

Legislation applicable to this project includes:

- North Coast Regional Strategic Weed Management Plan 2017-2022.
- *NSW Biosecurity Act 2015.*
- *NSW Biosecurity Regulation 2017.*
- *NSW Pesticides Act 1999.*
- *NSW Pesticides Regulation 2017.*

- Other legislation depending on the intended use.

2.4.2 Australian Pesticides and Veterinary Medicines Authority (APVMA)

Regulation of pesticides (including herbicides) in Australia is controlled by the APVMA. This is an Australian Government statutory authority which was established in 1993 to centralise the registration of all agricultural and veterinary chemical products into the Australian marketplace.

Use of pesticides and veterinary medicines are an integral part of providing high quality food and fibre production in Australia. It is estimated that Australia's primary production is worth $30 billion a year, with an export value of over $25 billion.

The APVMA states that they have an inventory of over 10,000 different pesticides and veterinary medicine products in the Australian marketplace. With such a wide choice of chemical products available, farmers need to know that the products they use will not only work, but will not harm themselves, their family, crops, animals or the environment. The APVMA is responsible for registration of all chemicals in Australia.

The APVMA provides a national registration system, requiring that these products are evaluated before they can be legally supplied, sold or used in Australia. The main role of the APVMA is as the industry regulator and it reviews all applications from industry and individuals to bring a chemical to marketplace. Applications undergo extensive evaluation and review by their internal expert staff or outside expertise, if required. Toxicity data is required and reviewed to address any human health and/or environmental concerns.

Registered pesticides carry an APVMA approved label that provides the users with all the information designed to minimise impacts on health, the environment and trade. By purchasing registered chemical products, consumers should expect:

- They have been assessed as suitable for use under Australian conditions.
- When used according to the label, products will not have any harmful effects on users, family, crops and animals or the environment.
- They are complying with the law.
- When used according to the label, there will be minimal waste and cost to user (http://www.apvma.gov.au/about/index.php#requireregistration).

As well as registering new agricultural and veterinary products, the APVMA also has the responsibility of reviewing older products to maintain safety, and re-evaluating registered chemicals when particular concerns are raised about their safety and effectiveness. In some cases, the review may result in confirmation of a chemical's registration or it may see registration continue with some changes to the way the chemical can be used. In other cases, the review may result in the registration of a chemical being cancelled.

In addition to the APVMA, the NSW Environment Protection Authority (EPA) is the State's statutory agency that enforces proper use of chemicals in NSW including pesticides, after the point of sale.

The *Pesticides Act 1999* governs the regulation of all pesticides after point of sale with the main focus of this legislation being the protection of health, the environment, property and trade while safeguarding responsible pesticide use.

APVMA Review of Glyphosate

The use of glyphosate far outweighs the use of other herbicides in Australia. This is due to its multipurpose application, effectiveness and relatively inexpensive chemical and labour costs. Glyphosate also has a relatively short half-life in water and soils (ANZG 2018).

There have been concerns raised in both the media and the scientific community about the use of glyphosate due to potential human health and environmental effects. In 2015, the International Agency for Research on Cancer (IARC) classified glyphosate as "probably carcinogenic to humans', among other 'commonly exposed' chemicals and activities including red meat consumption, processed food consumption, drinking hot beverages, drinking alcohol and exposure to sunlight. One major scientific criticism of the IARC assessments is that they don't account for how substances are handled, managed or used, which is an important part of the risk assessment process (CropLife 2021). This is a critical principle in chemical risk assessment, i.e. "it's the dose that makes the poison".

The APVMA has undertaken an extensive review in response to the above IARC classification and found no clear link between glyphosate and cancer. Their current stance is that the risk of glyphosate causing cancer is low, based on likely exposures when used according to the label (APVMA 2019). On this basis, the current assessment is that glyphosate is safe to use, when according to instructions.

Other international agencies, including the World Health Organisation (WHO), New Zealand Environmental Protection Authority (EPA), United States Environmental Protection Authority (EPA) and Health Canada's Pest Management Regulatory Authority have similarly assessed the risk of glyphosate as a carcinogen with similar conclusions to the APVMA.

However, on an international level, the use of glyphosate has already been restricted or banned in many cities, states or counties of numerous countries (Baum and Hedlund 2021). Within Australia, many councils have already ceased use of, or are currently reviewing or phasing out, the use of glyphosate (AIHs 2021).

There is a considerably increasing amount of new chemicals, including pesticides, being developed for retail and usage in a wide variety of applications. Combined with an expanding list of 'chemicals of concern' that have historically been approved for usage and then required to be phased out (including organochlorine (OC) and organophosphate (OP) pesticides) on the basis of environmental and human health risk (e.g. the alarming DDT 1940's advertisement in Figure 2-1). Given the historical basis of human risk assessment of chemicals, it is unsurprising that there is a degree of uncertainty and mistrust around the chronic long-term human and environmental health impacts of pesticides. In addition, given that the pesticides market and research is evolving, the precautionary principle should be adopted as much as possible.

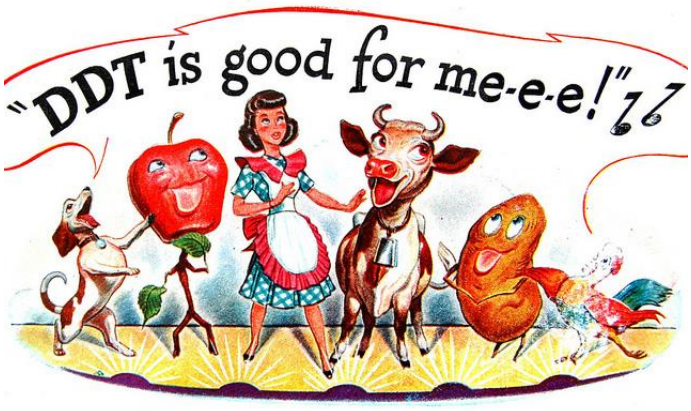

Figure 2-1 DDT American Marketing in 1940's during World War II (Science History Institute, 1947).

In 2018, Bryon Shire Council identified:

"Despite current regulation and improved knowledge about pesticide risk and responsible use, a degree of uncertainty will always exist. Uncertainty particularly surrounds possible long term effects of relatively new chemical formulations and existing registered pesticides that are under the spotlight of international and other national jurisdictions. This uncertainty alone provides justification for a policy of risk minimisation and underpins an increasing effort by municipalities throughout the world to reduce or cease pesticide use".

Surfactants called polyethoxylated tallow amines (POEAs) are commonly used in herbicide products as part of the formulation. The APVMA found that POEAs in various products were more toxic compared to the active glyphosate constituent. This needs to be an important consideration for transitioning to alternatives, although can be difficult to identify, as manufacturers are not required to include this information on labels.

2.5 CropLife Rating and Accreditation

CropLife is a global federation that represents the plant science industry. One of the areas that CropLife focuses on is resistance management. If pesticides with the same mode of action are used regularly and for extended periods of time, pest species can develop resistance to those pesticides. To help manage this issue, CropLife Australia have developed "Activity Group" ratings which are displayed on the label of all fungicide, herbicide and insecticide products. These activity groups, active constituents and examples of pesticide products, are listed on the CropLife website: http://www.croplifeaustralia.org.au/default.asp?V_DOC_ID=1952.

Agsafe is an independent subsidiary of CropLife and they implement three industry stewardship programs which include The Agsafe Accreditation & Training Program, drumMUSTER and ChemClear®. These programs are detailed on: www.agsafe.com.au.

The accreditation program provides training and accreditation for commercial stores that ensures personnel and premises safely transport, store, handle and provide appropriate advice from point of manufacture to point of sale.

2.6 Local Land Services

Within NSW, Local Land Services (LLS) (formerly NSW DPI) is the state government agency that provides support to landholders to manage pests and weeds under the *Biosecurity Act 2015*. LLS has published numerous supporting tools available to assist with weed management and the use of herbicides which include:

- NSW WeedWise Register and mobile phone application – a register of *Biosecurity Act 2015* listed weeds, biosecurity duty and herbicide control methods. Available from: NSW WeedWise.
- NSW Weed Control Handbook (NSW DPI 2018) – A guide to weed control in non-crop, aquatic and bushland situations. Available from: New South Wales Weed Control Handbook, Seventh Edition (nsw.gov.au).
- Integrated weed management overview (NSW DPI) – Website overview of integrated weed methodology. Available from: Integrated weed management (nsw.gov.au).

2.7 Pesticide Management Guidelines and Tools

Other relevant guidelines or tools for pesticide management include:

- Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZG 2018) – ANZG have recently released new water quality toxicant guidelines for the protection of aquatic ecosystems for various herbicides (including glyphosate and metsulfuron methyl). Available from: Water Quality Guidelines Home.
- Pesticide Impact Rating Index (PIRI) - a free software to assess pesticide mobility and likely impacts on water quality (Kookana et al. 2005). Available from: CSIRO Data Access Portal - Pesticide Impact Rating Index (PIRI) Software.

3 Review of Bellingen Shire Council Weed Management

3.1 Weed Management

A weed is defined by NSW DPI (2021) as "any plant growing where you do not want it to grow" and thus has the potential to cause economic, social and/or environmental impacts. While weeds are typically introduced species, native plant species can also become weeds when they grow outside of their natural range.

Within NSW, weeds can be categorised into agricultural weeds, environmental weeds, Weeds of National Significance (WoNS) and National Environmental Alert List weeds. Some weeds are priority weeds and require reporting, containment or eradication under NSW legislation or the North Coast Regional Strategic Weed Management Plan. The *Biosecurity Act 2015* prohibits some high risk activities and materials related to the spread of weeds and identifies that there is a general obligation for all people to take action to prevent the introduction and spread of weeds. Local governments have a legal responsibility to manage weeds within their boundaries and have controls in place to manage the risk of weeds effectively. Local councils are required to use suitable methods to manage weeds to increase the chance of control or complete eradication.

Integrated weed management is the process of using a combination of methods to reduce reliance on herbicides alone and requires considerable planning and a targeted approach to specific weed biology and life cycle. BSC currently adopt an integrated approach to weed management. This involves using a range of methods to control weeds including herbicides, mechanical, biological and manual forms of control. Herbicides are used as one of the options for weed management to maintain roadsides, road safety, curb and guttering, footpaths and parks and gardens.

Council's weed management and herbicide use falls under 3 departments:

- Town and park maintenance.
- Invasive plant management.
- Roadside maintenance.

The Pesticide Use Notification Plan (BSC 2014) "outlines how the Council notifies the community of the use of pesticides in any public place it owns or controls. The Council ensures that appropriate pesticides are applied to public places by suitably qualified persons in a safe and responsible manner, minimising risk to the community or environment."

A search of the NSW DPI WeedWise database for priority weeds on the NSW North Coast was made on 29th October 2021. There are 142 weeds listed on the North Coast, with search results provided in **Appendix A**. However, not all these weed species would be present within the Council operational areas of weed control.

3.2 Herbicide Use

3.2.1 Review Methodology

A review of BSC's current and previous herbicide usage was undertaken by reviewing the pesticide use notifications within a 12-month period. This was generally between July 2020 – August 2021, but with older records reviewed to January 2019 for some areas in order to capture enough data.

Key factors for assessment included:

- Name (chemical and retail name).
- Areas of use.
- Product (concentration/dilution and surfactant used in formulation).
- Method of application.
- Application timing including season.
- Purpose of use (multipurpose or targeted weed species).
- Whether used in combination with other methods.

3.2.2 General Overview

The full collated overview of herbicide usage by BSC is attached in **Appendix B** with a summary shown in Table 3-2.

Herbicides used by BSC across all areas included aminopyralid, bromoxynil (n -octanal ester), fluroxypyr, glyphosate, metsulfuron methyl, MCPA, picloram and triclopyr. A review of the environmental fate and toxicity of herbicides currently used by BSC is provided in **Appendix C**.

Methods of herbicide weed treatment used by BSC or their contractors during the reviewed period included:

- Spraying – pump and hose mechanical sprayers on vehicles/trailers, knapsack (backpack) hand pump units or handheld spray bottles including splatter guns.
- Cut and paint – used to treat woody weeds or those with substantial stems (such as blackberry, Madeira vine and Japanese honeysuckle). The stem of the weed is cut close to the ground and then the herbicide (metsulfuron methyl or glyphosate) is painted onto the cut end with a brush.
- Drilling – used to treat trees or substantial woody weeds (such as cockspur coral tree and broad-leaf pepper tree) where a hole is drilled into the cambium layer of the trunk and a small amount of herbicide is applied into the hole.

Weeds controlled with herbicides by BSC and areas treated are summarised in Table 3-1. Refer to Section 3.3.1 for a list of some issues with interpreting and collating a summary of the available records.

Table 3-1 Weeds treated by herbicides by area during review period (BSC 2021).

Common Name	Scientific Name	WeedWise Listing (relevant to BSC)	Areas treated
Aquatic Weeds			
Kidney-leaf mud plantain	*Heteranthera reniformis*	Regional Eradication Priority	B
Salvinia	*Salvinia molesta*	General Biosecurity Duty	B
Water Hyacinth	*Eichhornia crassipes*	Regional Containment Priority	P
Grasses			
Bristle grasses	*Setaria* spp.	General Biosecurity Duty	R
Elephant grass	*Pennisetum purpureum*	General Biosecurity Duty	B
Giant Parramatta grass	*Sporobolus fertilis*	General Biosecurity Duty	R
Introduced grasses	Various spp.	General Biosecurity Duty	B, P, R, W
Shrubs / Groundcovers			
Bindii	*Soliva pterosperma*	General Biosecurity Duty	P
Blue Billy goat weed	*Ageratum houstonianum*	General Biosecurity Duty	B
Castor oil	*Ricinus communis*	General Biosecurity Duty	B
Clover	*Trifolium* spp.	General Biosecurity Duty	P
Cobblers' pegs	*Bidens pilosa*	General Biosecurity Duty	P
Fireweed	*Senecio madagascariensis*	General Biosecurity Duty	P, R
Mahonia	*Berberis lomariifolia*	Regional Eradication Priority	
Mother of millions	*Bryophyllum delagoense*	General Biosecurity Duty	R
Ochna	*Ochna serrulate*	General Biosecurity Duty	B
Paterson's curse	*Echium plantagineum*	General Biosecurity Duty	R
Singapore daisy	*Sphagneticola trilobata*	General Biosecurity Duty	B, W
Tobacco	*Solanum mauritianum*	General Biosecurity Duty	B, R
Yellow bells	*Tecoma stans*	Regional Containment Priority	B
Creeping vines			
Balloon vine	*Cardiospermum grandiflorum*	General Biosecurity Duty	B
Banana passionfruit	*Passiflora tarminiana*	Local Eradication Priority	P, R
Cats claw creeper	*Dolichandra unguis-cati*	General Biosecurity Duty	B

Common Name	Scientific Name	WeedWise Listing (relevant to BSC)	Areas treated
Japanese honeysuckle	*Lonicera japonica*	General Biosecurity Duty	B, W
Kudzu	*Pueraria lobata*	Regional Containment Priority	B
Madeira vine	*Anredera cordifolia*	General Biosecurity Duty	B, W
Morning glory	*Ipomoea purpurea; I. indica*	General Biosecurity Duty	B, P
Moth vine	*Araujia sericifera*	General Biosecurity Duty	B
Orange trumpet vine	*Pyrostegia venusta*	General Biosecurity Duty	
Wandering trad	*Tradescantia fluminensis*	General Biosecurity Duty	B
Woody stemmed (at maturity)			
Bitou bush	*Chrysanthemoides monilifera* subsp. *Rotundata*	General Biosecurity Duty	B
Black locust	*Robinia pseudoacacia*	Regional Containment Priority	B
Blackberry	*Rubus fruticosus*	General Biosecurity Duty	B, P, R, W
Broad-leaf pepper tree	*Schinus terebinthifolius*	Regional Containment Priority	B
Camphor laurel	*Cinnamomum camphora*	General Biosecurity Duty	R
Cape broom	*Genista monspessulana*	Regional Eradication Priority	R
Cassia/Senna	*Senna pendula* var. *glabrata*	General Biosecurity Duty	B, R, W
Cockspur coral tree	*Erythrina crista-galli*	Regional Containment Priority	B, P, W
Green cestrum	*Cestrum parqui*	Regional Containment Priority	B
Groundsel bush	*Baccharis halimifolia*	Regional Containment Priority	R, B
Lantana	*Lantana camara*	General Biosecurity Duty	R, W
Mysore thorn	*Caesalpinia decapetala*	Regional Containment Priority	B
Privet	*Ligustrum* spp.	General Biosecurity Duty	B, P, R
Red cestrum	*Cestrum elegans*	Regional Eradication Priority	W
Scotch broom	*Cytisus scoparius* subsp. *Scoparius*	Regional Eradication Priority	R
White-stemmed blackberry	*Rubus niveus*	Regional Eradication Priority	B, R, W

P = parks, gardens and reserves, W = wastewater treatment plants, water treatment plants, waste depots and cemeteries, R= roadsides, B= bush regeneration sites.

3.2.3 Urban

Urban areas include parks and gardens, public reserves, cemeteries and waste depots.

Around high use areas, including parks and gardens, the urban maintenance team used a low volume of glyphosate (approximately 2 x 20L per year) applied with targeted spot spraying methods. Most of the weed management in urban areas is undertaken using whipper snipping, although it is noted that there has been some difficulty maintaining weed infestations including bindii and clover.

Most herbicide usage was around the waste depots and cemeteries. Herbicides used in these areas included glyphosate, metsulfuron methyl, triclopyr, picloram and aminopyralid. Application methods were both targeted (using cut and paint for metsulfuron methyl) and multipurpose targeted sprays using a backpack, hand spray or powered unit.

3.2.4 Bush Regeneration Sites

Bush regeneration sites are maintained by contractors. During the review period targeted herbicide application methods were used for weed management which resulted in minimal usage concentrations and only as required (i.e. last resort). Many of the bush regeneration sites (approximately 50%) are adjacent to waterways, so this is an important consideration for selecting herbicides to ensure there is no spray drift or entry into waterways.

Herbicides used included glyphosate, metsulfuron methyl, triclopyr, picloram and aminopyralid. Most of these are woody species or have substantial vines so were treated using cut and paint method or targeted spraying.

3.2.5 Roadside Maintenance

The roadside maintenance areas had the highest volume of herbicide usage during the review period. This is a reflection of the high number of roadside areas within the shire and also that integrated methods are more challenging to apply, or not suitable, for the woodier stemmed weeds.

Herbicides used included glyphosate, metsulfuron methyl, triclopyr, picloram and aminopyralid. Methods of application were targeted using cut and paint (metsulfuron methyl) or spot sprays using a backpack, hand spray or powered unit.

Table 3-2 Summary of herbicides used by Bellingen Shire Council in 2019.

Product	Herbicide	Concentration	Other ingredients	Mode of action	Target weed	CropLife Pesticide Group	Approximate Cost (November 2021)
Weedmaster Duo®	Glyphosate	360g/L	Water	Non-selective contact Inhibitor of EPSP synthase	Multipurpose	Group M	$195/20L
Roundup Bi-active®	Glyphosate	360g/L	Water, surfactants, and minor formulating ingredients (58.86%)	Non-selective contact Inhibitor of EPSP synthase	Multipurpose; aquatic	Group M	$190/20L
Met-sun® & Brush-off®	Metsulfuron methyl	600g/kg	Mixed with a wetting agent non-ionic surfactant, such as Pulse® (1020g/L)	Selective Inhibitor of acetolactate synthase (ALS), inhibitors of acetohydroxyacid synthase (AHAS)	Broadleaf weeds	Group B (sulfonylurea herbicide)	$26.50/500g
	Picloram	100g/L	Diethylene glycol monoethyl		Woody weed species.	Group I	$820/20L
	Triclopyr	300g/L					

Grazon Extra®; Conqueror	Aminopyralid	8g/L	ether (30-40%)	Selective (foliage and roots) & long lasting Disrupts plant cell growth	Brushweed and broadleaf weed control		
Bromocide 200®	Bromoxynil (n -octanal ester)	200g/L	--	Photosynthesis II inhibitor	Certain annual grasses and broad leaf weeds	Group C	$630/20L
	MCPA	200g/L		Disrupts plant cell growth	Bindii and broadleaf control	Group I	
Starane Advanced®	Fluroxypyr	333g/L	--	Disrupts plant cell growth	Woody, Buckleaf and Broadleaf Weed Control	Group I	$1,285/20L
Conqueror	Triclopyr	300g/L	--	Selective (foliage and roots) & long lasting Disrupts plant cell growth	Woody weed species. Brushweed and broadleaf weed control	Group I	Unknown.
	Picloram	100g/L					

3.3 Assessment

3.3.1 Herbicide Use Records

Based on the review of herbicide usage and available information it is considered that BSC and their contractors are generally selecting targeted methods that require the minimum concentration of herbicides and are using these in line with label recommendations and adequate WHS protocols.

Herbicide records are being maintained and mostly in line with requirements but there are some issues with interpreting and collating a summary of the records as listed below:

1. Not all records matched the pesticide notifications.
2. Some records did not have any weeds listed at all.
3. There was incorrect identification of some weeds.
4. Some records did not include environmental conditions.
5. Some records did not clearly identify which herbicides were used to treat which weeds.

A collated and accurate summary was able to be achieved with assistance from BSC. However, with inconsistent and incomplete records, there are challenges with collating the information and making an informed assessment. To meet the requirements of the *NSW Pesticides Act 1999* this information needs to be accurately recorded. Recommendations to rectify this issue are listed in Section 7.

3.3.2 Environmental Conditions

Environmental conditions (wind, temperature, humidity and rain) are an important consideration for selecting optimal conditions for herbicide application to reduce environmental impacts and WHS issues. The environmental conditions were assessed as either suitable (preferred or marginal) or unsuitable according to Figure 3-1 and Table 3-3. Some herbicide application records did not have this information, however, all available records were noted to be undertaken during suitable conditions, noting that Bellingen Shire experiences moderate humidity conditions (so it would be difficult to select conditions where humidity is <65%).

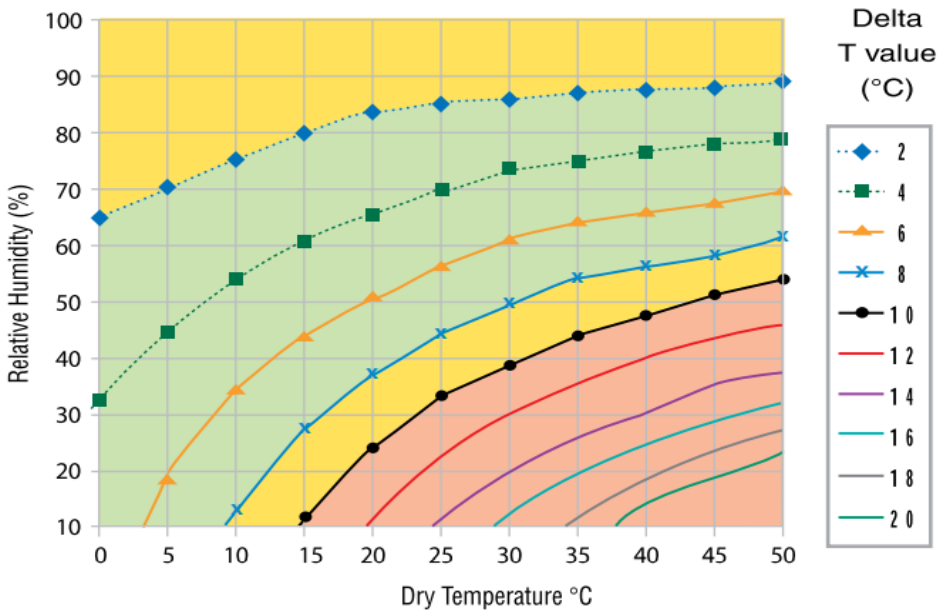

Figure 3-1 Optimal conditions for spraying (APVMA 2021, NSW DPI 2018).

Table 3-3 Criteria to assess suitable herbicide application methods.

Condition	Wind	Rain
Suitable - Preferred	0-5 km/hr	<1 mm day before, day of application and day after
Suitable - Marginal	5-15 km/hr	1-5 mm day before, day of application and day after
Unsuitable	>15 km/hr	>5 mm day before, day of application and day after

4 Review of Herbicide Alternatives

4.1 Selection of Alternatives

The selection of herbicide alternatives is challenging given that different approaches need to be specifically catered towards the target weeds and their location. What is suitable for an urban environment may not be applicable to bush regeneration sites adjacent to waterways or on roadsides.

Four factors need to be balanced when considering alternative methods or products in weed management as shown in Figure 4-1. Although some compromise might be possible for the costs/labour/effectiveness to transition to an alternative approach, on a large scale of council operations with limited resources this can be very challenging.

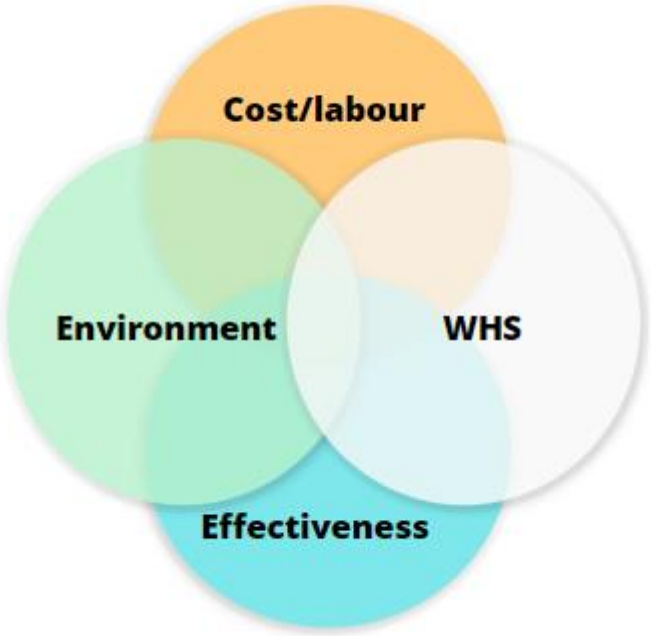

Figure 4-1 Important factors in considering herbicides alternatives.

4.2 Australian State and Local Government

This section outlines the findings of previous Australian local government (council's) investigations into herbicide alternatives and weed management approaches. Online searches were undertaken to review Australian council case studies where there has been a trial or transition of alternative products to glyphosate or other herbicides. The review of national case studies was undertaken through online searches using the key words "council", "glyphosate", "herbicide alternative", "phase out" and "Australia".

Information is usually provided in the form of a short online article published on the council's website so there are challenges in collating information on alternative trials. Case studies were reviewed to identify the following information:

- Alternative method or product used.

- Active constituent of alternative.
- Mechanism of action for weed control.
- Timing of transition.
- Pros and cons of alternative products.

The complete phasing out of herbicide use is not currently a practical or viable alternative and to our knowledge has not been achieved by councils anywhere else in Australia. However, there are councils (such as Bryon Bay Council) that have successfully completely ceased herbicide usage in urban areas.

A full summary of Australian case studies is provided in **Appendix D**.

4.2.1 Bellingen Shire Council

Since the 1990's BSC has undertaken numerous trials and work to investigate herbicide alternatives and decrease reliance on synthetic herbicides with varying success (Pers. Comm with various stakeholders, see Section 4.3.9) (Table 3-2).

It is important to consider and build upon these lessons learnt, identify which methods have already been trialled unsuccessfully and also to acknowledge that some of these alternative methods remain in place as part of BSC's integrated approach (as identified in Section 3).

Table 4-1 Summary of alternatives already trialed within Bellingen Shire.

Method	Overview	Method still in place?
Bioorganics: acetic acid, pelargonic acid, pine oil and sodium chloride	Mostly bioorganic products were found to be unsuitable replacements due to environmental impacts, WHS, cost and/or effectiveness. Of these, acetic acids (Localsafe®) showed the most promise although long term effectiveness was doubtful.	Yes, some are still in place as part of the toolbox approach and used where suitable.
Waipuna Steam weeding (1990's)	A steam weeding demonstration and some trials were undertaken within Bellingen Shire. It was considered to be unsuitable due to the impacts on greenhouse gases (uses diesel), however technology has significantly improved since.	No but there are suitable contractors available in the area.
Roadside Landcare Group	A roadside Landcare group formed whereby residents could maintain their property frontage. As this is on council land, residents needed to be inducted and WHS requirements met.	Noted that this option required a lot of resourcing in terms of induction and training. The register has not been maintained due to resourcing and WHS requirements.
Flame weeding (weed dragon)	Using a propane fueled wand to kill weeds. Was effective at killing some weeds including privet seedlings. Found that it stimulated seeds to germinate.	No.

Method	Overview	Method still in place?
Whipper-snipping and weed mat around banks	Effective approach but needs to be managed and more labour intensive.	Yes, in some areas. Whipper snipping is used as main method of weed management in urban maintenance and very minimal volumes of herbicides are used.
Wick wiping around roadsides (NSW DPI)	Wick wiping is using a rotary sprayer/slasher to apply herbicides in a targeted approach. This was a lot more effective in comparison to spraying. This was expensive and required a specialist contractor from QLD.	No longer used.
Flupropanate	A synthetic herbicide used to manage Paramatta grass.	No longer used. Assume that glyphosate is used in place.

4.2.2 Brisbane City Council

In 2019, Brisbane City Council undertook a comprehensive desktop review of glyphosate usage within 537 local councils across Australia on publicly available information. At the time of their review, it was identified that glyphosate usage was being reviewed at 27 councils and banned in some capacity at two councils. A summary of their review is shown below in Table 4-2.

Table 4-2 Brisbane City Council review of available information on glyphosate use (2019).

Criteria	Councils	State Governments / LG associations
No information/mention of glyphosate	397	5
Glyphosate mentioned in normal activities	86	4
Specific reference to the APVMA, no trials/reviews listed	15	4
Reviewing use and/or trialing/trialed/using alternatives	27	0
Use partially/fully banned currently	2	0
Other – Glyphosate mentioned without specific detail	15	2

The review also summarised and considered glyphosate alternatives including steam weeding, flame weeding, pine oil, pelargonic acid and acetic acid identifying that none of these were suitable as a replacement of glyphosate.

A number of recommendations were made based on this review including:

- Continued use of glyphosate as per APVMA up to date information.
- Review of procedures.
- Review of herbicide usage as according to label and standard operating procedures.
- Operators to hold an *Agricultural Chemicals Distribution Control Act 1966* (ACDC) licence.

- No spray zones (5 m) around BBQs and playgrounds.
- Development of a Pesticide Use Notification Plan.
- Continued review of alternative options.

4.2.3 Bryon Shire Council

In 2018, Bryon Shire Council produced a Shire wide integrated pest management policy and strategy which outlined how they have met two aspirations being:

1. "Cessation of the use of all herbicides (and repetitive use of pesticides to control pest animals) in highly frequented public use areas within five years".
2. "Promotion of Integrated Pest Management using methods with the least adverse effect on human health and the environment in all other areas that are not considered as a highly frequented public use area."

The Council identified that areas of frequent use include all areas within the boundaries of all town and village centres, children's playgrounds, sports fields (including golf courses), swimming pool areas and parks with facilities and infrastructure. The Council has successfully stopped using pesticides at all children's playgrounds, around bus shelters, all public gardens and urban kerbs (with exception of roundabouts) and at 70% of sporting fields and transitioned to steam and manual removal methods including hand weeding, brush cutting and mowing. It was noted that some situations could arise that present an unacceptable risk to the Council or public, where alternative methods are not suitable (such as bindii or fire ants).

A trial ceasing pesticide use on roadsides was undertaken by using alternative methods such as mowing, brush cutting and shoulder grading. However, they found that this created some situations that posed risks (e.g. by blocking line of sight or visibility) or were too costly.

The report also identified that there was a misalignment with some of the community understanding around the Council's pesticide usage, assuming that it was banned in all areas of the Shire. On this basis, it was recommended that a Pesticide Policy was developed to clearly outline the use of pesticides.

4.3 Overview of Alternative Options

This section provides an overview and review of all alternative options to reduce current herbicide usage or trial alternative products that may be more acceptable to the community. Products not registered and approved with the APVMA were not considered in this review as they are not regulated for use as herbicides for commercial application so their safety cannot be confirmed.

Several options were ruled out on the basis that they have already been trialled by BSC or other councils, were considered impractical or posed significant environmental or WHS risks.

None of the alternative herbicide methods and products listed in this section provide a competitive alternative in terms of meeting the four criteria including cost (labour and product), effectiveness, environmental and human health risks. It is also noted that the reviewed approaches tended to be more suitable for urban type areas and multipurpose treatment of more fragile (non-woody) species.

4.3.1 Integrated Weed Management

BSC currently adopts an integrated approach to weed management and aside from herbicide usage, other methods are used to control weeds including mechanical, biological and manual forms of control. While it is not viable or practical that integrated weed management techniques could ever completely replace herbicide usage, these options can be considered prior to the use of herbicides or as part of the toolbox approach.

Integrated weed management methods include:

- Restoration of soil health using soil conditioners to restore nutrients and promote microbial soil health.
- Mulching where practical to smother weeds and promote soil health.
- Competitive planting – planting of other species to outcompete the weeds.
- Biological control of weeds – used approved biological control methods for selected weeds of concern (for example - Weed Biocontrol (csiro.au))
- Better implementation of the existing 'No spray' register where residents form a volunteer group, register their property frontage to be excluded from chemical sprays by the Council on the provision that they will be responsible for the maintenance. There would be a requirement for inductions, training, supervision and possible litigation considerations for BSC.
- Introducing 'No spray' exclusion zones around sensitive areas including BBQs and children's playgrounds.

Assessment: Viable alternative as part of toolbox. BSC already has an integrated weed management approach, then these methods may already be adopted as much as possible. However, these methods are worth revisiting as there may be opportunities to transition to more integrated alternative methods in place of herbicide usage or allocate resources to improve on these methods where they are already being used but not successfully (For example the 'No Spray' register).

4.3.2 Mechanical methods

Mechanical methods are also part of BSC's integrated approach and similar to above these can be considered as alternatives, where they are not already in use.

Mechanical methods include:

- Hand weeding to manually remove weeds. This is a very effective but highly labour intensive method so would be difficult for BSC to implement on a large scale.
- Brush cutting and edge mowing. These are both effective in the short term but require more frequent applications to control weeds.

Assessment: Viable alternative as part of toolbox but may already be included as much as possible. If any of these options are not already being implemented BSC in areas and are suitable in terms of the labour budget, they should be considered in lieu of herbicide usage.

4.3.3 Steam Weeding

Steam weeding involves the use of a machine that uses high temperature water to generate steam which kills plants quickly via non-systematic contact. The mechanism of treatment is that the steam quickly heats up the water within plant cells, expanding and bursting the cell wall and soft tissue, causing the weeds to wilt and die (Steamweeders 2021).

Steam weeding has been trialed or adopted by numerous councils in addition to BSC (Section 4.2.1) including Brisbane City Council and Fairfield City Council. Recently, Royal Melbourne Institute of Technology (RMIT) University also trialed steam weeding alongside brush cutting and edge mowing and found that steam weeding performed best. Steam weeding had similar effectiveness to glyphosate during Summer but was less effective during Autumn/wet season.

Pros:

- Workers and the general public are not exposed to chemicals.
- Non-toxic and effective.
- No ongoing purchase or storage of chemicals is required.
- Weeds do not develop resistance so can be used repeatedly.

Cons:

- May not be viable to purchase given large initial outlay for unit and costly ongoing maintenance. Requires fuel or diesel and needs to be used close to a constant fresh water supply.
- May not be as effective following wet weather.
- Machines are noisy so usage would be restricted to within certain times of the day which are likely to be when more public are using these areas.
- Steam creates the risk of steam burns and WHS issues.
- Can generate a steam cloud, particularly during colder temperatures, blocking visibility.
- Staff need to be properly trained.
- Large heavy equipment that requires transportation.
- Uses large amount of water, diesel and petrol (affecting air emissions).
- Steam could stimulate some dormant weed species.
- More labour intensive.
- Probably not suitable for bush regeneration sites.

Assessment: Possibly viable alternative as part of toolbox. Given its success with other councils and the pros relating to this method, this could be a viable option to trial for use around public spaces. However, given the considerable WHS issues associated with this method this approach would only be

considered viable if maintenance staff were amenable to this option. Based on other trials, this option would not be suitable as a complete replacement of glyphosate.

4.3.4 Acetic Acid (Local Safe®)

Acetic acid, also known as vinegar, has been used as a non-selective 'bioorganic' alternative in a variety of products. In trials undertaken by councils, the most trialed product containing acetic acid was Local Safe® which also includes sulfamic acid and copper in the formulation.

Local Safe® has been trialed by BSC in 2016, Brisbane City Council in 2019, Armidale City Council in 2016 and Kingston Council in 2017. Kingston Council also combined a soil conditioner (containing limonene, non-ionic surfactants, and nutrients) with the application. Armidale City Council has transitioned to using this product as an alternative to glyphosate in certain public spaces around parks and sporting fields (in 2016). Based on these trials, there are mixed findings of this product as an alternative, but most have considered that it is useful as part of their toolbox approach.

Pros:

- Works as a non-systemic pesticide with good knockdown.
- Performed better than Pine oil and pelargonic acid in council trials in general.
- Stronger application can be applied for woody species.

Cons:

- Long term effectiveness was considered doubtful.
- Potential environmental impacts on soil microbial communities via lowered pH.
- Strong odour can linger with potential public concerns and impacts.
- Weeds need to be thoroughly coated.
- Roots aren't impacted so repeated applications are needed.
- Some reports that it doesn't control woody weeds and vines but unclear if higher doses were trialed.
- Potential corrosion of equipment.
- Risk of irritation to eyes, airways and skin. Toxic when inhaled in high doses.
- Not approved for waterways.

Assessment: Possibly viable alternative as part of a toolbox.

4.3.5 Pine Oil

Pine oil is marketed as an organic alternative to glyphosate in products such as Bioweed Organic®. Its mechanism as a herbicide is non-systematic (i.e. it does not affect roots) and works by stripping the outer wax cuticle coating of the plant or seed resulting in dehydration and cell death (Bioweed 2021). It is suitable for herbaceous weeds and grasses but not woody species such as lantana.

Trials using Bioweed Organic® were undertaken by BSC in 2015 and Brisbane City Council in 2019.

Pros:

- Good initial knockdown and follow-up treatments within one-two months are sufficient to remove most herbaceous weeds.
- Application is via a backpack or ground boom sprayer.

Cons

- More expensive than glyphosate.
- Can only be applied twice in one year.
- Cannot be used near waterways.
- Only effective on more fragile species.
- Ruined equipment, in particular rubber seals.
- Pungent Dettol-like lingering odour. In the Brisbane trial, members of the public expressed concern on the potential toxicity of the product due to the odour.
- Risk of irritation to skin, nose and throat and has potential to cause permanent eye damage.

Assessment: Not a viable alternative.

4.3.6 Pelargonic Acid (Slasher®)

Pelargonic (nonanoic) acid is another organic alternative which is available in products such as Slasher®. It is made from a fatty acid that occurs naturally in the esters of pelargonium plants and the mechanism is by non-selective desiccation and burn down of green tissues from contact with the product (Organic Crop Protectants 2021).

Slasher® has been trialed as a glyphosate alternative by BSC in 2019 in a small trial around wastewater treatment plants and bush regeneration sites. It was also trialed by Randwick Council and Armidale City Council, both in 2019. North Sydney Council has continued to use Slasher® as an alternative to glyphosate in certain areas of public use such as sporting fields and parks.

Pros:

- Good initial knockdown of weeds. However, the product must completely coat the weed plants to be effective.
- More effective in comparison to Pine oil trials.

Cons

- Comparable mammalian toxicity to glyphosate.
- Not as effective as glyphosate and particularly on weeds with extensive root systems or woody varieties. Regrowth is quicker and therefore respray times are shorter.

- More labor intensive.
- More costly in labor and product due to more applications needed.
- Equipment damage is likely from ongoing use.
- Safe handling of acid concentrate required.
- Not suitable near waterways or in any environmentally sensitive areas.
- Can cause discoloration of concrete resulting in amenity impacts.
- Has not been reported in the trials, but given the acidic nature of the product, potential impacts on soil pH and microbial communities should be considered or investigated as part of future trials.

Assessment: Not a viable alternative.

4.3.7 Sodium Chloride

Sodium chloride (salt) has been considered as an alternative and has been shown to be effective. However, repeated applications of sodium chloride can result in saline soils and therefore this is not considered a viable option.

Assessment: Not a viable alternative.

4.3.8 Flame Weeding

Flame weeding involves the use of a gas fueled flame gun to directly burn weeds. Given the WHS and environmental risks (starting bushfires) associated with this alternative, it was not considered a viable option for further investigation.

Assessment: Not a viable alternative.

4.3.9 Alternative Application Methods

There are alternative application methods where synthetic herbicides are still used but in a targeted approach to ensure that there is no spray drift and the minimum amount is used.

Alternative application methods include:

- Cut and paint – woody weeds are cut (slashed, drilled or scraped), and herbicide painted on open cut end to kill the whole plant.
- Wick wiping – direct application of herbicides via a wick curtain which is brushed against the targeted plant using a rotary equipment mounted on a vehicle or handheld.
- Pellet injection - specialised gun is used to inject a dry pellet into the woody plant to kill the whole plant.

Assessment: Viable alternative as part of toolbox but may already be included as much as possible. If any of these options are not already being implemented BSC in areas and are suitable in terms of the labour budget, they should be considered in lieu of spraying.

4.3.10 Glyphosate Alternatives

None of the alternative herbicide methods and products listed in this section are considered to provide a competitive herbicide alternative in terms of meeting the four criteria including cost (labour and product), effectiveness, environmental and human health risks.

In some scenarios where herbicide treatment is considered necessary, alternative herbicides may be considered. Other synthetic herbicides that could be used in lieu of glyphosate for multipurpose systematic treatment (i.e. treatment to roots) of herbaceous weeds could include glufosinate ammonium (naturally occurring) or imazapyr (synthetic). Imazapyr is reviewed in further detail as this is the most commonly used synthetic alternative and there are products approved for use near waterways.

Imazapyr

Imazapyr is a synthetic pesticide which is registered with the APVMA and is available in products such as Arsenal Super® and Poacher 750®. Its mechanism is systemic and is classified as a Group B Herbicide which inhibits the AHAS/ALS (plant specific) enzyme and translocates quickly to the roots and shoots of weed species and then prevents new cell growth immediately. It works slower then glyphosate and organic based alternatives. Plants stop growing immediately after treatment although visible wilting may take weeks and complete death can take up to 30 days. Other plants may be stunted and unproductive and then not reproduce.

Imazapyr was trialed by Georges River Council in 2019 and found to be a suitable complete replacement for glyphosate throughout the LGA. A trial is currently underway by RMIT and Melbourne Water using Imaza forms including Imazapyr within Melbourne catchments. This trial shows promising early results as an alternative to glyphosate.

Although it's a synthetic herbicide, the toxicity of Imazapyr to mammals, fish and invertebrates has been found to be 'low' and there is fast breakdown in the soil and water, based on available information. Chronic toxicity tests for imazapyr indicate that it is not carcinogenic, mutagenic, or neurotoxic. Based on the available information, it is not suspected to cause reproductive or developmental toxicity and is not a suspected endocrine disrupter (**Appendix E**). Although it is a synthetic herbicide, it is also worth noting that there are still environmental and human health risks associated with many of the bioorganic alternatives.

Imazapyr is toxic to plants (and hence effectiveness) but concerns have been raised on the potential impacts on off-target plants. On this basis application methods need to minimise or avoid spray drift.

Pros:

- Systematic, so kills the whole weed.
- Georges River Council found similar effectiveness to glyphosate in that it had similar 'multipurpose' properties to glyphosate. Useful for pre and post emergence and can also treat seeds and prevent new seedlings. Works on woody species.
- USEPA found that Imazapyr was practically non-toxic (lowest toxicity category) to mammals and birds and slightly toxic to fish.
- Short half-life in water and soil.

- Registered for high volume (handgun) and low volume (boom) applications.
- Toxicity (oral LD_{50} >2,000 and dermal LD_{50} >5,000) is similar to glyphosate (**Appendix E**). Noting that concerns around glyphosate do not relate to the short-term toxicity (LD50) (which is comparatively low to other pesticides on market) but to the chronic effects as a potential carcinogen.
- Has undergone the extensive review process of APVMA as part of the registration.
- There are Imazapyr products suitable for use in or near waterways to treat cattails, cogon grass, water lily, water primrose and alligator weed (i.e. NuFarm Polaris®).

Cons:

- More expensive than glyphosate.
- Not an organic product, which may raise issues with public perception.
- Has only been considered in limited trials. Limited information is also available online.
- Plants can develop resistance with repeated application (similar to other synthetic pesticides).
- Concentrated product is harmful if inhaled and may cause irritation to eyes. Some formulations (Chopper® and Stalker®) have caused irreversible eye damage so should be avoided.
- May not be as effective in legume weed species (such as fireweed).
- While the plant stops growing immediately, the death of weed species takes up to 30 days to occur, so it takes a while to get visible results.

Assessment: Possible viable alternative as a glyphosate replacement for multipurpose treatment of more fragile weeds or as part of toolbox.

Glufosinate ammonium

Glufosinate is naturally occurring herbicide that is produced by *Streptomyces* soil bacteria. It is non-selective and acts on contact with some systematic action. It has a similar chemical structure to glyphosate but a different mode of action to kill weeds by blocking essential amino acids required for the plant to use nitrogen and undertake photosynthesis.

Pros:

- Naturally occurring.
- Multipurpose effectiveness.
- Commonly used as a glyphosate alternative worldwide.
- Rapid breakdown in water and soil.
- Generally low toxicity for insects, birds and aquatic invertebrates.

Cons:

- Moderate-high toxicity to mammals (higher than glyphosate) and considered a neurotoxin.
- More expensive than glyphosate.
- Not as effective as glyphosate on larger or woody weeds.

Assessment: Possible alternative. Although this product is naturally occurring, the higher mammalian toxicity in comparison to glyphosate suggests higher WHS risks to people making this option unfavorable.

Flumioxazin (other synthetic herbicide) – aquatic weeds in standing water

Flumioxazin is a synthetic herbicide registered with APVMA and available for treatment of aquatic weeds in standing water bodies. It is available in a product called Clipper®. It is a contact herbicide and applied as a water dispersible granule to treat freshwater aquatic weeds including duckweed, water lettuce and salvinia (NuFarm).

Pros:

- Claims to be effective and superior to previous products.

Cons:

- Relatively new to the market.
- Expensive.
- Very toxic to aquatic life.
- There are restraints and withholding periods on where and when this can be applied (e.g. cannot be used if the rain forecast is within 3 days). This makes it difficult to find suitable situations for using this herbicide.

Assessment: Possibly viable alternative as a glyphosate replacement for aquatic weed treatment in standing water bodies.

4.4 International Perspectives

On a global scale, herbicide resistance is increasing. There are 266 unique weed species that has been reported to be resistant to herbicides (to 21 of the 31 sites of action and to 165 different herbicides) (Heap 2022) (Figure 4-2). Within Australia, there are 89 known unique resistant weed species. This has created a basis for trials and investigations into what alternative methods are available.

There are a variety of alternative weed control methods available internationally, similar to what has been trialled or adopted within Australia. They include mechanical weeding such as hand weeding, mowing and tillage, bioorganic herbicides (such as Slasher® and Local Safe®) and steam and/or flame weeding. Case studies of alternative methods used in Germany, France and Sweden are outlined below. These studies provide the positive and negative aspects of the alternatives trialled and may inform the use of alternatives that may potentially be implemented in Australia. When determining if similar measured could be used in Australia, it is important to consider factors like climate and specific site attributes as these are likely to vary from those in the northern hemisphere.

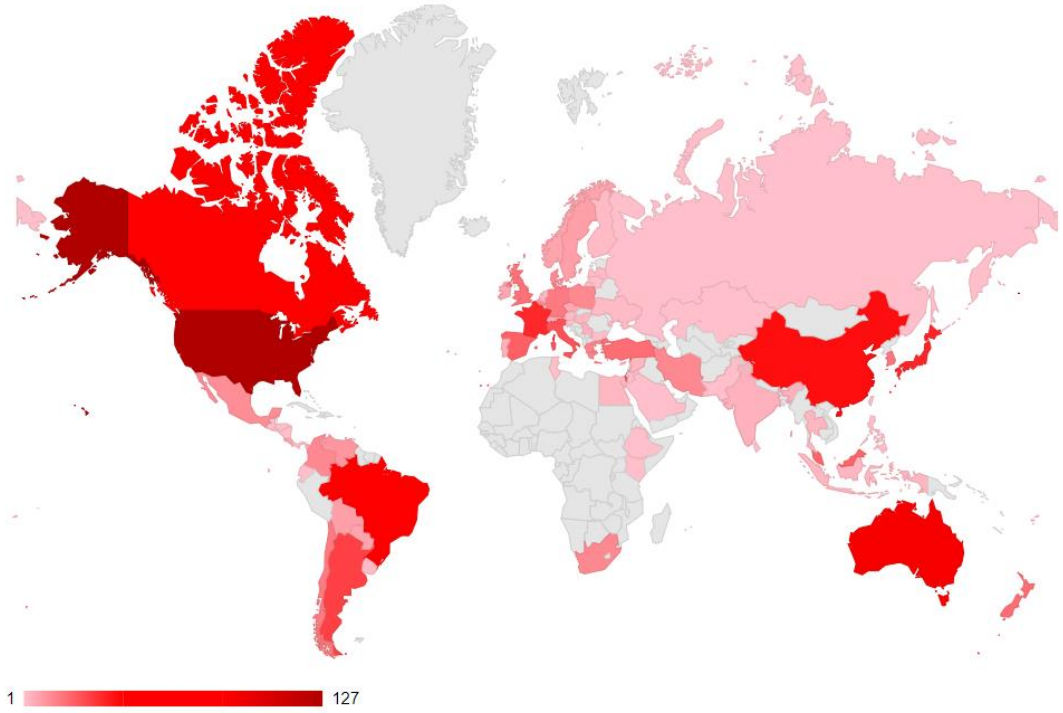

Figure 4-2 Global numbers of resistant weeds to synthetic herbicides (Heap 2022)

4.4.1 Germany

The sale and use of glyphosate herbicides in Germany has been increasing since 2005, with approximately 5,000 tonnes of the herbicide being sold each year (Kehlenbeck et al. 2016). Glyphosate herbicides are used to control weeds before seeding and are used as a standard in conservation tillage around the country. To assess glyphosate alternatives, Kehlenbeck et al. (2016) analysed mechanical alternatives and their efficacy. The study found that applying one to three tillage passes on a field had an effect almost equivalent to the application of glyphosate for stubble treatment (to eliminate volunteer plants, couch grass, weeds/weed grasses) and pre-sowing application (to eliminate volunteer plants, weeds/weed grasses, in particular resistant black grass and/or wind grass, mulching/cover crops and catch crop). Although effective, mechanical measures alone were not found to be an appropriate alternative for sustainable weed control without glyphosate.

Pros: Mechanical control has almost the same effect on removing weeds as glyphosate does. Cost of extra control was equivalent and cheaper than applying glyphosate in some cases (where one additional visit was efficient).

Cons: Mechanical control can cause increased erosion in high-risk erosion areas. Unfavourable conditions may incur additional costs. Mechanical control required additional working days, manpower and equipment.

4.4.2 France

In 2016, more than 6,800 tonnes of glyphosate herbicides were sold in France for agricultural use (Ballot et al. 2019). Following large public outcries about the potentially hazardous effects, the government banned the use of the herbicide within three years (with exemptions), forcing the hand of farmers to look for an alternative. A study by Jacquet et al. (2021) analysed inter-row non-chemical weed controls using mechanical operations throughout selected French vineyards. Mechanical weed management involved mowing, tillage using a disc tool and pronged tool, inter-row rotavator, inter-vine blades, inter-vine rotary and intra-row non-reversable vineyard ploughs. The study compared these results with those of a chemical-only weed control method and those of a mixed (mechanical and chemical) weed control method. The mixed weed control method was found to be most popular, largely due to its effectiveness and reasonable costs (Jacquet et al. 2021).

Pros: Young vines can set roots at depths adapted to mechanical weeding (productive vines in the future). Flora weeds are unable to adapt to mechanical weeding methods (like they can to chemical weeding) leading to an eased weed management over time. Crop cover can lead to improved soil carbon content, soil fertility and biodiversity and the provision of ecosystem services.

Cons: Mechanical controls required more working time to carry out weeding and were generally completed in Summer months (chemical controls are more time-flexible). Higher costs due to labour, traction tools and fuel required. Crop cover may limit water availability during dry Summer.

4.4.3 Sweden

In Sweden, glyphosate is the most widely used herbicide (28% of total herbicide use), and is used to control perennial weeds, and in non-permanent pastures to terminate growth and control perennial weeds (Kudsk & Mathiassen 2020). A study by Johansson et al. (2019) assessed the impacts that a glyphosate ban would have on cropping systems, the economy, greenhouse gas emissions and nitrogen leaching. Five farms with varying production systems, size, location and crops grown (strawberries, apples, onions) were chosen as the basis of this study. They found that without glyphosate, the alternatives needed to control weeds would be soil cultivation, changed crop rotation, and the use of "selected herbicides" (not specified). Despite specific trials nor data being publicly available, Sweden is moving to ban the use of herbicides products containing glyphosate (Bloomberg Law 2016), now forcing individuals to adopt these alternative methods.

Pros: Decreased glyphosate runoff to surface water and leaching to groundwater.

Cons: Increased intensity of soil cultivation and changing crop rotations may lead to reduced incomes for farmers due to increased labour and tool costs.

5 Stakeholder Consultation

5.1 Approach

Informing, consulting and involving stakeholders in BSC's review of herbicide use is a way to ensure change is more likely to be successful and sustainable, when the people it affects are involved in the process. The review will consider a long-term sustainable solution to ongoing concerns surrounding the use of herbicides.

Stakeholder engagement was undertaken by Advisian in September and October in accordance with the BSC Community and Stakeholder Engagement Plan (C&SEP). The purpose of this stakeholder engagement was to provide information to relevant stakeholders, gather feedback, and involve key stakeholders in the decision making around the transition to herbicide alternative products and/or methods.

The level of impact informed the consultation approach. The 'likely level of impact' on identified Stakeholders was assessed according to Section 6.3 of the C&SEP (BSC 2015) and indicated that this project aligned with the following criteria:

- Lower impact, although still some real or perceived impact or risk across Bellingen Shire.
- Potential for some controversy or conflict.
- Potential for some, although not significant, impact on State or regional strategies or directions.

On this basis, the project was assessed as Level 3 - Lower impact Shire wide. The basis of this assessment is that the project scope is an improvement to a Bellingen Shire wide service (e.g. pesticides management) and will result in a reduction of environmental and human-health impacts.

For the purposes of all stakeholder consultation, all responses are anonymous or de-identified in this report.

5.2 Stakeholder Survey

5.2.1 Method

A stakeholder survey was undertaken in September 2021. The survey was prepared to provide stakeholders an overview of the project background and ask questions to inform the design of the alternatives trial (refer to **Appendix F).**

Relevant stakeholders were identified in consultation with BSC and according to the process outlined in the C&SEP (BSC 2015) to develop a stakeholder advisory group for pesticides management.

These included:

- Existing databases from BSC on interested community members. Noting that BSC has already identified priority groups in the C&SEP (BSC 2015).
- A review of previous records of people that have showed interest or concern regarding herbicide usage.

- Subject matter experts in herbicide usage and management including Local Land Services and BSC invasive weeds and maintenance departments.
- Priority stakeholder groups identified in the C&SEP (BSC 2015).
- Community in general, targeted through social media platforms (BSC website and Facebook).

5.2.2 Results

This section summarises the results of the stakeholder survey. The survey response cross section is shown in Figure 5-1. There was a good cross-section of responses with the main category being community, followed by rural landholders and then environmental groups. There were three weed managers/contractors that replied which is considered good representation.

Stakeholders were asked about their preference for areas to undertake a trial of herbicide alternatives as shown in Figure 5-2. The highest preference was for a trial in roadside areas, followed by near waterways then all/any areas.

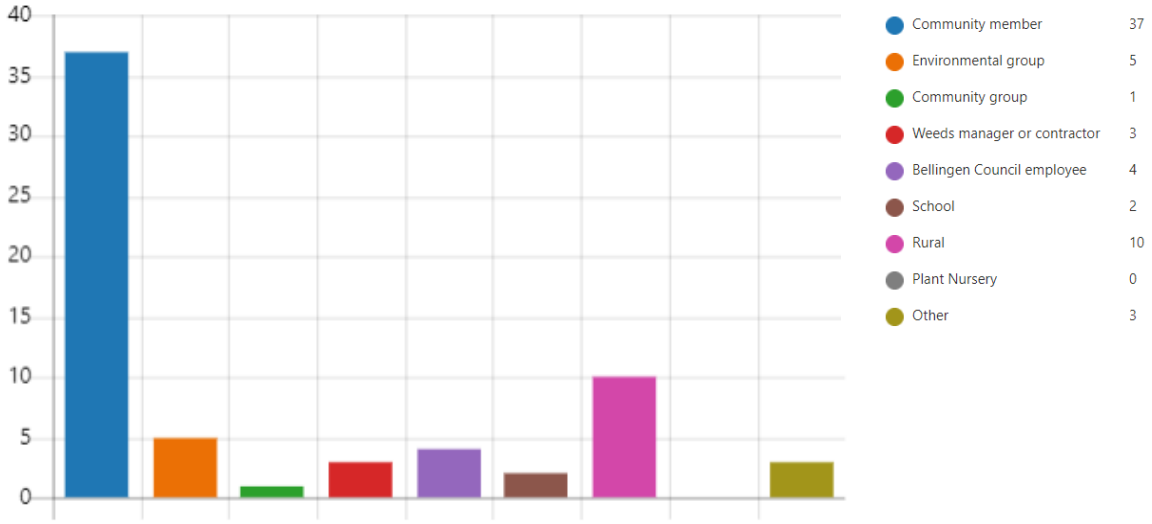

Figure 5-1 Survey response cross-section.

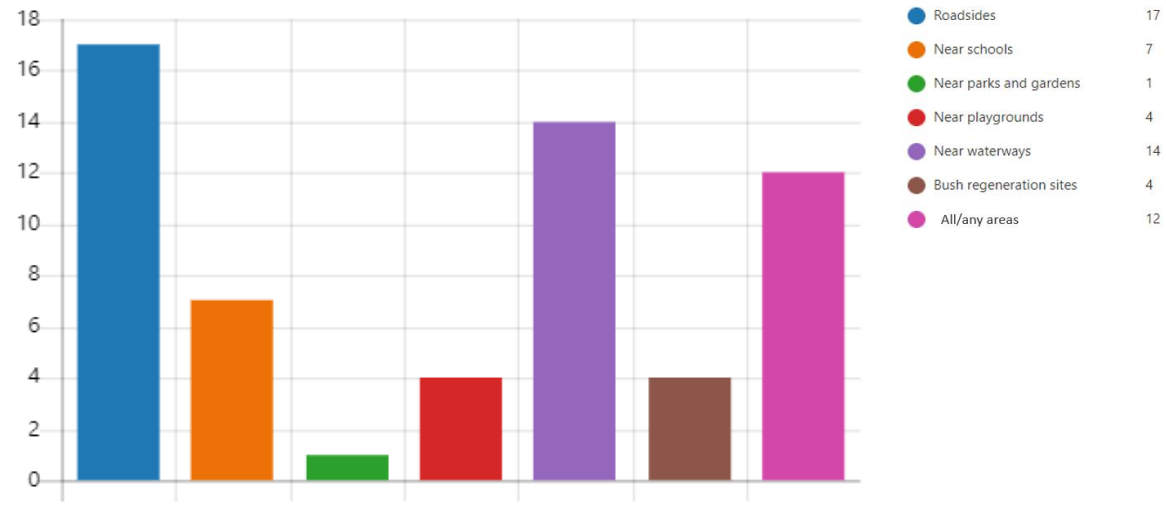

Figure 5-2 Survey preference on trial location.

Stakeholders were asked to rank ten previously identified herbicide or glyphosate alternative methods, or products that they would prefer to see included in a trial. They were provided with a short description of each of the alternative methods, the main pros and cons of each method and which areas they would be suitable to be trialed in. The results are shown in Figure 5-3.

As not all alternatives are suitable to all areas, these can be further divided into the top three preferences per area being:

Urban (parks and gardens, around schools and playing fields) - 1. Steam weeding, 2. A 'no spray' 20 m exclusion zone around BBQs and playgrounds, and 3. Bioorganic herbicide LocalSafe®.

Roadsides – 1. Bioorganic herbicide LocalSafe® (herbaceous weeds), 2. Community involvement in maintaining property frontage, and 3. Glyphosate alternative herbicide (such as imazapyr or glufosinate ammonium).

Bush Regeneration - 1. Bioorganic herbicide LocalSafe® (herbaceous weeds), 2. Glyphosate alternative herbicide (such as imazapyr or glufosinate ammonium), and 3. Grooming and slashing.

Near Waterways (noting that a lot of the bush regeneration sites are near waterways) - 1. Glyphosate alternative herbicide (such as imazapyr or glufosinate ammonium), 2. Grooming and slashing and 3. Alternative application methods.

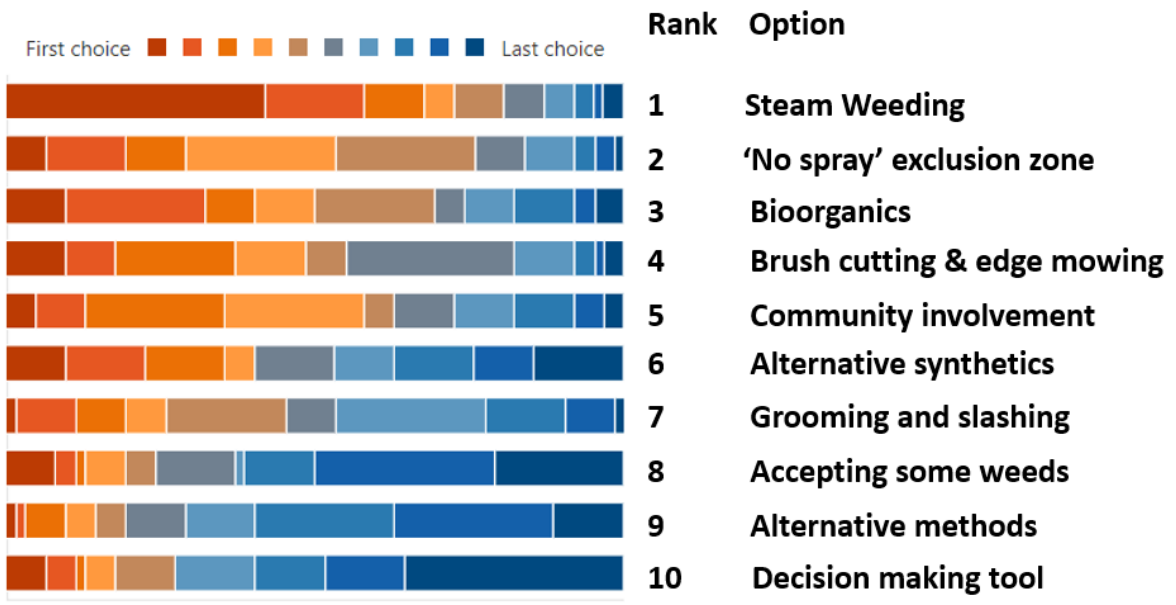

Figure 5-3 Ranking of potential alternatives to trial.

Stakeholders were also asked the three open-ended questions below, with results summarised in Table 5-1.

1. Do you have any concerns around herbicide usage?
2. Are there any alternative products or methods that you feel are unsuitable?
3. Alternative methods or products (not already included in the survey)?

Table 5-1 Stakeholder open-ended responses.

Do you have any concerns around herbicide usage?	
No concerns	Herbicides are currently being used in the most effective method for the target weed species.
Alternative herbicide trial approach	Potential waste of ratepayer money and lessons learnt from past alternative trials by BSC need to be incorporated into the trial.
Inappropriate use	Potential impacts from overspray and drift on non-target plants, animals or entering waterways. Non-compliance with label directions. Usage in situations where there are alternative (non-herbicide) methods available including parks, gardens and high public use areas.

	Used in situations where mechanical methods such as slashing could be used. Unnecessary 'broadscale' spraying where targeted methods could be used.
Human health toxicity impacts	Impacts on sensitive receptors, including Veterans, children and elderly. Impacts on human health via drinking water contamination. Non-direct chronic impacts via reduction of environmental health which is connected to human health.
Environmental impacts	Entry into waterways and impacting on aquatic ecology. Herbicide residuals in soils. Ecological toxicity impacts including on insects and native frogs.
Glyphosate specifically	Carcinogen listing. It has been banned in other countries.
Weed management	Some weeds including Parramatta grass and privet are not being effectively managed. Needs to be more weed management for roadsides. Weed management can be 'hit and miss', resulting in ineffectiveness results.

Are there any alternative products or methods that you feel are unsuitable?
Resourcing requirements for brushcutting and manual controls given the current numbers are inadequate and high plant growth in region.
Community involvement has been an issue in the past due to lack of resourcing and compliance in rural areas.
Vinegar based formulations have the potential to impact soil health and organisms significantly, impact on fungal and bacterial populations. May be appropriate in limited settings (e.g. parks, paths).
Use of chemicals/herbicides are not alternative measures and therefore unsuitable. Stick to weeding, slashing, brushcutting, mulching and weedmats.
Citronella spray.

Any herbicides are unsuitable and mechanical methods should be used.
Steam weeding or organics won't provide a long-term control option.
Alternative methods or products (not already included in the survey)?
Weed mats, widespread smothering with black plastic, use of bulldozers in thickly infested areas.
Design a program for volunteer community members to participate in hand weeding, say one to two hours every month.
Goats.
Collaboration with the justice system and facilitated by Council; a program where people pay off fines and minor charges by weeding.
Outcompete the weeds with dense planting of natives, accept a different level of aesthetic and change species composition.
Release of biocontrol. For example, fungus wandering trad.
Herbicides appropriate to the weeds in the spraying area.

5.3 Focus Group

The stakeholder survey included the opportunity for participants to attend a 2-hour follow up workshop which was held on the 27th October 2021. The workshop included a presentation of the project findings to date and a discussion of trial methods.

Key points raised during the workshop included:

- Need for consistent herbicide application records.
- Training of supervisors in weed identification would assist in more accurate records and management of weeds.
- Herbicide applicators face difficulties in doing their job due to frequent approaches by community members.
- Issues around herbicide application by volunteers due to inadequate training.
- Agreement on suitable locations for alternative herbicide trial and clarification of methods.
- Challenges around an alternative method for roadside weed management. It was discussed that it would be good to get wick wiping back in place, which has previously worked in Bellingen.

6 Herbicide Alternative Trial

6.1 Methodology

A trial of herbicide alternatives was undertaken to determine the effectiveness of alternative methods within the Council's LGA. This was a collaboration with design and analysis undertaken by Advisian, oversight of trial and monitoring by the Council and weed treatment applications by a subcontractor.

6.1.1 Locations

Three different locations included in the trial were Bellingen Waste Depot (Figure 6-1), Dorrigo Sewage Treatment Plant (STP) (Figure 6-2) and Mylestom Tennis Courts (Figure 6-3). The aerial images of these sites indicate the location of transects undertaken for the trial. These locations were selected to represent the variety of climatic conditions within the Council's LGA.

Figure 6-1 Location of Bellingen trial at the Bellingen Waste Depot.

Figure 6-2 Location of Dorrigo trial at Dorrigo Sewage Treatment Plant.

Figure 6-3 Location of Mylestom trial at the Mylestom Tennis Courts.

6.1.2 Treatments

Four treatments were trialed at each location:

1. Glyphosate (Roundup®) (360g/L)
2. Imazapyr (Arsenal Super® or Poacher 750®) (240g/L)
3. Local Safe® (acetic acid 90g/L and sulfamic acid 9g/L)
4. Steam weeding

All treatments were applied at the start of the trial.

Local Safe® and steam weeding had a second application in week 7 (28th January). This was based on the results during the first 6 weeks of the trial at Dorrigo and Mylestom, which showed little effectiveness compared to glyphosate.

6.1.3 Temporal and Spatial Replication

The trial was undertaken during Summer and Autumn and between the dates of 8th December 2021 to 15th March 2022.

Five (1 m x 1 m) photoquadrats were measured at fixed points along a fixed 20 m transect at 0 m, 5 m, 10 m, 15 m and 19 m. It was considered that fixed point quadrats were the best method to track changes over time and account for any initial variations in weeds along or between transects.

Measurements were taken five times during the trial including prior to application at 0 weeks (T0) and following application at 3 weeks (T3), 6 weeks (T6), 9 weeks (T9) and 12 weeks (T12).

1. T0 on 8th December 2021

   Application 1 on 10th December 2021 – all treatments

2. T3 on 31st December 2021
3. T6 on 24th January 2022

   Application 2 on 28th January 2022 – Only for Local Safe® and Steam Weeding

4. T9 on 14th February 2022
5. T12 on 15th March 2022

6.1.4 Field Data Collection

The following methods were applied in the field for each sampling time:

- Photoquadrats were obtained by taking a vertical photograph of the fixed quadrat (from above). Photos were labelled and organised to identify the site, time, treatment/transect and quadrat number.
- Field notes were recorded of the weeds (common name) that were present within each quadrat.

- Weed profiles were prepared for each of the main species that were recorded during the trial.
- The pesticide application records were completed by the subcontractor that applied the treatments and using the template prepared by the Council (**Appendix G**).

6.1.5 Data Analysis

The following methods were applied for data analysis:

1. Photos were trimmed and organised into tables for each location, treatment and monitoring time.
2. Data entry of all field notes into excel for analysis.
3. Photoquadrats were analysed using a program called SamplePoint© (Booth et al. 2019) as follows:
    a. The main categories were used of abiotic (leaf litter, rocks, soil and dead plants), grasses, herbs, bulbs, native, woody and sedges.
    b. Brown weeds were assumed dead (also confirmed by absence in later monitoring times). Discoloured plants (shades of yellow or green) were assumed to still be alive.
    c. Nearly all plants were weeds and either herbaceous or grasses. No native species were identified in T0.
    d. SamplePoint© overlays a grid of 25 points over the photos and then each point is identified and assigned a category as above. The edges of the quadrats (and weeds creeping in) were not included in the grid.
    e. The data is then calculated into a percentage cover (%Cover) and exported for analysis.
    f. To reduce bias the same user undertook all analysis and treatments were randomised and cross-checked against field notes.
    g. There are some limitations to the method as it can be difficult to identify to species level in the photograph (i.e. due to overlapping plants or insufficient resolution).
4. Graphs were prepared of the %Cover of each category for each location, treatment and monitoring time.
5. Statistical analysis was undertaken using PRIMER 7 (Clarke et al. 2014) by comparison to T0 measurements at each quadrat. This approach overcomes the variation in initial T0 weed coverage between quadrats and transects. Permutational Analysis of Variance (PERMANOVA) was used to answer the following questions:
    a. Were treatments effective at reducing invasive weed cover and how long did this last? This analysis was undertaken by comparing the abiotic %Cover to T0.
    b. Were treatments more effective at reducing invasive grasses or herbaceous weed cover? This analysis was undertaken by comparing the %Cover of the herb and grass categories

to T0. Note there was insufficient data to be able to analyse other categories (i.e. bulb weeds, woody weeds, sedge weeds or natives).

6.1.6 Overview of Design

In summary, the design included three locations x four treatments x five fixed point quadrats x five-time measurements. This resulted in a total of 300 photoquadrats.

The design for the alternative trials is provided in Figure 6-4. The concept was been based on the NSW DPI Guidelines for Monitoring Weed Control (Auld 2009), the review of similar scientific trials to test herbicide alternatives (Section 4.2) and sufficient replication to be able to undertake statistical analyses.

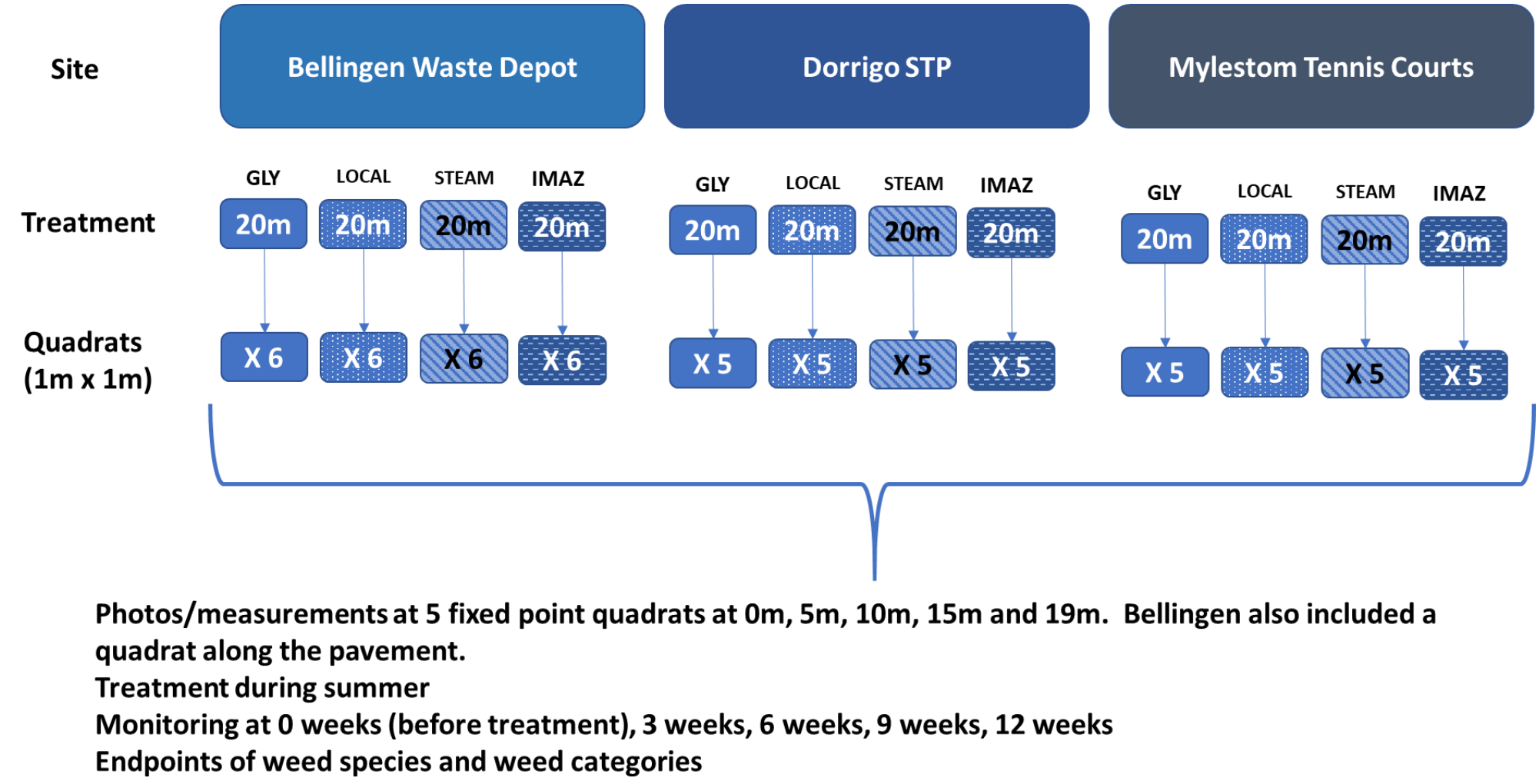

Figure 6-4 Overview of potential trial design. GLY = glyphosate (Round Up®), LOCAL = acetic acid (Local Safe®), STEAM = steam weeder, IMAZ = imazapyr (Arsenal Super®) .

6.2 Results and Discussion

This section provides a summary of the trial results with all photoquadrats and full detailed results in **Appendix H**. Profiles of the weeds encountered in the trial are attached in **Appendix I**.

6.2.1 Overall Effectiveness

An analysis was undertaken to assess treatments that were most effective at each location and monitoring time in comparison to T0. The results are shown in Table 6-1 and show the following:

- Glyphosate and imazapyr worked better at Dorrigo and Mylestom where there was more coverage of grass weeds in initial T0 measurements.
- Local Safe® was the most effective (of all treatments) at Bellingen where there was more herbaceous weed coverage in initial T0 measurements.
- Steam weeding was not as effective as the other treatments. The initial treatment did result in significant reductions at Bellingen and Mylestom that were maintained for 3-6 weeks. A second application at 7 weeks did not really improve effectiveness. This may be because there was high rainfall during the trial and steam weeding may not work as well on soils with high moisture content.
- There was a lot of variation between locations. All treatments seemed to work better at Bellingen which is probably due to a higher initial coverage of weeds resulting in treatments having a greater reduction. Dorrigo and Mylestom had been maintained and slashed so initial weed coverage wasn't as extensive in comparison to Bellingen.

Table 6-1 PERMANOVA analysis on effectiveness of treatments in reducing the % invasive cover.

	Treatment	T3	T6	T9	T12	Effectiveness (at reducing % invasive cover)
Bellingen	Glyphosate	***	***	NS	NS	Glyphosate was very effective to week 6.
	Imazapyr	***	NS	NS	NS	Imazapyr was very effective to week 3.
	Local Safe® (x2)	***	***	***	***	Local Safe® (two applications) was very effective to end of trial at week 12.
	Steam weeding (x2)	***	***	*	NS	Steam weeding was very effective to week 6.
Dorrigo	Glyphosate	*	**	**	*	Glyphosate was effective to week 9-12.
	Imazapyr	NS	*	**	**	Imazapyr took 6 weeks to work, then was effective to week 12.
	Local Safe® (x2)	NS	NS	*	**	Local Safe® worked after the second application.
	Steam weeding (x2)	NS	NS	NS	NS	Steam weeding was not effective at all.
Mylestom	Glyphosate	**	**	**	**	Glyphosate and imazapyr were the most effective treatments at Mylestom.
	Imazapyr	**	**	*	**	
	Local Safe® (x2)	NS	NS	**	*	Local Safe® worked after the second application.
	Steam weeding (x2)	**	NS	NS	NS	Steam weeding was only effective for 3 weeks.

*** = very good reduction (p≤0.001), ** = good reduction (p<0.005) * = moderate reduction (p<0.05) and NS = not significant reduction in % cover.

6.2.2 Effectiveness on Grasses Versus Herbs

An analysis was undertaken to assess whether treatments were more effective at removing grasses or herbs and the length of time they took to grow back to similar coverage as T0. The results are shown in Table 6-2 and show the following:

- Glyphosate and imazapyr were very effective at reducing the %Cover of grasses. However, imazapyr took longer to work which is related to a different mechanism.
- Local Safe® was more effective at reducing %Cover of herbaceous weeds (noting that this treatment received a second application and could also be related to differences among the environment of locations noted above).
- There is not enough data to analyse categories of bulbs, sedges, woody weeds and natives as the %Cover of these categories was very low.
- Although there are considerable differences in climate and soil quality among locations, the patterns in weed reduction are very similar (i.e. glyphosate and imazapyr worked better at reducing grasses while Local Safe® was better at reducing herbaceous weeds).

Table 6-2 PERMANOVA analysis on effectiveness of treatments in reducing grass weed cover.

	Treatment	T3	T6	T9	T12	Effectiveness (at reducing % invasive cover)
Bellingen	Glyphosate	***	***	**	**	Glyphosate worked well to reduce grass cover to week 6 and maintained a good reduction to week 12. Steam weeding worked well for a short period to week 3.
	Imazapyr	NS	NS	NS	NS	
	Local Safe® (x2)	NS	NS	NS	NS	
	Steam weeding (x2)	***	NS	NS	NS	
Dorrigo	Glyphosate	***	***	***	***	Glyphosate and imazapyr worked well to reduce grass cover for the duration of experiment. Local Safe® worked well after a second application for a short period.
	Imazapyr	*	***	***	***	
	Local Safe® (x2)	NS	NS	***	NS	
	Steam weeding (x2)	NS	NS	NS	NS	
Mylestom	Glyphosate	***	***	***	***	Glyphosate and imazapyr worked well to reduce grass cover for the duration of experiment. Local Safe® worked well after a second application for a short period. Steam weeding worked well for a short period to week 3.
	Imazapyr	***	***	***	***	
	Local Safe® (x2)	NS	NS	***	*	
	Steam weeding (x2)	***	NS	NS	NS	

*** = very good reduction (p≤0.001), ** = good reduction (p<0.005) * = moderate reduction (p<0.05) and NS = not significant reduction in % cover.

Table 6-3 PERMANOVA analysis on effectiveness of treatments in reducing herbaceous weed cover.

	Treatment	T3	T6	T9	T12	Effectiveness (at reducing % invasive cover)
Bellingen	Glyphosate	NS	NS	NS	NS	Two applications of Local Safe® worked best to reduce herbaceous weeds. Imazapyr and steam weeding worked for a short duration to 3 weeks.
	Imazapyr	***	NS	NS	NS	
	Local Safe® (x2)	***	*	***	***	
	Steam weeding (x2)	*	NS	NS	NS	
Dorrigo	Glyphosate	***	***	NS	NS	Two applications of Local Safe® worked best to reduce herbaceous weeds. Imazapyr took 6 weeks to see results. Glyphosate and steam weeding worked for 6 weeks.
	Imazapyr	NS	NS	***	*	
	Local Safe® (x2)	***	**	***	*	
	Steam weeding (x2)	*	***	*	NS	
Mylestom	Glyphosate	NS	***	NS	NS	As there was very low %Cover of herbaceous weeds at T0 little results could be seen in the Mylestom trial.
	Imazapyr	NS	NS	NS	NS	
	Local Safe® (x2)	NS	NS	***	NS	
	Steam weeding (x2)	**	***	NS	NS	

*** = very good reduction (p≤0.001), ** = good reduction (p<0.005) * = moderate reduction (p<0.05) and NS = not significant reduction in % cover.

6.2.3 Other Observations and Limitations

Other observations of the trial results (i.e. that could not be addressed in the statistical analysis) include:

- The trial was undertaken during a very wet Summer (La Nina) which likely had an influence on all the results.
- There are likely to be seasonal differences; Summer and Spring would be expected to have the highest growth rates of weeds.
- At Bellingen, all treatments worked better on pavements in comparison to the transects. This may be related to the initial lower coverage and diversity of weeds present prior to the treatments but also there are less edges for weeds to 'creep back' in.
- Imazapyr seemed to work better on grasses and Local Safe® on herbs, however these observations could also be related to location differences. Also, initially there was higher herbaceous weed coverage at Bellingen and higher grass weed coverage at Mylestom and Dorrigo.

6.2.4 Overall Trial Conclusions

None of the trialed alternative products are considered suitable as replacement of glyphosate usage in terms of meeting the criteria that are required for a long-term replacement (see Section 4.1).

However, imazapyr and Local Safe® are recommended for inclusion as part of the toolbox approach, particularly in urban areas.

Steam weeding showed some potential, but only at the Bellingen location. It is not recommended for future inclusion due to the lack of effectiveness, costs, safety concerns and labour requirements.

6.2.5 Comparison of Treatments

A comparison of treatments based on the trial and the review of alternatives is provided in Table 6-4. Note that this table is based on broad estimates only.

This comparison estimates that the chemical costs of using imazapyr or Local Safe© would be approximately five-fold and ten-fold that of glyphosate, respectively. Actual labour costs have not been included but a multiplier has been used for Local Safe© and steam weeding to account for additional applications that would be required to achieve the same effectiveness as glyphosate.

Steam weeding is more challenging to compare the costs, however this is going to be a much more expensive option as would likely require a subcontractor to apply treatments. If the Council, were to purchase their own unit there would be a large initial outlay, running costs (fuel) and ongoing maintenance costs. In addition, there would be much higher labour costs to account for more frequent applications that would be needed.

Table 6-4 Comparison of treatments based on trial results.

Product	Active Constituent	(a) Application rate	(b) Diluted product cost /100L	(c) Application multiplier	(a)x(b)x(c)	Short term mammal toxicity (LD50)	Long term mammal toxicity (NOEL)	Safety	Comments
Weedmaster Duo	glyphosate 360mg/L	1	$975	1x	$975	>2000	351	PPE as according to label.	Community concerns on health implications (based on long term exposures).
Arsenal Super	Imazapyr 240g/L	1	$5,000	1x	$5000	>2000	10,000	PPE as according to label.	Weed death takes longer (up to 30 days). Much lower long term exposure toxicity in comparison to glyphosate.
Local Safe©	Acetic acid 900g/L and Sulfamic acid 10g/L	4	$1,320	2x (treatments require more frequent applications)	$10,560	3530	Not known.	PPE as according to label. Potential corrosion of equipment.	More frequent applications needed. Not approved for waterways. Not as effective on woody weeds (based on findings from other studies).
Steam Weeding	N/A	1	$2,500 per month (based on one off cost of approx. 30k)	10x (treatments take longer and require more frequent applications)	N/A	N/A	N/A	Risk of steam burns and other WHS related to heavy equipment.	One off cost of ~30k plus maintenance costs. Requires good site access and nearby water supply. Impractical for roadsides or woody weeds on larger scale. Not as effective in soils with high moisture. Training required or use of specialised subcontractors.

Application rate = volume of diluted product required for one treatment; labour time = estimate based on time to apply treatments (relative to glyphosate); overall effectiveness = based on statistical analysis of trial results; LD50 (acute exposures) = 50% lethal dose; NOEL (chronic exposures) = No observed effect level.

7 Recommendations

7.1 Recommendation 1 – Consider Alternatives

The Council's current approach to integrated weed management should be maintained with weed management undertaken on a case-by-case basis and preference given for alternative methods where feasible, affordable (accounting for labour and chemical costs) and practical.

Based on the currently available herbicide alternatives, it is not considered viable to completely phase out the use of synthetic herbicides across all operations (urban, roadsides and bush regeneration) while maintaining the Council's requirement to manage weeds.

However, within urban areas, as there is a very low volume of herbicides used, the Council may be able to phase out with usage restricted to certain circumstances.

7.2 Recommendation 2 – Continue to use Glyphosate

Continue to use synthetic based herbicides (including glyphosate) as part of operations, where there are no suitable alternatives. The Council should use the minimum required concentrations and in line with label recommendations and relevant safety controls as part of the existing integrated approach. Consideration should continue to be given to more targeted methods (cut and paint, targeted spot spraying) to avoid broadscale spraying. It is acknowledged that more targeted applications may also not be suitable for roadsides, where line-of-sight vegetation needs to be removed for safety purposes and using the most effective methods.

There are currently no suitable alternatives that achieve the efficiencies required for local roads, but the Council should continue to investigate and employ alternatives where appropriate.

Much of the weed management in bush regeneration already uses minimal herbicides and alternative methods. For woody weeds there are few viable alternatives available.

7.3 Recommendation 3 – Exclusion Zones around Urban Sensitive Areas

A 'no spray' 20 m exclusion zone for synthetic herbicides applied around sensitive and high use urban areas as identified in the Pesticide Notification Plan.

7.4 Recommendation 4 – Education and Training

Suitable training for herbicide use provided for all pesticide applicators including bush regeneration volunteers (Competency Level AQF2 for using under supervision and AQF3 for working unsupervised).

Education program in weed identification for Council operators, targeted at supervisor levels to start.

7.5 Recommendation 5 – Weed Profile Record Keeping

It is recommended that field staff are provided education and training on integrated weed management (i.e., how to select the best treatments at all levels). This can consist of a new field handbook and procedure for integrated weed management, which includes weed profiles using a

consistent Council template (**Appendix G**). Correct identification of weeds will assist with selecting appropriate management controls.

7.6 Recommendation 6 – Pesticide Record Keeping

During the project there were difficulties in collating the pesticide usage record information due to poor record keeping (i.e. missing information, inconsistent records or incorrect identification of weeds). To meet the requirements of the *NSW Pesticides Act 1999* this information needs to be accurately recorded.

A recommendation is to use a consistent template for pesticide records, which staff are trained in how to fill out the template and the importance of maintaining correct records (**Appendix G**).

7.7 Recommendation 7 – Continued Review

Pesticide usage should have ongoing review and a formal review is recommended every five years. The Council should continue to monitor information from APVMA on the use of synthetic herbicides. The Council should also continue to investigate new and emerging alternative technology and treatment options for weed management.

7.8 Recommendation 8 - Revision of Pesticide Use Notification Plan (2014)

Specifically, the following recommendations are made to the Pesticide Use Notification Plan (2014):

Section 1: Amend to "This pesticide use notification plan (the plan) has been prepared in accordance with the requirements of the *Pesticides Regulation 2017* (the Regulation)".

Section 2: The table could be amended to reflect regular user groups that are more likely to be sensitive (e.g. young children, sick, pregnant or elderly people) and an additional column added on "Notification Arrangement".

Section 3: Include what information will be displayed on notification signs. Could include information on: date of notice, notice to, date range of pesticide application, full name of pesticide product, full name and concentration of active constituent, pest(s) or weed(s) being treated, where pesticides will be applied, re-entry restrictions (if any), name of pesticide applicator, Council contact number.

Section 3.1: Consider addition of "Bellingen Shire Council Facebook Page."

Section 3.1: Addition of information on how notice will be provided to the community on pesticide use within the interiors of the Council building including the Council chambers, libraries, community halls/centres and childcare facilities.

Section 3.4.1: Addition of: "The EPA requires that at least 5 working days advance notice is given to neighboring sensitive places when pesticides are applied by outdoor spraying within 20 metres of a common boundary" (NSW EPA 2021).

Section 4.4: Amend to "Clause 39".

Section 3.4.6: The Council template (**Appendix G**) could also be attached to the Pesticide Notification Plan for use by Council staff and contractors. Pesticide records need to be completed as soon as practicable after the use of the pesticide and no later than 48 hours after application.

Section 3.4.7: A new subsection "Prevailing Weather Conditions – prevailing weather conditions will be checked prior to weather applications and recorded in the pesticide use records. Pesticides will not be applied in unsuitable weather conditions as described in the product MSDS. This may include wind and rain."

Section 4: Amend to "In accordance with clause 41 (1) (h) of the Regulation.

Section 5: Consider addition of "Bellingen Shire Council Facebook Page."

Section 7: Up to date contact details including name, job title or description and telephone number.

Appendices: could include 1) A template of the Pesticide Use Records (**Appendix G**), 2) a map of the LGA boundaries and 3) a map or public places within the BSC LGA (parks, playgrounds, picnic areas, sporting fields) or list including addresses. A public place register may be more suitable on the BSC website, where it can be updated more regularly than the Pesticide Use Notification Plan.

As per Clause 42 of the *Pesticide Regulation Plan* (2017), the Council is required to undertake public consultation on the revised Pesticide Notification Plan.

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Appendix A
WeedWise Search

NSW Weedwise Search Results
Priority weeds for the North Coast

Note: this region includes the local council areas of Ballina, Bellingen, Byron, Clarence Valley, Coffs Harbour, Kempsey, Kyogle, Lismore, Nambucca, Port Macquarie-Hastings, Richmond Valley and Tweed.
Search undertaken in October 2021.

Weed	Duty
All plants	**General Biosecurity Duty** *All plants are regulated with a **general biosecurity duty** to prevent, eliminate or minimise any biosecurity risk they may pose. Any person who deals with any plant, who knows (or ought to know) of any biosecurity risk, has a duty to ensure the risk is prevented, eliminated or minimised, so far as is reasonably practicable.*
Aaron's beard prickly pear *Opuntia leucotricha*	**Prohibition on certain dealings** *Must not be imported into the state, sold, bartered, exchanged or offered for sale.*
African boxthorn *Lycium ferocissimum*	**Prohibition on certain dealings** *Must not be imported into the state, sold, bartered, exchanged or offered for sale.*
Aleman grass *Echinochloa polystachya*	**Regional Recommended Measure** *Land managers should mitigate the risk of new weeds being introduced to their land. The plant should be eradicated from the land and the*

	land kept free of the plant. The plant should not be bought, sold, grown, carried or released into the environment.
Alligator weed *Alternanthera philoxeroides*	**Prohibition on certain dealings** *Must not be imported into the state, sold, bartered, exchanged or offered for sale.*
Alligator weed *Alternanthera philoxeroides*	**Biosecurity Zone** The Alligator Weed Biosecurity Zone is established for all land within the state except land in the following regions: Greater Sydney; Hunter (but only in the local government areas of City of Lake Macquarie, City of Maitland, City of Newcastle or Port Stephens). *Within the Biosecurity Zone this weed must be eradicated where practicable, or as much of the weed destroyed as practicable, and any remaining weed suppressed. The local control authority must be notified of any new infestations of this weed within the Biosecurity Zone*
Anchored water hyacinth *Eichhornia azurea*	**Prohibited Matter** *A person who deals with prohibited matter or a carrier of prohibited matter is guilty of an offence. A person who becomes aware of or suspects the presence of prohibited*

	matter must immediately notify the Department of Primary Industries
Asparagus fern *Asparagus virgatus*	**Regional Recommended Measure** Exclusion zone: Whole region excluding the core infestation area of Nambucca Valley Council, Kempsey Shire Council, Port Macquarie Hastings Council, Richmond Valley Council, Ballina Shire Council, Lismore Council, Kyogle Council, Byron Shire Council and Tweed Shire Council. *Whole region: The plant or parts of the plant should not be traded, carried, grown or released into the environment. Exclusion zone: The plant should be eradicated from the land and the land kept free of the plant. Land managers should mitigate the risk of the plant being introduced to their land. Core infestation area: Land managers should reduce impacts from the plant on priority assets.*
Athel pine *Tamarix aphylla*	**Prohibition on certain dealings** *Must not be imported into the state, sold, bartered, exchanged or offered for sale.*
Bellyache bush *Jatropha gossypiifolia*	**Prohibition on certain dealings** *Must not be imported into the state, sold, bartered, exchanged or offered for sale.*

Bitou bush *Chrysanthemoides monilifera* subsp. *rotund ata*	**Prohibition on certain dealings** *Must not be imported into the state, sold, bartered, exchanged or offered for sale.*
Bitou bush *Chrysanthemoides monilifera* subsp. *rotund ata*	**Biosecurity Zone** The Bitou Bush Biosecurity Zone is established for all land within the State except land within 10 kilometres of the mean high water mark of the Pacific Ocean between Cape Byron in the north and Point Perpendicular in the south. *Within the Biosecurity Zone this weed must be eradicated where practicable, or as much of the weed destroyed as practicable, and any remaining weed suppressed. The local control authority must be notified of any new infestations of this weed within the Biosecurity Zone*
Black knapweed *Centaurea x moncktonii*	**Prohibited Matter** *A person who deals with prohibited matter or a carrier of prohibited matter is guilty of an offence. A person who becomes aware of or suspects the presence of prohibited matter must immediately notify the Department of Primary Industries*
Black locust *Robinia pseudoacacia*	**Regional Recommended Measure** An exclusion zone is established for all lands in the region, except the core infestations comprising of

	historic plantings. Historic plantings are individual mature plants at least 100 m away from waterways and floodplains. *Whole region: The plant or parts of the plant are not sold, traded, carried, grown or released into the environment. Exclusion zone: The plant is eradicated from the land and the land is kept free of the plant. Land managers mitigate the risk of the plant being introduced to their land. Core infestations: Land managers may retain individual mature historic plants if they are being effectively managed to destroy any new plants sprouting from the roots of the parent tree. Land managers should consult with their local council weeds officer to determine if historic plants on their property meet the criteria. If mature, historic plants senesce, they may not be replaced with new black locust plants.*
Black willow *Salix nigra*	**Prohibition on certain dealings** *Must not be imported into the state, sold, bartered, exchanged or offered for sale.*
Black willow *Salix nigra*	**Regional Recommended Measure** Exclusion zone: all lands in the region, except the core infestation area of: Clarence Valley Council and Nambucca Valley Shire Council *Exclusion zone: The plant should be eradicated from the land and the land kept free of the plant. Land*

	managers should mitigate the risk of the plant being introduced to their land. Core infestation area: Land managers reduce impacts from the plant on priority assets.
Blackberry *Rubus fruticosus* species aggregate	**Prohibition on certain dealings** *Must not be imported into the state, sold, bartered, exchanged or offered for sale.* **All species in the Rubus fruiticosus species aggregate have this requirement, except for the varietals Black Satin, Chehalem, Chester Thornless, Dirksen Thornless, Loch Ness, Murrindindi, Silvan, Smooth Stem, and Thornfree**
Blind cactus *Opuntia rufida*	**Prohibition on certain dealings** *Must not be imported into the state, sold, bartered, exchanged or offered for sale.*
Blue heliotrope *Heliotropium amplexicaule*	**Regional Recommended Measure** Exclusion zone: whole region excluding the core infestation area of Clarence Valley Council and Port Macquarie-Hastings Council *Whole region: The plant or parts of the plant should not be traded, carried, grown or released into the environment. Exclusion zone: The plant should be eradicated from the land and the land kept free of the plant. Land managers should mitigate the risk of the plant being*

	introduced to their land. Core infestation area: Land managers should reduce impacts from the plant on priority assets.
Boneseed *Chrysanthemoides monilifera* subsp. *monilif era*	**Prohibition on certain dealings** *Must not be imported into the state, sold, bartered, exchanged or offered for sale.*
Boneseed *Chrysanthemoides monilifera* subsp. *monilif era*	**Control Order** Bonseed Control Zone: Whole of NSW *Boneseed Control Zone (Whole of NSW): Owners and occupiers of land on which there is boneseed must notify the local control authority of new infestations; immediately destroy the plants; ensure subsequent generations are destroyed; and ensure the land is kept free of the plant. A person who deals with a carrier of boneseed must ensure the plant (and any seed and propagules) is not moved from the land; and immediately notify the local control authority of the presence of the plant.*
Boxing glove cactus *Cylindropuntia fulgida* var. *mamillata*	**Prohibition on certain dealings** *Must not be imported into the state, sold, bartered, exchanged or offered for sale.*

Bridal creeper *Asparagus asparagoides*	**Prohibition on certain dealings** *Must not be imported into the state, sold, bartered, exchanged or offered for sale.* ***this requirement also applies to the Western Cape form of bridal creeper**
Bridal creeper *Asparagus asparagoides*	**Regional Recommended Measure** Exclusion zone: whole region excluding the core infestation area of Nambucca Valley Council and Kempsey Shire Council. *Exclusion zone: The plant should be eradicated from the land and the land kept free of the plant. Land managers should mitigate the risk of the plant being introduced to their land. Core infestation area: Land managers should reduce impacts from the plant on priority assets.*
Bridal veil creeper *Asparagus declinatus*	**Prohibited Matter** *A person who deals with prohibited matter or a carrier of prohibited matter is guilty of an offence. A person who becomes aware of or suspects the presence of prohibited matter must immediately notify the Department of Primary Industries*
Broad-leaf pepper tree *Schinus terebinthifolius*	**Regional Recommended Measure** Exclusion zone: whole region excluding the core infestation area

	of Richmond Valley Council, Ballina Shire Council, Lismore Council, Kyogle Council, Byron Shire Council and Tweed Shire Council *Whole region: The plant or parts of the plant should not be traded, carried, grown or released into the environment. Exclusion zone: The plant should be eradicated from the land and the land kept free of the plant. Land managers should mitigate the risk of the plant being introduced to their land. Core infestation area: Land managers should reduce impacts from the plant on priority assets.*
Broomrapes *Orobanche* species	**Prohibited Matter** *A person who deals with prohibited matter or a carrier of prohibited matter is guilty of an offence. A person who becomes aware of or suspects the presence of prohibited matter must immediately notify the Department of Primary Industries* **All species of Orobanche are Prohibited Matter in NSW, except Clover broomrape, Orobanche minor and Australian broomrape, Orobanche cernua var. australiana.**
Bunny ears cactus *Opuntia microdasys*	**Prohibition on certain dealings** *Must not be imported into the state, sold, bartered, exchanged or offered for sale.*

Cabomba *Cabomba caroliniana*	**Prohibition on certain dealings** *Must not be imported into the state, sold, bartered, exchanged or offered for sale.*
Cane cactus *Austrocylindropuntia cylindrica*	**Prohibition on certain dealings** *Must not be imported into the state, sold, bartered, exchanged or offered for sale.* **All species in the Austrocylindropuntia genus have this requirement**
Cape broom *Genista monspessulana*	**Prohibition on certain dealings** *Must not be imported into the state, sold, bartered, exchanged or offered for sale.*
Cape broom *Genista monspessulana*	**Regional Recommended Measure** *Land managers should mitigate the risk of the plant being introduced to their land. The plant should be eradicated from the land and the land kept free of the plant.*
Cat's claw creeper *Dolichandra unguis-cati*	**Prohibition on certain dealings** *Must not be imported into the state, sold, bartered, exchanged or offered for sale.*

Cecropia *Cecropia* species	**Regional Recommended Measure** *Land managers should mitigate the risk of new weeds being introduced to their land. The plant should be eradicated from the land and the land kept free of the plant. The plant should not be bought, sold, grown, carried or released into the environment.*
Chicken dance cactus *Opuntia schickendantzii*	**Prohibition on certain dealings** *Must not be imported into the state, sold, bartered, exchanged or offered for sale.*
Chilean needle grass *Nassella neesiana*	**Prohibition on certain dealings** *Must not be imported into the state, sold, bartered, exchanged or offered for sale.*
Chinese celtis *Celtis sinensis*	**Regional Recommended Measure** Exclusion zone: whole region excluding the core infestation area of Richmond Valley Council, Ballina Shire Council, Lismore Council, Kyogle Council, Byron Shire Council and Tweed Shire Council *Whole region: The plant or parts of the plant should not be traded, carried, grown or released into the environment. Exclusion zone: The plant should be eradicated from the land and the land kept free of the plant. Land managers should mitigate the risk of the plant being*

	introduced to their land. Core infestation area: Land managers should reduce impacts from the plant on priority assets.
Chinese knotweed *Persicaria chinensis*	**Regional Recommended Measure** *Land managers should mitigate the risk of new weeds being introduced to their land. The plant should be eradicated from the land and the land kept free of the plant. The plant should not be bought, sold, grown, carried or released into the environment. Notify local control authority if found.*
Chinese tallow tree *Triadica sebifera*	**Regional Recommended Measure** Exclusion zone: whole region excluding the core infestation area of Richmond Valley Council, Ballina Shire Council, Lismore Council and Kyogle Council, Byron Shire Council and Tweed Shire Council *Whole region: The plant or parts of the plant should not be traded, carried, grown or released into the environment. Exclusion zone: The plant should be eradicated from the land and the land kept free of the plant. Land managers should mitigate the risk of the plant being introduced to their land. Core infestation area: Land managers should reduce impacts from the plant on priority assets.*

Chinese violet *Asystasia gangetica* subsp. *micrantha*	**Control Order** *Owners and occupiers of land on which there is Chinese violet must notify the local control authority for the area if the Chinese violet is part of a new infestation on the land, destroy all Chinese violet on the land ensuring that subsequent generations of Chinese violet are destroyed; and keep the land free of Chinese violet. A person who deals with a carrier of Chinese violet must ensure the plant (and any seed and propagules) is not moved from the land; and immediately notify the local control authority of the presence of the plant on the land, or on or in a carrier.*
Climbing asparagus *Asparagus africanus*	**Prohibition on certain dealings** *Must not be imported into the state, sold, bartered, exchanged or offered for sale.*
Climbing asparagus fern *Asparagus plumosus*	**Prohibition on certain dealings** *Must not be imported into the state, sold, bartered, exchanged or offered for sale.*
Cockspur coral tree *Erythrina crista-galli*	**Regional Recommended Measure** Exclusion zone: whole region excluding the core infestation area of Richmond Valley Council, Ballina Shire Council, Lismore Council, Kyogle Council, Byron Shire Council and Tweed Shire Council

	Whole region: The plant or parts of the plant should not be traded, carried, grown or released into the environment. Exclusion zone: The plant should be eradicated from the land and the land kept free of the plant. Land managers should mitigate the risk of the plant being introduced to their land. Core infestation area: Land managers should reduce impacts from the plant on priority assets.
Common pear *Opuntia stricta*	**Prohibition on certain dealings** *Must not be imported into the state, sold, bartered, exchanged or offered for sale.*
Devil's fig *Solanum torvum*	**Regional Recommended Measure** Exclusion zone: whole region excluding the core infestation area of: Ballina Shire Council, Byron Shire Council, Kyogle Council, Richmond, Lismore Council, Valley Council and Tweed Shire Council *Whole region: The plant or parts of the plant should not be traded, carried, grown or released into the environment. Exclusion zone: The plant is eradicated from the land and the land is kept free of the plant. Land managers mitigate the risk of the plant being introduced to their land. Core infestation area: Land managers reduce impacts from the plant on priority assets. Land managers mitigate the risk of the plant spreading from their land to neighbouring properties that are*

	not currently infested with not currently infested with the weed or exclusion zones.
East Indian hygrophila *Hygrophila polysperma*	**Regional Recommended Measure** Exclusion zone: all waters in the region excluding the core infestation area of Richmond Valley Council, Ballina Shire Council, Lismore Council, Kyogle Council, Byron Shire Council and Tweed Shire Council. *Whole region: The plant or parts of the plant should not be traded, carried, grown or released into the environment. Exclusion zone: The plant should be eradicated from the land and the land kept free of the plant. Land managers should mitigate the risk of the plant being introduced to their land. Core infestation area: Land managers should reduce impacts from the plant on priority assets.*
Eurasian water milfoil *Myriophyllum spicatum*	**Prohibited Matter** *A person who deals with prohibited matter or a carrier of prohibited matter is guilty of an offence. A person who becomes aware of or suspects the presence of prohibited matter must immediately notify the Department of Primary Industries*

Eve's needle cactus *Austrocylindropuntia subulata*	**Prohibition on certain dealings** *Must not be imported into the state, sold, bartered, exchanged or offered for sale.* **All species in the Austrocylindropuntia genus have this requirement**
Fireweed *Senecio madagascariensis*	**Prohibition on certain dealings** *Must not be imported into the state, sold, bartered, exchanged or offered for sale.*
Flax-leaf broom *Genista linifolia*	**Prohibition on certain dealings** *Must not be imported into the state, sold, bartered, exchanged or offered for sale.*
Foxtail fern *Asparagus densiflorus*	**Prohibition on certain dealings** *Must not be imported into the state, sold, bartered, exchanged or offered for sale.*
Frogbit *Limnobium laevigatum*	**Prohibited Matter** *A person who deals with prohibited matter or a carrier of prohibited matter is guilty of an offence. A person who becomes aware of or suspects the presence of prohibited matter must immediately notify the Department of Primary Industries* **All species of Limnobium are Prohibited Matter**

Gamba grass *Andropogon gayanus*	**Prohibited Matter** *A person who deals with prohibited matter or a carrier of prohibited matter is guilty of an offence. A person who becomes aware of or suspects the presence of prohibited matter must immediately notify the Department of Primary Industries*
Giant devil's fig *Solanum chrysotrichum*	**Regional Recommended Measure** Exclusion zone: whole region excluding the core infestation area of Richmond Valley Council, Ballina Shire Council, Lismore Council, Kyogle Council, Byron Shire Council and Tweed Shire Council *Whole region: The plant or parts of the plant should not be traded, carried, grown or released into the environment. Exclusion zone: The plant should be eradicated from the land and the land kept free of the plant. Land managers should mitigate the risk of the plant being introduced to their land. Core infestation area: Land managers should reduce impacts from the plant on priority assets.* **This biosecurity duty also applies to devil's fig (*Solanum torvum*)**
Giant rat's tail grass *Sporobolus pyramidalis*	**Regional Recommended Measure** *Land managers should mitigate the risk of new weeds being introduced to their land. The plant should be eradicated from the land and the land kept free of the plant. The plant should not be bought, sold,*

	grown, carried or released into the environment. Notify local control authority if found. **This Regional Recommended Measure applies to *Sporobolus jacquemontii* (American rat's tail grass)**
Giant reed *Arundo donax*	**Regional Recommended Measure** Exclusion zone: whole region excluding core infestation area of the Clarence Valley Council, Bellingen Shire Council and Coffs Harbour City Council. *Whole region: The plant or parts of the plant should not be traded, carried, grown or released into the environment. Exclusion zone: The plant should be eradicated from the land and the land kept free of the plant. Land managers should mitigate the risk of the plant being introduced to their land. Core infestation area: Land managers should reduce impacts from the plant on priority assets.*
Glory lily *Gloriosa superba*	**Regional Recommended Measure** Exclusion zone: whole region excluding the core infestation area of Kempsey Shire Council, Richmond Valley Council, Ballina Shire Council, Bellingen Shire Council, Clarence Valley Council, Coffs Harbour City Council, Lismore Council, Kyogle Council, Byron Shire Council and Tweed Shire Council.

	Whole region: The plant or parts of the plant should not be traded, carried, grown or released into the environment. Exclusion zone: The plant should be eradicated from the land and the land kept free of the plant. Land managers should mitigate the risk of the plant being introduced to their land. Core infestation area: Land managers should reduce impacts from the plant on priority assets.
Gorse *Ulex europaeus*	**Prohibition on certain dealings** *Must not be imported into the state, sold, bartered, exchanged or offered for sale.*
Gorse *Ulex europaeus*	**Regional Recommended Measure** *Land managers should mitigate the risk of the plant being introduced to their land. The plant should be eradicated from the land and the land kept free of the plant.*
Green cestrum *Cestrum parqui*	**Regional Recommended Measure** Exclusion zone: whole region excluding the core infestation area of Bellingen Shire Council, Richmond Valley Council, Ballina Shire Council, Lismore Council, Kyogle Council, Byron Shire Council and Tweed Shire Council *Whole region: The plant or parts of the plant should not be traded, carried, grown or released into the*

	environment. Exclusion zone: The plant should be eradicated from the land and the land kept free of the plant. Land managers should mitigate the risk of the plant being introduced to their land. Core infestation area: Land managers should reduce impacts from the plant on priority assets.
Grey sallow *Salix cinerea*	**Prohibition on certain dealings** *Must not be imported into the state, sold, bartered, exchanged or offered for sale.*
Grey sallow *Salix cinerea*	**Regional Recommended Measure** *Land managers should mitigate the risk of the plant being introduced to their land. The plant should be eradicated from the land and the land kept free of the plant.*
Ground asparagus *Asparagus aethiopicus*	**Prohibition on certain dealings** *Must not be imported into the state, sold, bartered, exchanged or offered for sale.*
Groundsel bush *Baccharis halimifolia*	**Regional Recommended Measure** Exclusion zone: whole region excluding the core infestation area of Richmond Valley Council, Ballina Shire Council, Lismore Council, Kyogle Council, Byron Shire Council

	and Tweed Shire Council *Whole region: The plant or parts of the plant should not be traded, carried, grown or released in the environment. Exclusion zone: Land managers should mitigate the risk of spread of the plant from their land. Land managers should mitigate the risk of the plant establishing on their land. Core infestation: Land managers should reduce impacts from the plant on priority assets.*
Hawkweeds *Pilosella* species	**Prohibited Matter** *A person who deals with prohibited matter or a carrier of prohibited matter is guilty of an offence. A person who becomes aware of or suspects the presence of prohibited matter must immediately notify the Department of Primary Industries* **All species in the genera *Pilosella* and *Hieracium* a re Prohibited Matter except for *Hieracium murorum*.**
Honey locust *Gleditsia triacanthos*	**Regional Recommended Measure** Exclusion zone: whole region excluding the core infestation area of Richmond Valley Council, Ballina Shire Council, Clarence Valley Council (Mann catchment), Lismore Council, Kyogle Council, Byron Shire Council and Tweed Shire Council *Whole region: The plant or parts of the plant should not be traded, carried, grown or released into the*

	environment. Exclusion zone: The plant should be eradicated from the land and the land kept free of the plant. Land managers should mitigate the risk of the plant being introduced to their land. Core infestation area: Land managers should reduce impacts from the plant on priority assets.
Horsetails *Equisetum* species	**Regional Recommended Measure** *Land managers should mitigate the risk of new weeds being introduced to their land. The plant should be eradicated from the land and the land kept free of the plant. The plant should not be bought, sold, grown, carried or released into the environment.*
Hudson pear *Cylindropuntia pallida*	**Prohibition on certain dealings** *Must not be imported into the state, sold, bartered, exchanged or offered for sale.*
Hydrocotyl *Hydrocotyle ranunculoides*	**Prohibited Matter** *A person who deals with prohibited matter or a carrier of prohibited matter is guilty of an offence. A person who becomes aware of or suspects the presence of prohibited matter must immediately notify the Department of Primary Industries*

Hygrophila *Hygrophila costata*	**Regional Recommended Measure** Exclusion zone: all waters in the region excluding the core infestation area of Richmond Valley Council, Ballina Shire Council, Lismore Council, Kyogle Council, Byron Shire Council and Tweed Shire Council *Whole region: The plant or parts of the plant should not be traded, carried, grown or released into the environment. Exclusion zone: The plant should be eradicated from the land and the land kept free of the plant. Land managers should mitigate the risk of the plant being introduced to their land. Core infestation area: Land managers should reduce impacts from the plant on priority assets.*
Hymenachne *Hymenachne amplexicaulis* and hybrids	**Prohibition on certain dealings** *Must not be imported into the state, sold, bartered, exchanged or offered for sale.*
Hymenachne *Hymenachne amplexicaulis* and hybrids	**Regional Recommended Measure** *Land managers should mitigate the risk of the plant being introduced to their land. The plant should be eradicated from the land and the land kept free of the plant.*

Japanese walnut *Juglans ailantifolia*	**Regional Recommended Measure** *Land managers should mitigate the risk of new weeds being introduced to their land. The plant should be eradicated from the land and the land kept free of the plant. The plant should not be bought, sold, grown, carried or released into the environment.*
Karoo acacia *Vachellia karroo*	**Prohibited Matter** *A person who deals with prohibited matter or a carrier of prohibited matter is guilty of an offence. A person who becomes aware of or suspects the presence of prohibited matter must immediately notify the Department of Primary Industries*
Kei apple *Dovyalis caffra*	**Regional Recommended Measure** *Land managers should mitigate the risk of new weeds being introduced to their land. The plant should be eradicated from the land and the land kept free of the plant. The plant should not be bought, sold, grown, carried or released into the environment. Notify local control authority if found.*
Kidney-leaf mud plantain *Heteranthera reniformis*	**Regional Recommended Measure** *Land managers should mitigate the risk of new weeds being introduced to their land. The plant should be*

	eradicated from the land and the land kept free of the plant. The plant should not be bought, sold, grown, carried or released into the environment. Notify local control authority if found.
Kochia *Bassia scoparia*	**Prohibited Matter** *A person who deals with prohibited matter or a carrier of prohibited matter is guilty of an offence. A person who becomes aware of or suspects the presence of prohibited matter must immediately notify the Department of Primary Industries* **Excluding the subspecies *trichophylla***
Koster's curse *Clidemia hirta*	**Prohibited Matter** *A person who deals with prohibited matter or a carrier of prohibited matter is guilty of an offence. A person who becomes aware of or suspects the presence of prohibited matter must immediately notify the Department of Primary Industries*
Kudzu *Pueraria lobata*	**Regional Recommended Measure** Exclusion zone: whole region excluding the core infestation area of Richmond Valley Council, Ballina Shire Council, Bellingen Shire Council, Clarence Valley Council, Coffs Harbour City Council, Lismore Council, Kyogle Council, Byron Shire Council and Tweed Shire Council

	Whole region: The plant or parts of the plant should not be traded, carried, grown or released into the environment. Exclusion zone: The plant should be eradicated from the land and the land kept free of the plant. Land managers should mitigate the risk of the plant being introduced to their land. Core infestation area: Land managers should reduce impacts from the plant on priority assets.
Lagarosiphon *Lagarosiphon major*	**Prohibited Matter** *A person who deals with prohibited matter or a carrier of prohibited matter is guilty of an offence. A person who becomes aware of or suspects the presence of prohibited matter must immediately notify the Department of Primary Industries*
Lantana *Lantana camara*	**Prohibition on certain dealings** *Must not be imported into the state, sold, bartered, exchanged or offered for sale.*
Leaf cactus *Pereskia aculeata*	**Regional Recommended Measure** *Land managers should mitigate the risk of new weeds being introduced to their land. The plant should be eradicated from the land and the land kept free of the plant. The plant should not be bought, sold,*

	grown, carried or released into the environment.
Leucaena *Leucaena leucocephala*	**Regional Recommended Measure** Exclusion zone: all lands in the region except the core infestation area of Richmond Valley Council, Ballina Shire Council, Lismore Council, Kyogle Council, Byron Shire Council, Tweed Shire Council. *Whole region: The plant or parts of the plant should not be traded, carried, grown or released into the environment. Exclusion zone: The plant should be eradicated from the land and the land kept free of the plant. Land managers should mitigate the risk of the plant being introduced to their land. Core infestation area: Land managers should reduce impacts from the plant on priority assets.*
Long-leaf willow primrose *Ludwigia longifolia*	**Regional Recommended Measure** Exclusion zone: All lands in the region except the core infestation area of Nambucca Shire Council, Bellingen Shire Council, Coffs Harbour City Council, Clarence Valley Council, Richmond Valley Council, Ballina Shire Council, Lismore Council, Kyogle Council, Byron Shire Council and Tweed Shire Council. *Whole region: The plant or parts of the plant should not be traded, carried, grown or released into the environment. Exclusion zone: The*

	plant should be eradicated from the land and the land kept free of the plant. Land managers should mitigate the risk of the plant being introduced to their land. Core infestation area: Land managers should reduce impacts from the plant on priority assets.
Ludwigia *Ludwigia peruviana*	**Regional Recommended Measure** *Land managers should mitigate the risk of new weeds being introduced to their land. The plant should be eradicated from the land and the land kept free of the plant. The plant should not be bought, sold, grown, carried or released into the environment. Notify local control authority if found.*
Madeira vine *Anredera cordifolia*	**Prohibition on certain dealings** *Must not be imported into the state, sold, bartered, exchanged or offered for sale.*
Mahonia *Berberis lomariifolia*	**Regional Recommended Measure** *Land managers should mitigate the risk of new weeds being introduced to their land. The plant should be eradicated from the land and the land kept free of the plant. The plant should not be bought, sold, grown, carried or released into the environment.*

Mesquite *Prosopis* species	**Prohibition on certain dealings** *Must not be imported into the state, sold, bartered, exchanged or offered for sale.* **All species in the genus *Prosopis* have this requirement**
Mexican feather grass *Nassella tenuissima*	**Prohibited Matter** *A person who deals with prohibited matter or a carrier of prohibited matter is guilty of an offence. A person who becomes aware of or suspects the presence of prohibited matter must immediately notify the Department of Primary Industries*
Miconia *Miconia* species	**Prohibited Matter** *A person who deals with prohibited matter or a carrier of prohibited matter is guilty of an offence. A person who becomes aware of or suspects the presence of prohibited matter must immediately notify the Department of Primary Industries* **All species of *Miconia* are Prohibited Matter in NSW**
Mikania vine *Mikania micrantha*	**Prohibited Matter** *A person who deals with prohibited matter or a carrier of prohibited matter is guilty of an offence. A person who becomes aware of or suspects the presence of prohibited matter must immediately notify the Department of Primary Industries* ***all species in the**

	genus *Mikania* are Prohibited Matter in NSW
Mimosa *Mimosa pigra*	**Prohibited Matter** *A person who deals with prohibited matter or a carrier of prohibited matter is guilty of an offence. A person who becomes aware of or suspects the presence of prohibited matter must immediately notify the Department of Primary Industries*
Ming asparagus fern *Asparagus macowanii*	**Regional Recommended Measure** *Land managers should mitigate the risk of new weeds being introduced to their land. The plant should be eradicated from the land and the land kept free of the plant. The plant should not be bought, sold, grown, carried or released into the environment.*
Monkey's comb *Pithecoctenium crucigerum*	**Regional Recommended Measure** *Land managers should mitigate the risk of new weeds being introduced to their land. The plant should be eradicated from the land and the land kept free of the plant. The plant should not be bought, sold, grown, carried or released into the environment. Notify local control authority if found.*

Moonflower *Ipomoea alba*	**Regional Recommended Measure** Exclusion zone: whole region excluding the core infestation area of Clarence Valley Council, Richmond Valley Council, Ballina Shire Council, Lismore Council, Kyogle Council, Byron Shire Council and Tweed Shire Council. *Whole region: The plant or parts of the plant should not be traded, carried, grown or released into the environment. Exclusion zone: The plant should be eradicated from the land and the land kept free of the plant. Land managers should mitigate the risk of the plant being introduced to their land. Core infestation area: Land managers should reduce impacts from the plant on priority assets.*
Mysore thorn *Caesalpinia decapetala*	**Regional Recommended Measure** Exclusion zone: all lands in the region except for the core infestation area of Richmond Valley Council, Ballina Shire Council, Lismore Council, Kyogle Council, Byron Shire Council and Tweed Shire Council. *Whole region: The plant or parts of the plant should not be traded, carried, grown or released into the environment. Exclusion zone: The plant should be eradicated from the land and the land kept free of the plant. Land managers should mitigate the risk of the plant being introduced to their land. Core infestation area: Land managers*

	should reduce impacts from the plant on priority assets.
Pampas grass *Cortaderia* species	**Regional Recommended Measure** *Land managers should mitigate the risk of new weeds being introduced to their land. The plant should be eradicated from the land and the land kept free of the plant. The plant should not be bought, sold, grown, carried or released into the environment.* **This Regional Recommended Measure applies to *Cortaderia selloana* and *Cortaderia jubata* (pink pampas grass)**
Paper mulberry *Broussonetia papyrifera*	**Regional Recommended Measure** *Land managers should mitigate the risk of new weeds being introduced to their land. The plant should be eradicated from the land and the land kept free of the plant. The plant should not be bought, sold, grown, carried or released into the environment.*
Parkinsonia *Parkinsonia aculeata*	**Prohibition on certain dealings** *Must not be imported into the state, sold, bartered, exchanged or offered for sale.*

Parkinsonia *Parkinsonia aculeata*	**Control Order** Parkinsonia Control Zone: Whole of NSW *Parkinsonia Control Zone (Whole of NSW): Owners and occupiers of land on which there is parkinsonia must notify the local control authority of new infestations; immediately destroy the plants; ensure subsequent generations are destroyed; and ensure the land is kept free of the plant. A person who deals with a carrier of parkinsonia must ensure the plant (and any seed and propagules) is not moved from the land; and immediately notify the local control authority of the presence of the plant.*
Parthenium weed *Parthenium hysterophorus*	**Prohibited Matter** *A person who deals with prohibited matter or a carrier of prohibited matter is guilty of an offence. A person who becomes aware of or suspects the presence of prohibited matter must immediately notify the Department of Primary Industries*
Parthenium weed *Parthenium hysterophorus*	**Prohibition on certain dealings** *The following equipment must not be imported into NSW from Queensland: grain harvesters (including the comb or front), comb trailers (including the comb or front), bins used for holding grain during harvest operations, augers or similar for moving grain, vehicles used to transport grain harvesters, support vehicles driven in paddocks during harvest operations, mineral*

	exploration drilling rigs and vehicles used to transport those rigs, unless set out as an exception in Division 5, Part 2 of the Biosecurity Order (Permitted Activities) 2017
Pond apple *Annona glabra*	**Prohibited Matter** *A person who deals with prohibited matter or a carrier of prohibited matter is guilty of an offence. A person who becomes aware of or suspects the presence of prohibited matter must immediately notify the Department of Primary Industries*
Prickly acacia *Vachellia nilotica*	**Prohibited Matter** *A person who deals with prohibited matter or a carrier of prohibited matter is guilty of an offence. A person who becomes aware of or suspects the presence of prohibited matter must immediately notify the Department of Primary Industries*
Prickly pears - Austrocylindropuntias *Austrocylindropuntia* species	**Prohibition on certain dealings** *Must not be imported into the state, sold, bartered, exchanged or offered for sale.* **All species in the Austrocylindropuntia genus have this requirement**
Prickly pears - Cylindropuntias *Cylindropuntia* species	**Prohibition on certain dealings** *Must not be imported into the state, sold, bartered, exchanged or offered*

	for sale. **All species in the Cylindropuntia genus have this requirement**
Prickly pears - Opuntias *Opuntia* species	**Prohibition on certain dealings** *Must not be imported into the state, sold, bartered, exchanged or offered for sale.* **For all Opuntia species except for *Opuntia ficus-indica* (Indian fig).**
Rope pear *Cylindropuntia imbricata*	**Prohibition on certain dealings** *Must not be imported into the state, sold, bartered, exchanged or offered for sale.* **All species in the Cylindropuntia genus have this requirement**
Rubber vine *Cryptostegia grandiflora*	**Prohibited Matter** *A person who deals with prohibited matter or a carrier of prohibited matter is guilty of an offence. A person who becomes aware of or suspects the presence of prohibited matter must immediately notify the Department of Primary Industries*
Sagittaria *Sagittaria platyphylla*	**Prohibition on certain dealings** *Must not be imported into the state, sold, bartered, exchanged or offered for sale.*

Salvinia *Salvinia molesta*	**Prohibition on certain dealings** *Must not be imported into the state, sold, bartered, exchanged or offered for sale.*
Scotch broom *Cytisus scoparius* subsp. *scoparius*	**Prohibition on certain dealings** *Must not be imported into the state, sold, bartered, exchanged or offered for sale.*
Scotch broom *Cytisus scoparius* subsp. *scoparius*	**Regional Recommended Measure** *Land managers should mitigate the risk of the plant being introduced to their land. The plant should be eradicated from the land and the land kept free of the plant.*
Sea spurge *Euphorbia paralias*	**Regional Recommended Measure** *Land managers should mitigate the risk of new weeds being introduced to their land. The plant should be eradicated from the land and the land kept free of the plant. The plant should not be bought, sold, grown, carried or released into the environment. Notify local control authority if found.*
Seeded banana *Musa* species	**Regional Recommended Measure** *Land managers should mitigate the risk of new weeds being introduced to their land. The plant should be*

	eradicated from the land and the land kept free of the plant. The plant should not be bought, sold, grown, carried or released into the environment.
Senegal tea plant *Gymnocoronis spilanthoides*	**Regional Recommended Measure** *Land managers should mitigate the risk of the plant being introduced to their land. The plant should be eradicated from the land and the land kept free of the plant.*
Serrated tussock *Nassella trichotoma*	**Prohibition on certain dealings** *Must not be imported into the state, sold, bartered, exchanged or offered for sale.*
Shoebutton ardisia *Ardisia elliptica*	**Regional Recommended Measure** *Land managers should mitigate the risk of new weeds being introduced to their land. The plant should be eradicated from the land and the land kept free of the plant. The plant should not be bought, sold, grown, carried or released into the environment.*
Siam weed *Chromolaena odorata*	**Prohibited Matter** *A person who deals with prohibited matter or a carrier of prohibited matter is guilty of an offence. A person who becomes aware of or*

	suspects the presence of prohibited matter must immediately notify the Department of Primary Industries
Sicklethorn *Asparagus falcatus*	**Regional Recommended Measure** *Land managers should mitigate the risk of new weeds being introduced to their land. The plant should be eradicated from the land and the land kept free of the plant. The plant should not be bought, sold, grown, carried or released into the environment.*
Silverleaf nightshade *Solanum elaeagnifolium*	**Prohibition on certain dealings** *Must not be imported into the state, sold, bartered, exchanged or offered for sale.*
Skunk vine *Paederia foetida*	**Regional Recommended Measure** *Land managers should mitigate the risk of new weeds being introduced to their land. The plant should be eradicated from the land and the land kept free of the plant. The plant should not be bought, sold, grown, carried or released into the environment. Notify local control authority if found.*
Smooth tree pear *Opuntia monacantha*	**Prohibition on certain dealings** *Must not be imported into the state,*

	sold, bartered, exchanged or offered for sale.
Snakefeather *Asparagus scandens*	**Prohibition on certain dealings** *Must not be imported into the state, sold, bartered, exchanged or offered for sale.*
Spongeplant *Limnobium spongia*	**Prohibited Matter** *A person who deals with prohibited matter or a carrier of prohibited matter is guilty of an offence. A person who becomes aware of or suspects the presence of prohibited matter must immediately notify the Department of Primary Industries* **All species of *Limnobium* are Prohibited Matter**
Spotted knapweed *Centaurea stoebe* subsp. *micranthos*	**Prohibited Matter** *A person who deals with prohibited matter or a carrier of prohibited matter is guilty of an offence. A person who becomes aware of or suspects the presence of prohibited matter must immediately notify the Department of Primary Industries*
Tiger pear *Opuntia aurantiaca*	**Prohibition on certain dealings** *Must not be imported into the state, sold, bartered, exchanged or offered for sale.*

Tobacco weed *Elephantopus mollis*	**Regional Recommended Measure** *Land managers should mitigate the risk of new weeds being introduced to their land. The plant should be eradicated from the land and the land kept free of the plant. The plant should not be bought, sold, grown, carried or released into the environment.*
Tropical soda apple *Solanum viarum*	**Control Order** Tropical Soda Apple Control Zone: Whole of NSW *Tropical Soda Apple Control Zone (Whole of NSW): Owners and occupiers of land on which there is tropical soda apple must notify the local control authority of new infestations; destroy the plants including the fruit; ensure subsequent generations are destroyed; and ensure the land is kept free of the plant. A person who deals with a carrier of tropical soda apple must ensure the plant (and any seed and propagules) is not moved from the land; and immediately notify the local control authority of the presence of the plant on the land, or on or in a carrier.*
Velvety tree pear *Opuntia tomentosa*	**Prohibition on certain dealings** *Must not be imported into the state, sold, bartered, exchanged or offered for sale.*

Water caltrop *Trapa* species	**Prohibited Matter** *A person who deals with prohibited matter or a carrier of prohibited matter is guilty of an offence. A person who becomes aware of or suspects the presence of prohibited matter must immediately notify the Department of Primary Industries* **All species in the *Trapa* genus are Prohibited Matter in NSW**
Water hyacinth *Eichhornia crassipes*	**Prohibition on certain dealings** *Must not be imported into the state, sold, bartered, exchanged or offered for sale.*
Water hyacinth *Eichhornia crassipes*	**Biosecurity Zone** The Water Hyacinth Biosecurity Zone applies to all land within the State, except for the following regions: Greater Sydney or North Coast, North West (but only the local government area of Moree Plains), Hunter (but only in the local government areas of City of Cessnock, City of Lake Macquarie, MidCoast, City of Maitland, City of Newcastle or Port Stephens), South East (but only in the local government areas of Eurobodalla, Kiama, City of Shellharbour, City of Shoalhaven or City of Wollongong). *Within the Biosecurity Zone this weed must be eradicated where practicable, or as much of the weed destroyed as practicable, and any remaining weed suppressed. The local control authority must be notified of any new infestations of*

	this weed within the Biosecurity Zone
Water lettuce *Pistia stratiotes*	**Regional Recommended Measure** *Land managers should mitigate the risk of new weeds being introduced to their land. The plant should be eradicated from the land and the land kept free of the plant. The plant should not be bought, sold, grown, carried or released into the environment. Notify local control authority if found.*
Water mimosa *Neptunia oleracea*	**Regional Recommended Measure** *Land managers should mitigate the risk of new weeds being introduced to their land. The plant should be eradicated from the land and the land kept free of the plant. The plant should not be bought, sold, grown, carried or released into the environment. Notify local control authority if found.* **This Regional Recommended Measure also applies to *Neptunia plena***
Water soldier *Stratiotes aloides*	**Prohibited Matter** *A person who deals with prohibited matter or a carrier of prohibited matter is guilty of an offence. A person who becomes aware of or suspects the presence of prohibited*

	matter must immediately notify the Department of Primary Industries
Water star grass *Heteranthera zosterifolia*	**Regional Recommended Measure** *Land managers should mitigate the risk of new weeds being introduced to their land. The plant should be eradicated from the land and the land kept free of the plant. The plant should not be bought, sold, grown, carried or released into the environment.*
Wheel cactus *Opuntia robusta*	**Prohibition on certain dealings** *Must not be imported into the state, sold, bartered, exchanged or offered for sale.*
White blackberry *Rubus niveus*	**Regional Recommended Measure** *Land managers should mitigate the risk of new weeds being introduced to their land. The plant should be eradicated from the land and the land kept free of the plant. The plant should not be bought, sold, grown, carried or released into the environment.*
Willows *Salix* species	**Prohibition on certain dealings** *Must not be imported into the state, sold, bartered, exchanged or offered for sale.* **All species in the *Salix* genus**

	have this requirement, except *Salix babylonica* (weeping willows), *Salix x calodendron* (pussy willow) and *Salix x reichardtii* (sterile pussy willow)
Witchweeds *Striga* species	**Prohibited Matter** *A person who deals with prohibited matter or a carrier of prohibited matter is guilty of an offence. A person who becomes aware of or suspects the presence of prohibited matter must immediately notify the Department of Primary Industries* **All species in the *Striga* genus are Prohibited Matter in NSW, except the native *Striga parviflora***
Yellow bells *Tecoma stans*	**Regional Recommended Measure** Exclusion zone: whole region excluding the core infestation area of Richmond Valley Council, Ballina Shire Council, Lismore Council, Kyogle Council, Byron Shire Council, Tweed Shire Council, Bellingen Shire Council and Coffs Harbour City Council (Bruxner Park and Woolgoolga only). *Whole region: The plant or parts of the plant should not be traded, carried, grown or released into the environment. Exclusion zone: The plant should be eradicated from the land and the land kept free of the plant. Land managers should mitigate the risk of the plant being introduced to their land. Core*

	infestation area: Land managers should reduce impacts from the plant on priority assets.
Yellow burrhead *Limnocharis flava*	**Prohibited Matter** *A person who deals with prohibited matter or a carrier of prohibited matter is guilty of an offence. A person who becomes aware of or suspects the presence of prohibited matter must immediately notify the Department of Primary Industries*

The content provided here is for information purposes only and is taken from the *Biosecurity Act 2015* and its subordinate legislation, and the Regional Strategic Weed Management Plans (published by each Local Land Services region in NSW). It describes the state and regional priorities for weeds in New South Wales, Australia.

Appendix B
Summary of BSC Herbicide Usage

Table 8-1 Summary of BSC Herbicide Usage.

Product	Pesticide	Concentration/s	Formulation used	Application rate	Total volume (L)	Total volume (g)	Area general	Area specific	Area	method of application	Application date	Conditions	Season	Purpose of use	Weeds
--	Metsulfuron methyl	600g/kg	Marker dye, wetting agent	20g/10L		12	Bush Regeneration	Baker Street, Fernmont	--	Backpack	13/01/2021	Marginal (>30)	Summer	Targeted	Cats Claw, Madeira vine
--	Glyphosate 450	450mg/L	Marker dye	60mL/10L	0.36		Bush Regeneration	Baker Street, Fernmont	--	Backpack	13/01/2021	Marginal (>30)	Summer	Multipurpose	Annuals
--	Metsulfuron methyl	600g/kg	Marker dye, wetting agent	60mL/10L		6	Bush Regeneration	Baker Street, Fernmont	--	Spray	27/01/2021	Marginal (>30)	Summer	Targeted	Cats Claw, Madeira vine
--	Glyphosate 450	450mg/L	Marker dye	60mL/10L	0.36		Bush Regeneration	Baker Street, Fernmont	--	Spray	27/01/2021	Marginal (>30)	Summer	Multipurpose	Annuals
Grazon	Triclopyr, picloram, aminopyralid	300g/L, 100g/L, 8g/L	--	3L/600L	13.5		Rural	Nash Road Deervale	5 ha	Spot spray	20/04/2021	Preferred	Autumn	Targeted	Red cestrum
--	Metsulfuron methyl	600g/kg	Anionic Surfactant wetter	60g/600L		270	Rural	Nash Road Deervale	5 ha	Spot spray	20/04/2021	Preferred	Autumn	Targeted	Red cestrum
Grazon	Triclopyr, picloram, aminopyralid	300g/L, 100g/L, 8g/L	--	500mL/100L	16.5		Rural	Deervale Road, Deervale	4 ha	Spot spray	17/05/2021	Preferred	Autumn	Targeted	Red cestrum
--	Metsulfuron methyl	600g/kg	Anionic Surfactant wetter	10g/100L		330	Rural	Deervale Road, Deervale	4 ha	Spot spray	17/05/2021	Preferred	Autumn	Targeted	Red cestrum
Grazon	Triclopyr, picloram, aminopyralid	300g/L, 100g/L, 8g/L	--	500mL/100L	6		Rural	Deervale Road, Deervale	4 ha	Spot spray	26/05/2021	Preferred	Autumn	Targeted	Red cestrum
--	Metsulfuron methyl	600g/kg	Anionic Surfactant Wetter	10g/100L		120	Rural	Deervale Road, Deervale	4 ha	Spot spray	26/05/2021	Preferred	Autumn	Targeted	Red cestrum
Weedmaster Duo	Glyphosate	360g/L	--	--	0.46		Cemetery	--	--	Posion bottle - drilled	29/03/2021	Preferred	Autumn	Multipurpose	mixed
Weedmaster Duo	Glyphosate	360g/L	--	--	0.41		Cemetery	--	--	Posion bottle - drilled	30/03/2021	Preferred	Autumn	Multipurpose	mixed
Weedmaster Duo	Glyphosate	360g/L	--	--	0.1		Cemetery	--	--	Cut and paint	31/03/2021	Preferred	Autumn	Targeted	Coral berry and honeysuckle
Brush-off	Metsulfuron methyl	600g/kg	Non-ionic surfactant (Pulse)	--	0.15		Cemetery	--	--	Spray	31/03/2021	Preferred	Autumn	Targeted	Coral berry and honeysuckle
Weedmaster Duo	Glyphosate	360g/L	--	--	1.15		Periurban	--	--	Posion bottle - drilled	--	Preferred	Autumn	Targeted	Coxspur tree
Weedmaster Duo	Glyphosate	360g/L	--	--	1.65		Public Reserve	Mylestom Crown	--	Posion bottle - drilled	22/04/2021	--	Autumn	Targeted	Broadleaf pepper
Weedmaster Duo	Glyphosate	360g/L	--	--	0.255		Residential	Tamarind Drive	--	Spray and poison bottle	9/04/2021	--	Autumn	Multipurpose	mixed
Weedmaster Duo	Glyphosate	360g/L	--	--	0.2		Public Reserve	--	--	Posion bottle - drilled	9/02/2021	--	Summer	Targeted	Coxspur tree

Product	Pesticide	Concentration/s	Formulation used	Application rate	Total volume (L)	Total volume (g)	Area general	Area specific	Area	method of application	Application date	Conditions	Season	Purpose of use	Weeds
Weedmaster Duo	Glyphosate	360g/L		--	0.45		Periurban	--	--	Backpack	1/04/2021	Preferred	Autumn	Targeted	Blackberry
--	Glyphosate	360g/L		--	1.05		Periurban	Connell Street, Coronation Place, sunset ridge, tamarind dr, glenwater road	--	Posion bottle - drilled	2/03/2021 & 9/3/21	Preferred	Autumn	--	--
Weedmaster Duo	Glyphosate	360g/L	--	--	0.98		Periurban	--	--	Posion bottle - drilled	2/2/2021 & 23/2/21	Preferred	Summer	Targeted	White and common blackberry
Weedmaster Duo	Glyphosate	360g/L	--	6 to 1	0.98		Periurban	--	--	Splatter gun	28/08/2020	Preferred	Summer	Multipurpose	Grasses, elephant grass, blue billygoat, madiera vine, ballon vine
Weedmaster Duo	Glyphosate	360g/L	--	100 to 1	0.98		Periurban	--	--	Spray	28/08/2020	Preferred	Summer	Multipurpose	Grasses, elephant grass, blue billygoat, madiera vine, ballon vine
--	Metsulfuron methyl	600g/kg	Wetting agent	1.5g/10L	0.98		Bush Regeneration	West End Bellingen Island	--	Spray	28/08/2020	Preferred	Summer	Multipurpose	Grasses, elephant grass, blue billygoat, madiera vine, ballon vine
--	Metsulfuron methyl	600g/kg	Wetting agent	3.75g/25L	25		Bush Regeneration	West End Bellingen Island	--	Spray	4/09/2020	Preferred	Summer	Targeted	Madeira vine
--	Metsulfuron methyl	600g/kg	Wetting agent	1.5g/10L	12		Bush Regeneration	West End Bellingen Island	--	Spray	21/09/2020	Preferred	Spring	Targeted	Madeira vine
--	Metsulfuron methyl	600g/kg	Wetting agent	1.5g/10L	13		Bush Regeneration	West End Bellingen Island	--	Spray	5/02/2021	Preferred	Summer	Targeted	Madeira vine
--	Metsulfuron methyl	600g/kg	Wetting agent	1.5g/10L	25		Bush Regeneration	West End Bellingen Island	--	Spray	12/02/2021	Preferred	Summer	Targeted	Madeira vine
--	Metsulfuron methyl	600g/kg	Wetting agent	1.5g/10L	1.5		Bush Regeneration	West End Bellingen Island	--	Spray	26/03/2021	Preferred	Autumn	Targeted	Madeira vine
--	Metsulfuron methyl	600g/kg	Wetting agent	3g/20L	1.5		Bush Regeneration	West End Bellingen Island	--	Spray	15/05/2021	marginal	Winter	Targeted	Madeira vine
--	Metsulfuron methyl	600g/kg	Wetting agent	1.5g/10L	30		Bush Regeneration	West End Bellingen Island	--	Spray	11/06/2021	perferred	Winter	Targeted	Madeira vine
--	Metsulfuron methyl	600g/kg	Wetting agent	100 to 1	46		Bush Regeneration	West End Bellingen Island	--	Spray	26/02/2021	perferred	Summer	Multipurpose	Grasses, blue billygoat, baloon vine
							Bush Regeneration	Dorrigo Plateau							
Weedmaster Duo, Metsun	Glyphosate & metsulfuron methyl	500g/L; 600g/kg	Wetting agent (metsulfuron methyl)	1500ml/100L, 10g/100L	300		Waste Depot	Kerbs & gutters	--	Hand spray & powered	22/07/2021	--	Winter	Multipurpose	--
Weedmaster Duo, Metsun	Glyphosate & metsulfuron methyl	500g/L; 600g/kg	Wetting agent	1500ml/100L, 10g/100L	400		Waste Depot	Kerbs & gutters, traffic islands	--	Hand spray & powered	21/07/2021	--	Winter	Multipurpose	--

Product	Pesticide	Concentration/s	Formulation used	Application rate	Total volume (L)	Total volume (g)	Area general	Area specific	Area	method of application	Application date	Conditions	Season	Purpose of use	Weeds
			(metsulfuron methyl)												
Weedmaster Duo	Glyphosate & metsulfuron methyl	500g/L; 600g/kg	Wetting agent (metsulfuron methyl)	1.200m/100L	80		Waste Depot	Borders and Fences at Raleigh Depot	--	Hand spray	14/07/2021	--	Winter	Targeted	Multipurpose
Weedmaster Duo, Metsun	Glyphosate & metsulfuron methyl	500g/L; 600g/kg	Wetting agent (metsulfuron methyl)	1500ml/100L, 10g/100L	400		Waste Depot	Roadway at Whites Quarry	--	Hand spray & powered	24/04/2021	--	Autumn	Targeted	Blackberry, privet
Weedmaster Duo, Metsun	Glyphosate & metsulfuron methyl	500g/L; 600g/kg	Wetting agent (metsulfuron methyl)	1500ml/100L, 10g/100L	300		Waste Depot	Kerbs & gutters	--	Powered	11/11/2020	--	Spring	Multipurpose	--
Weedmaster Duo, Metsun	Glyphosate & metsulfuron methyl	500g/L; 600g/kg	Wetting agent (metsulfuron methyl)	1500ml/100L, 10g/100L	200		Waste Depot	Kerbs	--	Powered	22/09/2020	--	Spring	Multipurpose	--
Weedmaster Duo, Metsun	Glyphosate & metsulfuron methyl	500g/L; 600g/kg	Wetting agent (metsulfuron methyl)	1500ml/100L, 10g/100L	200		Waste Depot	compound ground at Bellingen Bridge Stock Pile	--	Powered	--	--		Multipurpose	--
Weedmaster Duo, Metsun	Glyphosate & metsulfuron methyl	500g/L; 600g/kg	Wetting agent (metsulfuron methyl)	1500ml/100L, 10g/100L	150		Waste Depot	Kerbs & gutters	--	Powered	30/07/2020	--	Winter	Multipurpose	--
Weedmaster Duo, Metsun	Glyphosate & metsulfuron methyl	500g/L; 600g/kg	Wetting agent (metsulfuron methyl)	1500ml/100L, 10g/100L	200		Waste Depot	Roads & buildings, kerbs & gutters	--	Powered	29/07/2020	--	Winter	Multipurpose	--
Weedmaster Duo, Metsun	Glyphosate & metsulfuron methyl	500g/L; 600g/kg	Wetting agent (metsulfuron methyl)	1500ml/100L, 10g/100L	400		Waste Depot	Kerbs & gutters, yards	--	Powered	30/04/2020	--	Autumn	Multipurpose	--
Weedmaster Duo, Metsun	Glyphosate & metsulfuron methyl	500g/L; 600g/kg	Wetting agent (metsulfuron methyl)	1500ml/100L, 10g/100L	--		Waste Depot	Raleigh Waste Centre	--	Powered	6/03/2020	--	Autumn	Multipurpose	--
Weedmaster Duo, Metsun	Glyphosate & metsulfuron methyl	500g/L; 600g/kg	Wetting agent (metsulfuron methyl)	1500ml/100L, 10g/100L	600		Waste Depot	Raleigh Waste Centre & streets	--	Hand spray & powered	29/04/2020	--	Autumn	Multipurpose	--
Conqueror®	Triclopyr, picloram	400ml/100L	--	--	1200		Public Reserve, Periurban, pastures	Dorrigo Sportsground, Nymbodia River, Prices Road, Clarks Road, McIndoss Road, Deervale Road, Johsens Road	270.6 km	Dual reel petrol pump	19/01/2021, 20/01/2021 & 21/01/2021	preferred, marginal (humidity >65%)	Summer	Targeted	Blackberry, banana passionfruit
Conqueror®	Triclopyr, picloram	400ml/100L	--	--	620		Periurban	Cascade Road, Coramba Road, Bev..., Maynards Plains Road, Wisky Creek Road, Deer	270.6 km	Dual reel petrol pump	19/01/2021, 20/01/2021 & 21/01/2021	Marginal (humidity >65%)	Summer	Targeted	Blackberry, banana passionfruit, broom, lantana,

Product	Pesticide	Concentration/s	Formulation used	Application rate	Total volume (L)	Total volume (g)	Area general	Area specific	Area	method of application	Application date	Conditions	Season	Purpose of use	Weeds
								Vale loop Road, Fernbrook loop Road							
Conqueror®	Triclopyr, picloram	400ml/100L	--	--	1105		Periurban	Waterfall Way, Lower Bielsdown Road, Slingsbys Road, Breakwells Road, Rogers Road, Davidson Road, Beaumonts Road, Clarks Road, Nash Road	270.6 km	Dual reel petrol pump	19/01/2021, 20/01/2021 & 21/01/2021	preferred, marginal (humidity >65%)	Summer	Targeted	Blackberry, coolatai grass
Grazon®, Apparent®, Consume®, marker dye	Triclopyr, picloram, aminopyralid, metsulfuron methyl	400mL/100L; 10g/100mL; 100mL/100L	--	--	1200		National Park	Cascade National Park	--	Dual reel petrol pump	11/05/2021, 12/05/2021	Marginal (humidity >65%)	Autumn	Targeted	Red cestrum
Cascade®	Endothal	100mL/100L	--	--	600		National Park	Cascade National Park	--	Dual reel petrol pump	11/05/2021, 12/05/2021	Marginal (humidity >65%)	Autumn	Targeted	
Grazon®, Apparent®, Consume®	Triclopyr, picloram, aminopyralid, metsulfuron methyl	400mL/100L; 10g/100mL; 100mL/100L	--	--	1050		Waste Depot	Dorrigo Waste Depo	--	Dual reel petrol pump	11/05/2021, 12/05/2021	Preferred, marginal (humidity >65%)	Autumn	Targeted	Red cestrum
--	Metsulfuron methyl	--	Marker dye/Pulse	2g/10L		200	Public Reserve	Rocky Creek Reserve	--	Backpack	2/02/2021	--	Summer	Targeted	honeysuckle, privet, blackberry
Grazon®	Triclopyr, picloram, aminopyralid & glyphosate	300g/L; 100g/L; 8g/L	Marker dye/Pulse	40ml/10L & 60ml/10L	0.224 and 0.428		Drain	Gabion Drain	--	Backpack, spray bottle	4/2/21 & 11/2/21	--	Summer	Targeted	Vine woods (madieria, balloon, ivy), ochna, senna
Grazon®	Triclopyr, picloram, aminopyralid & glyphosate	300g/L; 100g/L; 8g/L	Marker dye/Pulse	40ml/10L & 80ml/10L	0.5 and 6.32		--	--	--	Backpack, spray bottle, cut/paint	23/2/21, 10/3/21, 11/3/21, 1/4/21, 8/4/21, 9/4/21	--	Summer & autumn	Targeted	Kudzu
Grazon®	Triclopyr, picloram, aminopyralid	300g/L; 100g/L; 8g/L	Pulse	40ml/10L	0.04		--	--	--	Backpack	9/04/2021	--	Autumn	Targeted	Kudzu
Grazon®	Triclopyr, picloram, aminopyralid	300g/L; 100g/L; 8g/L	Pulse	40ml/10L	3.08		Waste Depot	Raleigh Waste Depot	--	Spray unit & backpack	20/4/21, 18/5/21, 1/6/21	--	Autumn & winter	Targeted	Lantana, senna, castor oil, madieria, singapore daisy
--	Metsulfuron methyl	--	Pulse	1.5g/10L		40	Waste Depot	Raleigh Waste Depot	--	Spray unit	20/04/2021	--	Autumn	Targeted	Lantana, senna, castor oil, madieria, singapore daisy
--	Glyphosate	--	Pulse	80ml/10L	0.096		Periurban	Robert Wolfe Park Tennis Courts	--	Spray Bottle	16/09/2020	--	Spring	Targeted	multipurpose including morning

Product	Pesticide	Concentration/s	Formulation used	Application rate	Total volume (L)	Total volume (g)	Area general	Area specific	Area	method of application	Application date	Conditions	Season	Purpose of use	Weeds
															glory and privet
Grazon®	Triclopyr, picloram, aminopyralid	300g/L; 100g/L; 8g/L	Pulse	40ml/10L	0.048		Periurban	Robert Wolfe Park Tennis Courts	--	Spray Bottle	16/09/2020	--	Spring	Targeted	multipurpose including morning glory and privet
Grazon®	Triclopyr, picloram, aminopyralid	300g/L; 100g/L; 8g/L	Pulse	40ml/10L	0.02		Periurban	Winter Ave Mylestome, PO 8291 RSL	--	Spray Bottle	12/07/2021	--	Winter	Targeted	Maderia, fishbone fern, morning glory and poinsottia
Grazon®	Triclopyr, picloram, aminopyralid	300g/L; 100g/L; 8g/L	Pulse	35ml/10L	0.21		Bush Regeneration	Bellingen Island Flying Fox Camp	--	Backpack	25/01/2019	--	Summer	Targeted	Maderia, privet, coral tree, balloon vine, elephant grass, castor oil
	Glyphosate	360g/L		80ml/10L	0.48		Bush Regeneration	Bellingen Island Flying Fox Camp	--	Backpack	25/01/2019	--	Summer	Targeted	Maderia, privet, coral tree, balloon vine, elephant grass, castor oil
Grazon®	Triclopyr, picloram, aminopyralid	300g/L; 100g/L; 8g/L	Pulse	35ml/10L & 80ml/10L	0.21		Bush Regeneration	Bellingen Island Flying Fox Camp	--	Backpack & cut/paint	1/02/2019	--	Summer	Targeted	Maderia, privet, coral tree, balloon vine, elephant grass, castor oil
	Glyphosate	360g/L		80ml/10L	1.8		Bush Regeneration	Bellingen Island Flying Fox Camp	--	Backpack & cut/paint	1/02/2019	--	Summer	Targeted	Maderia, privet, coral tree, balloon vine, elephant grass, castor oil
Grazon®	Triclopyr, picloram, aminopyralid	300g/L; 100g/L; 8g/L	Pulse	35ml/10L & 80ml/10L	0.88		Bush Regeneration	Bellingen Island Flying Fox Camp	--	Spray & cut/paint	11/02/2019	--	Summer	Targeted	Maderia, privet, coral tree, balloon vine, elephant grass, castor oil
	Glyphosate	360g/L		80ml/10L	0.21		Bush Regeneration	Bellingen Island Flying Fox Camp	--	Backpack & cut/paint	1/02/2019	--	Summer	Targeted	Maderia, privet, coral tree, balloon vine, elephant grass, castor oil
--	Glyphosate	360g/L	--	neat	0.2		Bush Regeneration	Bellingen Island Flying Fox Camp	--	Cut/paint	5/03/2019	--	Autumn	Targeted	Maderia, privet, coral tree, balloon vine, elephant grass, castor oil

Product	Pesticide	Concentration/s	Formulation used	Application rate	Total volume (L)	Total volume (g)	Area general	Area specific	Area	method of application	Application date	Conditions	Season	Purpose of use	Weeds
--	Glyphosate	360g/L		80g/10L	0.16		Bush Regeneration	Bellingen Island Flying Fox Camp	--	Backpack	26/06/2019	--	Winter	Targeted	Maderia, privet, coral tree, balloon vine, elephant grass, castor oil
--	Metsulfuron methyl		Pulse	1g/10L		2	Bush Regeneration	Bellingen Island Flying Fox Camp	--	Backpack	26/06/2019	--	Winter	Targeted	Maderia, privet, coral tree, balloon vine, elephant grass, castor oil
--	Metsulfuron methyl	--	Pulse	1g/10L		3	Bush Regeneration	Bellingen Island Flying Fox Camp	--	Backpack	11/07/2019	--	Winter	Targeted	Maderia, privet, coral tree, balloon vine, elephant grass, castor oil
--	Glyphosate	--		80g/10L	0.48		Bush Regeneration	Bellingen Island Flying Fox Camp	--	Backpack	5/08/2019	--	Winter	Targeted	Maderia, privet, coral tree, balloon vine, elephant grass, castor oil
--	Metsulfuron methyl	--	Fuluse Acid	2g/10L		12	Bush Regeneration	Bellingen Island Flying Fox Camp	--	Backpack	5/08/2019	--	Winter	Targeted	Maderia, privet, coral tree, balloon vine, elephant grass, castor oil
Grazon®	Triclopyr, picloram, aminopyralid	300g/L; 100g/L; 8g/L	Pulse	40 & 80	0.12	80	Bush Regeneration	Bellingen Island Flying Fox Camp	--	Backpack	4/11/2019	--	Summer	Targeted	Maderia, privet, coral tree, balloon vine, elephant grass, castor oil
--	Glyphosate & metsulfuron methyl	--	Pulse	80g & 2g	0.72	45	Bush Regeneration	Bellingen Island Flying Fox Camp	--	Backpack & cut/paint	24/08/2020	--	Winter	Targeted	Maderia, privet, coral tree, balloon vine, elephant grass, castor oil
--	Glyphosate & metsulfuron methyl	--	Pulse	80g & 1g	0.32	45	Bush Regeneration	Bellingen Island Flying Fox Camp	--	Backpack	18/09/2020	--	Spring	Targeted	Maderia, privet, coral tree, balloon vine, elephant grass, castor oil
--	Glyphosate	--	Pulse	80g/10L	0.8		Bush Regeneration	Bellingen Island Flying Fox Camp	--	Backpack	8/10/2020	--	Spring	Targeted	Maderia, privet, coral tree, balloon vine, elephant grass, castor oil

Product	Pesticide	Concentration/s	Formulation used	Application rate	Total volume (L)	Total volume (g)	Area general	Area specific	Area	method of application	Application date	Conditions	Season	Purpose of use	Weeds
Grazon®	Triclopyr, picloram, aminopyralid	300g/L; 100g/L; 8g/L		500mL/100L (label)											
Metsun®	Metsulfuron methyl	600g/kg	Wetting agent	1.5g/10L (label)											
Weedmaster®	Glyphosate	470g/L		1500mL/100L (label)											
Brush-off®	Metsulfuron methyl	600g/kg	Wetting agent	1.5g/10L (label)	6589		Roadsides	McBaron Road, Ballards Road, Buffer Creek, Gleniffer, John Clyde Road, Bowra Road, Mc'Graths Road, Wills Road, Hains Lane, Rigney Road, Nobles Lane, Deervale Road, Clarkes Road, Emersons Road, Paddys Plain, Snows Road, Martells road, Uranga HWY to Bridge, Smiths Lane, Bennets Road, Woodlands Road, Shepards Road, Rocky Creek Road, Harness Cask Road, North Bank Road, Mc'Barons Road, Keevers Road, Billings Road, Briggsvale Road, Darkwood Road, Gossips Road, Valnery Road, Martells Road, Yellow Rock Road, Raliegh Depot, Prices Road, Summerviller Road, Gordonville Road, Deervale Road, Rigney Road, Adans Lane, Frieda Hicks Drive, Buffer Creek Road, Little North Arm, Mahers Lane, Cabans Road, Ballards Road, Oyster Creek Road, Weronah Close, Clarks Road, Prices Road, Macindoes Road, Maynards Plains, South Arm Road.		Hand spot spray	May 2020, June 2020, September 2020, October 2020, November 2020, December 2020, January 2021, February 2021	Preferred	All	Multipurpose	Lantana, Tobbaco, Cassia, Privet, Raspberry, Rubber Tree, Camphor, pattersons curse, Blackberry, Pine, Purple Berry, Groundsel Bush, various grasses.

Appendix C
Herbicide Review – Environmental Fate and Toxicity

Table 8-2 Herbicide Review – Environmental Fate and Toxicity.

Herbicide (active ingredient)		Aminopyralid	Bromoxynil	Endothal	Fluroxypr	Glyphosate	Metsulfuron methyl	Picloram	Triclopyr
Product/s		Grazon Extra®	Bromocide®	Cascade®	Stardane Advanced®	Weedmaster Duo®, Roundup Biactive®, Weedmaster®	Metsun®, Brush-off®	Grazon Extra®, Conquerer®	Grazon Extra®, Conquerer®
Environmental Fate		Low binding to soil with potential to leach.	Broken down by soil bacteria but can also inhibit bacteria activity.	Mobile in soil, however rapid degradation	Mobile to very mobile in soils.	Binds strongly to soils, especially highly organic soils. Breakdown via microbes.	Very mobile and breakdown dependent on soil or water properties.	Highly mobile in water and susceptible to leaching.	Not strongly adsorbed to soil and has to potential to be mobile.
Half Life (max days based on field trials)	**Soil**	12-185	1 - 8	Fast	1-13	15-170	54	112	90
	Water	0.6	13	Fast	10.5-34.7	9.9	115	80.8	4
Kow	**P**	1.35×10^{-3}	1.86×10^{00}	8.13×10^{01}	1.10×10^{00}	6.31×10^{-4}	1.35×10^{-2}	1.2×10^{-2}	3.55×10^{-1}
	Log	-2.87	0.27	1.91	0.04	-3.2	-1.87	-1.92	-0.45
Mobility	**Koc**	--	302	85	--	High	--	13	27
	Class	Highly mobile-mobile	Moderately mobile	Moderately mobile	Mobile	Slightly mobile	Very mobile	Very mobile	Mobile
Bioconcentration Factor		100	Low	Low	Low	Low	Low	Low	Low
Toxicity risk in mammals	**Acute**	Low – moderate	High	High	Low-high	Low- moderate	Low	Low	Moderate – high

Herbicide (active ingredient)		Aminopyralid	Bromoxynil	Endothal	Fluroxypr	Glyphosate	Metsulfuron methyl	Picloram	Triclopyr
	Chronic	Low	Moderate	--	Low	Low	Low	Low	Moderate
Toxicity risk in birds	**Acute**	Low	Moderate	Low	Low	--	Low	Moderate	Moderate
	Chronic	Moderate	Moderate	--	Moderate	Moderate	Moderate	Moderate	Moderate
Toxicity risk in fish	**Acute**	Low	Moderate	Moderate	Moderate	Moderate	Low	Moderate	Low
	Chronic	Moderate	Moderate	Moderate	Low	Moderate	Low	Moderate	Low
Toxicity risk in aquatic invertebrates	**Acute**	Low	Moderate	Moderate	Low	Moderate	Moderate	Moderate	Low
	Chronic	Low	Moderate	Moderate	Low	Moderate	Moderate	Moderate	Low
Toxicity risk in algae	**Acute**	Low	Moderate	Low	Low	Low	Moderate	Low	Low- moderate
	Chronic	--	Moderate	--	Low	Low	Moderate	--	Low
Other notes		Not known as a carcinogen or neurotoxin based on available information. Not enough data to assess as an endocrine disruptor.	Not known as a neurotoxin based on available information. Identified endocrine disruptor. Not enough data to assess as a carcinogen.	Not known as a carcinogen, endocrine disruptor, neurotoxin based on available information.	Not known as a carcinogen based on available information. Not enough data to assess neurotoxicity or endocrine disruption.	IARC Group 2A carcinogen; USEPA & APVMA no evidence to support classification as carcinogen. Endocrine – disruption of aromatase activity.	Not known as a carcinogen, endocrine disruptor, neurotoxin based on available information.	Not known as endocrine disruptor based on available information. Not enough data to assess neurotoxicity or carcinogen.	Not known as a carcinogen or endocrine disruption based on available information. Not enough data to assess neurotoxicity.
Link		Aminopyralid (Ref: XDE 750) (herts.ac.uk)	Bromoxynil (Ref: ENT 20852) (herts.ac.uk)	Endothal (herts.ac.uk)	https://sitem.herts.ac.uk/aeru/iupac/Reports/347.htm	https://sitem.herts.ac.uk/aeru/iupac/Reports/373.htm#none	https://sitem.herts.ac.uk/aeru/iupac/Reports/470.htm	https://sitem.herts.ac.uk/aeru/iupac/Reports/525.htm	https://sitem.herts.ac.uk/aeru/iupac/Reports/659.htm

Lewis, K.A., Tzilivakis, J., Warner, D. and Green, A. (2016) An international database for pesticide risk assessments and management. *Human and Ecological Risk Assessment: An International Journal*, **22**(4), 1050-1064. Toxicity risk was assessed by assumptions and pre-defined criteria by Lewis et al. (2016) on available data. Ecotoxicology testing for short term was based on LC50 or EC50 and chronic exposures on NOEL, NOEC or NOAEL. It is noted that this is based on a simplified interpretation and available data at the time of comparison so should be viewed with some caution - Background and Support (herts.ac.uk).

Appendix D
Australian Case Studies

Table 8-3 Summary of Australian case studies of glyphosate alternative trials or complete phase out.

Council	Alternative	Trial Details	Pro's	Con's
Armidale City Council	Local Safe® (acetic acid, copper, sulfamic acid)	2016 – trialed by Parks and Gardens department in sporting fields	Multipurpose, non-selective and effective. Application best sprayed as a fine mist.	Stronger application needed for woody/hardier plants.
Bellingen Shire Council	BioWeed Organic (Pine oil)	2015	Bioweed was recommended to be used in the toolbox of weed management if appropriate.	Only killed fragile species and ruined equipment. Staff had reactions to product. Not appropriate as replacement product.
	Localsafe (acetic acid, copper, sulfamic acid)	2016 - small scale trial	Works as a knock down, not systemic	Won't control woody weeds, vines. Long term effectiveness was considered doubtful.
	Slasher (Pelargonic acid)	2019 - small scale trial around wastewater treatment works & bush regeneration sites.	Performed better than Pine oil.	Not as effective as glyphosate – regrowth is quicker and respray times shorter. More labour intensive & more costly due to more product being needed.
Blacktown City Council	Alternative organic products	2021 - 5-month trial is planned comparing effect of Roundup and organic alternative		
Brisbane City Council (2019)	Pine oil	2019 - Trial of multiple Glyphosate alternatives as weed control methods	Good initial knockdown & wilting of target weeds	Can only be used twice every 12 months, pungent/lingering smell, irritates nose, skin & throat, & potential to cause permeant eye damage
	Pelargonic/nonanoic acid		Good initial knockdown of weeds	Not as effective on plants with good root systems, equipment damage from ongoing use likely
	Acetic acid		Good initial knockdown of weeds, browning off plant above quickly	Acid concentrate is corrosive (impacts seals/equipment & increasing risk of leaks), irritates eyes, airways, skin & digestive tract, toxic if inhaled at high doses, strong vinegar smell

Council	Alternative	Trial Details	Pro's	Con's
	Sodium chloride		Good initial knockdown & wilting of target weeds	Plants grow back quickly, risk of creating saline soil, potential irritation, eye damage & respiratory issues
	Steam weeding		No exposure to residual herbicide, weeds unlikely to become resistant	Noise pollution, equipment heavy & hard to transport, hot steam increases risk of burns, uses large amounts of water, diesel & petrol to operate, steam can stimulate dormant weed seeds
	Flame weeding		--	Risk of burns, catastrophic equipment failure (explosion), wildfires starting
Fairfield Council	Non-hazardous chemicals and organic weed killer	2019 - replaced in sensitive areas including parks, roadsides and combination of organic products and steam weeding.	--	--
	Steam weed control		Effective and non-toxic method.	More labour intensive. Staff need to be trained in using properly. Risk of burns and WHS.
Georges River Council	Arsenal Super (Imazapyr)	June 2019 - Completely replaced glyphosate throughout the LGA.	Imazapyr was found to be an effectiveness method of weed control with similar multipurpose non-selective properties to glyphosate. Good at woody species and most effective post emergent. Considered practically non-toxic (lowest EPA category) to mammals, birds and very slightly toxic to fish and invertebrate. Low half-life in water (3 days) and soil (10	Group B herbicide – plants can develop resistance with repeated usage which is a common issue to all pesticides. Concentrated product can be harmful if inhaled or potential irritation to skin/eyes. Some formulations (Chopper and Stalker) have caused significant irreversible eye damage relating to the formulation ingredients. Imazapyr may be actively excluded from the roots of legume species and not be effective in these species.

Council	Alternative	Trial Details	Pro's	Con's
			days). Used in waterways in US.	
Kingston Council	Local Safe® (acetic acid, copper, sulfamic acid) + Soil conditioner (Limonene & non-ionic surfactants, nutrients)	June 2017 - 12-month trial around 114 playgrounds.		
Kingston Council	Hand weeding	November 2019 - Hand weeding was undertaken for all Council playgrounds; glyphosate was phased out in other areas.	Likely to be an effective method.	Highly labour intensive.
Randwick Council	Slasher Weedkiller (pelargonic acid)	June 2019 - Trial in parks, open spaces, garden beds, footpaths. Council continued the use of non-selective herbicides (other than glyphosate) in parks and sports field for targeted control of bindii and clover.		
Waverly Council	Hand weeding, brush cutting, chipping, mulching and suppression of seed heads, mowing	August 2019 - Phased out in applications to footpaths, kerbs, gutters, stormwater infrastructure		
Yarra Council	Mechanical removal, hand-sprayed glyphosate	February 2020 - Mechanical removal supported by hand-sprayed glyphosate for kerb and channel weed control only		

Appendix E
Review of Proposed Alternatives Toxicity and Environmental Fate

Table 8-4 Review of Proposed Alternatives Toxicity and Environmental Fate.

Herbicide (active ingredient)		Glyphosate	Acetic Acid	Imazapyr	Glufosinate-ammonium
Product/s		Weedmaster Duo®, Roundup Biactive®, Weedmaster®	Local Safe®	Arsenal®	Basta®,
Diluted cost per 100L*		~$5/100L	~$200/100L	~$50/100L	
Environmental Fate		Binds strongly to soils, especially highly organic soils. Breakdown via microbes.			Soluble and non-persistent in waters. Broken down by microbes.
Half Life (max days based on field trials)	**Soil**	15-170	Fast	11	7.4
	Water	9.9	Fast	Fast	7.2
Kow	**P**	6.31×10^{-4}	1.23×10^{0}	1.29×10^{0}	9.77×10^{-5}
	Log	-3.2	0.09	0.11	-4.01
Mobility	**Koc**	High	0	--	600
	Class	Slightly mobile	Very mobile	Mobile	Mobile
Bioconcentration Factor		Low	Low	Low	Low
Toxicity risk in mammals	**LC50 or LD50**	>2000	3530	>2000	416
	Acute	Low- moderate	Low	Low	High

Herbicide (active ingredient)		Glyphosate	Acetic Acid	Imazapyr	Glufosinate-ammonium
	NOAEL	351	--	--	6.3
	Chronic	Low – moderate	--	--	High
Toxicity risk in birds	**Acute**	--	--	Low	Low
	Chronic	Moderate	--	--	Moderate
Toxicity risk in fish	**Acute**	Moderate	Moderate	Low	Low
	Chronic	Moderate	--	Low	Low
Toxicity risk in aquatic invertebrates	**Acute**	Moderate	Moderate	Low	Low
	Chronic	Moderate	Low	Low	Low
Toxicity risk in algae	**Acute**	Low	Low- moderate	Low	Low
	Chronic	Low	--	--	Low
Other notes		IARC Group 2A carcinogen; USEPA & APVMA no evidence to support classification as carcinogen. Endocrine disruption of aromatase activity.	Not identified as a neurotoxin, carcinogen based on available information. No information available on endocrine disruption.	Not identified as a neurotoxin, carcinogen based on available information. No information available on endocrine disruption.	Identified as a neurotoxin and to cause reproductive effects. Not known as a carcinogen.
Link		https://sitem.herts.ac.uk/aeru/iupac/Reports/373.htm#none	https://sitem.herts.ac.uk/aeru/iupac/Reports/1333.htm	https://sitem.herts.ac.uk/aeru/iupac/Reports/393.htm	https://sitem.herts.ac.uk/aeru/iupac/Reports/372.htm

* Comparison of same quantity of alternative required to achieve similar result to glyphosate.

Appendix F
Stakeholder Survey

Bellingen Shire Council Herbicide Use Review

Advisian is currently undertaking a project on behalf of Bellingen Shire Council which involves a review of their herbicide usage and a 6-month trial of alternative herbicides and/or other weed management methods within Bellingen Shire. The drivers for this project are Council's commitment to the community and ecologically sustainable development, together with their role in invasive weed management.

Advisian are consulting with all relevant stakeholders regarding this project and would appreciate if you could complete this short anonymous survey.

Please read below for **further optional** additional information, **or skip ahead to the survey.**
Contact megan.priestley@advisian.com (mailto:megan.priestley@advisian.com) with any questions.

Description
Bellingen Shire Council currently adopt an integrated approach to weed management. This involves a range of methods to control weeds including herbicide, mechanical, biological and manual forms of control. Council's use of herbicide extends beyond weed management. Where necessary, herbicides are used to maintain roadsides, road safety, curb and guttering, footpaths, parks and gardens and bush regeneration sites.

The complete phasing out of herbicide use has not been achieved by Councils anywhere else in Australia. The focus will be on reducing herbicide usage where possible, building on the existing integrated weed management framework used by Bellingen Shire Council. In certain areas and scenarios, herbicide use may continue to be the best option for weed management and maintaining the important biodiversity of this region.

A trial of alternatives is planned for October 2021 – March 2022. The design of the trial will be based on a review of alternative herbicide and method trials elsewhere and the outcomes of this stakeholder and community consultation. Suitable alternatives will be identified based on a combination of requirements including Work Health and Safety (WHS), effectiveness of method, stakeholder and community concerns/requirements, human health and environmental risks. Identification of an alternative method is challenging as there is not one method currently available that meets all these criteria. Selection needs to be based on the best fit, particularly for WHS risks. Most of the alternatives available are more suitable for multipurpose and more fragile weeds, i.e. not woody weeds.

Trial Methodology
Methodology will be refined following the stakeholder consultation process:

* Trialing glyphosate (e.g. Roundup®) alternative methods around sensitive urban areas (parks and playgrounds) and reducing herbicide usage around other areas.

* Potential sites for the trial include sensitive urban areas (i.e. around schools, public parks and playgrounds), bush sites and under powerlines and roadsides.

* Each site will be divided into transects which will receive different treatments including the traditionally used method, and two-three alternative trials. This will allow for site specific comparisons between the effectiveness of alternative methods to occur.

* Throughout the 6-month trial, measurements will be taken by the weed control contractor and/or council to assess the effectiveness of the different methods. Statistical analysis will be undertaken on this data to determine whether there are any differences, significant or otherwise, between the methods in controlling weeds.

* Based on the trial results, recommendations will be made on suitable future weed management options for Bellingen Shire Council. Proposed methods would need to be approved by Council and ensure that they are able to maintain adequate maintenance, community safety and be able to resource.

1. Type of stakeholder group (select all relevant)

- ◯ Community member
- ◯ Environmental group
- ◯ Community group
- ◯ Weeds manager or contractor
- ◯ Bellingen Council employee
- ◯ School
- ◯ Rural
- ◯ Plant Nursery
- ◯ Other

2. What are your main concerns (if any) around current herbicide usage within Bellingen Shire?

3. Do you have any preferences on areas to trial alternatives?

- ◯ Roadsides
- ◯ Near schools
- ◯ Near parks and gardens
- ◯ Near playgrounds
- ◯ Near waterways
- ◯ Bush regeneration sites
- ◯ Other

4. We have identified potential alternatives to trial based on our review. All options are being considered but would be dependent on the councils ability to resource. Please click and drag to rank your preference (top= most preferred).

Steam/heat weeding - a machine with high temperature water to kill plants which have been successfully trialed and adopted by some other councils as a non-toxic and effective method. Some cons are that machines can be noisy, have WHS risks, require transportation and use water, diesel, or petrol. It is a more labour intensive method and requires more intensive staff training. Best suited for urban areas.

Bioorganic herbicide products (LocalSafe/Vinegar) - Bioorganic products show some promise for multipurpose weed management but generally aren't as effective and more labour intensive. Other previously trialled bioorganics (Pine oil and pelargonic acid) have been deemed unsuitable based on ineffectiveness or environmental impacts. Risks from LocalSafe are corrosion to equipment, impacts on soil and WHS risks. Suitable for all areas, except near water.

Alternative synthetic herbicides (e.g. Imazapyr) - Other councils have transitioned to Imazapyr, or similar, to replace glyphosate as a cost effective and systematic weed treatment. Toxicity of Imazapyr to mammals and wildlife ranks favourably compared to other pesticides. There are potential impacts on plants from drift so this needs be prevented. Treatment takes longer to work and plants can develop resistance. Suitable for all areas.

Community involvement (no spray register) - Where community elect to maintain their own property frontage and this is excluded from council chemical sprays. Proposed methods and regularity of self-maintenance on council land would need to be discussed with and approved by council to ensure that adequate maintenance and community safety issues were addressed, and such a program would be dependent on Councils ability to resource it. Suitable for urban areas.

'No Spray' Exclusion Zone around Playground and BBQs - 'No Spray' 20m exclusion zones around sensitive areas including BBQs and children's playgrounds. Weed management around these areas is managed using non-chemical methods. Suitable for urban areas.

More brush cutting and edge trimming - Increasing the amount of brush cutting, edge trimming and hand weeding for urban sensitive areas, where not already being done. They are more labour intensive and not as effective so require more regular maintenance. The advantage is that chemicals are not required, and the seed bank is maintained. Suitable for urban areas.

Grooming and slashing - Increasing the usage of slashing to control weeds (by reducing their height) where not already currently being undertaken. This is more labour intensive and not as effective so requires more regular maintenance. This method can be combined with very targeted woody weed maintenance using herbicides. Suitable for bush and near waterways.

Alternative application method - Pellet injection (woody weeds) - injection of dry herbicide pellets into woody trees which also eliminates the need for wetting agents. Suitable for bush regeneration sites.

Acceptance of some weeds - Acceptance of some weeds that don't present as problematic infestations might be acceptable on a case by case basis. Suitable for all areas.

Decision-making tool - A decision-making flow chart tool for weed managers to guide whether herbicide use is necessary based on the area and type of weed management needs or whether other alternatives can be used.

5. Are there any alternative products or methods that you feel are unsuitable? Please provide reasons.

6. Are there any alternative products or methods not listed that you suggest should be considered?
(Note bioorganic products (containing pine oil, sodium chloride, pelargonic acid), flame weeding and animals have already been excluded /considered unsuitable).

7. Would you be interested in being part of a focus group in October requiring attendance at a 60 min online workshop? If yes, please provide an email address for further communications.

Appendix G
Herbicide Use and Weed Profile Templates

Chemical Application Plan		
Applicator details		
Name	Address	Contact number
Application details		
Application Date	Start time	Finish Time

Property address	Paddock or area name/GPS (clear description/delineation)
Target area/crop (e.g. roadside furniture)	
Type of equipment used	
Full product name/s (e.g. Bayfidan 250 EC Fungicide® – not just 'Bayfidan')	
Total amount of concentrate used	Total amount of water, oil, other mixed with concentrate
Size of area sprayed	Order area/blocks were treated (e.g. North to South)

Weather Conditions		
Estimate of wind speed and direction at start of spraying	Temperature	Humidity (if required on label)

Rain forecast	Changes during application

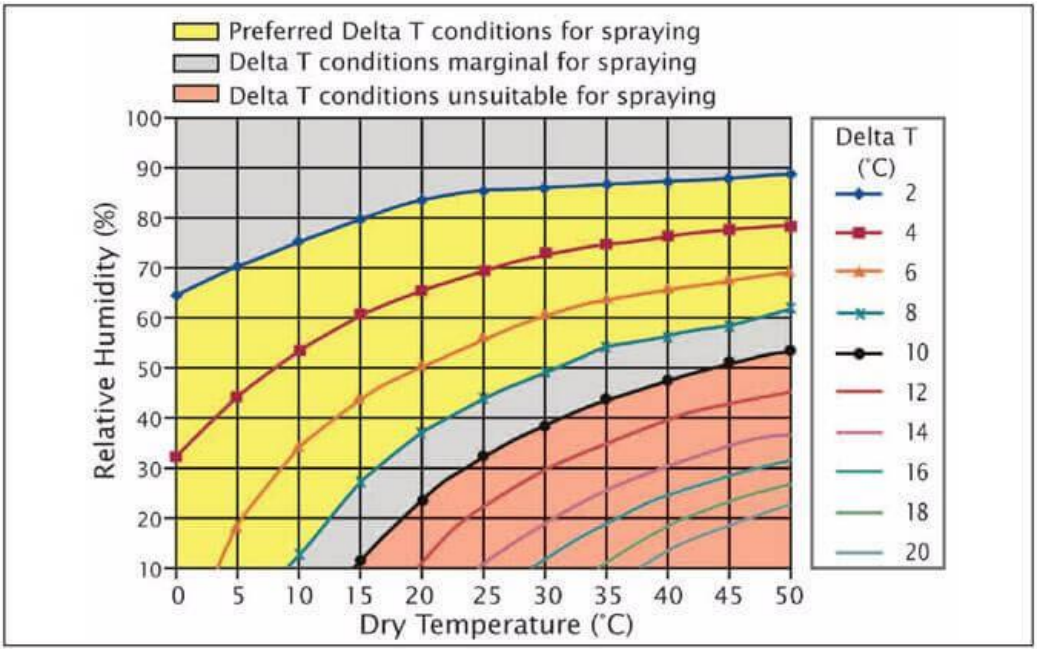
Name:

Signature:

Date:

Beaufort Wind Scale

Beaufort scale number	Descriptive term	Units in km/h	Units in knots	Description on Land	Description at Sea
0	Calm	0	0	Smoke rises vertically	Sea like a mirror.
1-3	Light winds	19 km/h or less	10 knots or less	Wind felt on face; leaves rustle; ordinary vanes moved by wind.	Small wavelets, ripples formed but do not break: A glassy appearance maintained.
4	Moderate winds	20 - 29 km/h	11-16 knots	Raises dust and loose paper; small branches are moved.	Small waves - becoming longer; fairly frequent white horses.
5	Fresh winds	30 - 39 km/h	17-21 knots	Small trees in leaf begin to sway; crested wavelets form on inland waters	Moderate waves, taking a more pronounced long form; many white horses are formed - a chance of some spray
6	Strong winds	40 - 50 km/h	22-27 knots	Large branches in motion; whistling heard in telephone wires; umbrellas used with difficulty.	Large waves begin to form; the white foam crests are more extensive with probably some spray
7	Near gale	51 - 62 km/h	28-33 knots	Whole trees in motion; inconvenience felt when walking against wind.	Sea heaps up and white foam from breaking waves begins to be blown in streaks along direction of wind.
8	Gale	63 - 75 km/h	34-40 knots	Twigs break off trees; progress generally impeded.	Moderately high waves of greater length; edges of crests begin to break into spindrift; foam is blown in well-marked streaks along the direction of the wind.
9	Strong gale	76 - 87 km/h	41-47 knots	Slight structural damage occurs - roofing dislodged; larger branches break off.	High waves; dense streaks of foam; crests of waves begin to topple, tumble and roll over; spray may affect visibility.
10	Storm	88 - 102 km/h	48-55 knots	Seldom experienced inland; trees uprooted; considerable structural damage.	Very high waves with long overhanging crests; the resulting foam in great patches is blown in dense white streaks; the surface of the sea takes on a white appearance; the tumbling of the sea becomes heavy with visibility affected.
11	Violent storm	103 - 117 km/h	56-63 knots	Very rarely experienced - widespread damage	Exceptionally high waves; small and medium sized ships occasionally lost from view behind waves; the sea is completely covered with long white patches of foam; the edges of wave crests are blown into froth.
12+	Hurricane	118 km/h or more	64 knots or more	Very rarely experienced - widespread damage	The air is filled with foam and spray. Sea completely white with driving spray; visibility very seriously affected

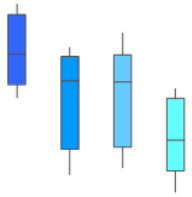


Weed Profile Temple					
Common Name					
Scientific Name					
Indigenous Name					
Weed Significance					
Priority - Eradicate	WoNS	State/Regional Priority	GBD		
Life Cycle					
Annual	Perennial	Semi-Annual			
Plant Type					
Herbaceous	Shrub	Tree	Vine	Aquatic	
Description of growing site					
Distinguishing Features					
Description of propagules					

Appendix H
Alternative Trial Results

8.1 All locations

Boxplots of the %Cover of the main identification groups are shown in Figure 8-1, Figure 8-2 and Figure 8-3. In these boxplots, the following information is shown.



End of upper whisker = maximum value excluding outliers
Upper end of box = 75th percentile value
Middle line = median value
Lower end of box = 25th percentile value
End of lower whisker = minimum value excluding outliers

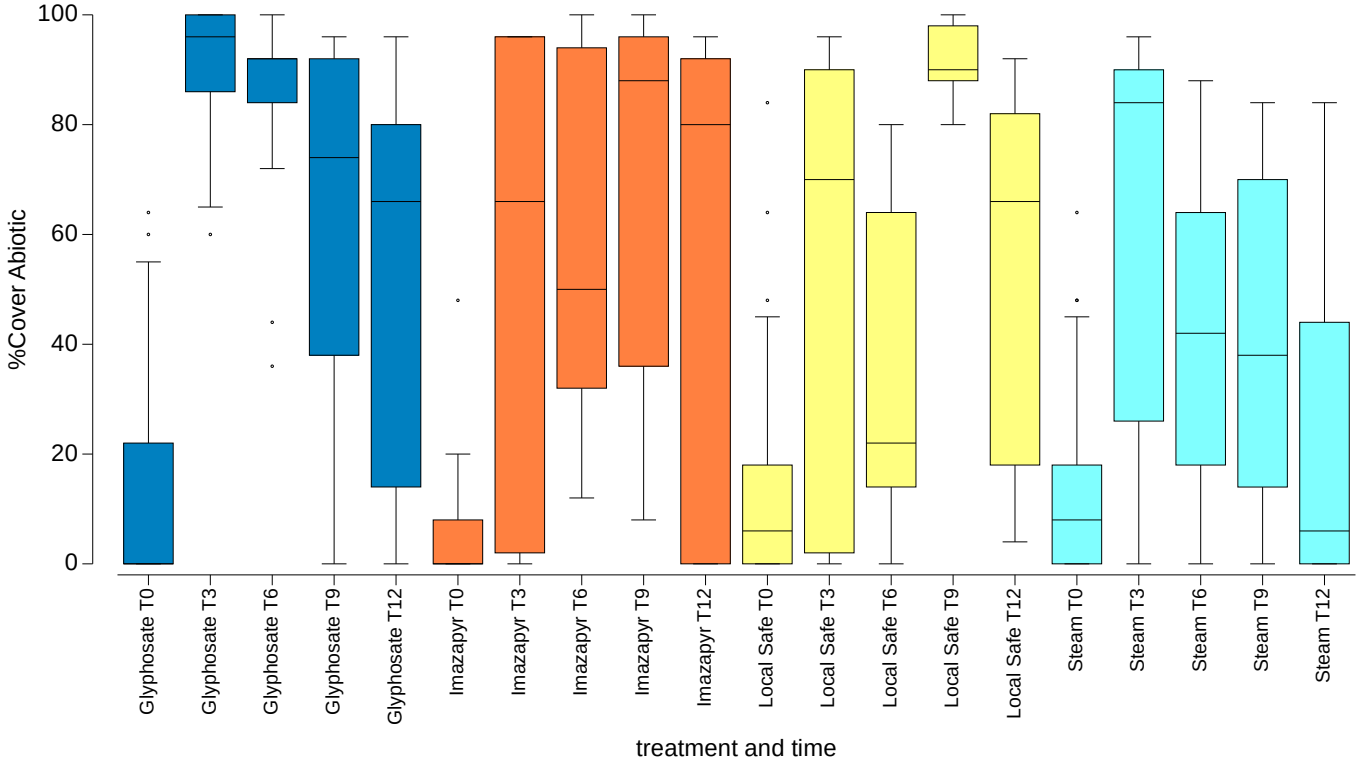


Figure 8-1 %Cover of abiotic (leaf litter, soil, rocks and dead plants) in treatments and times at all locations.

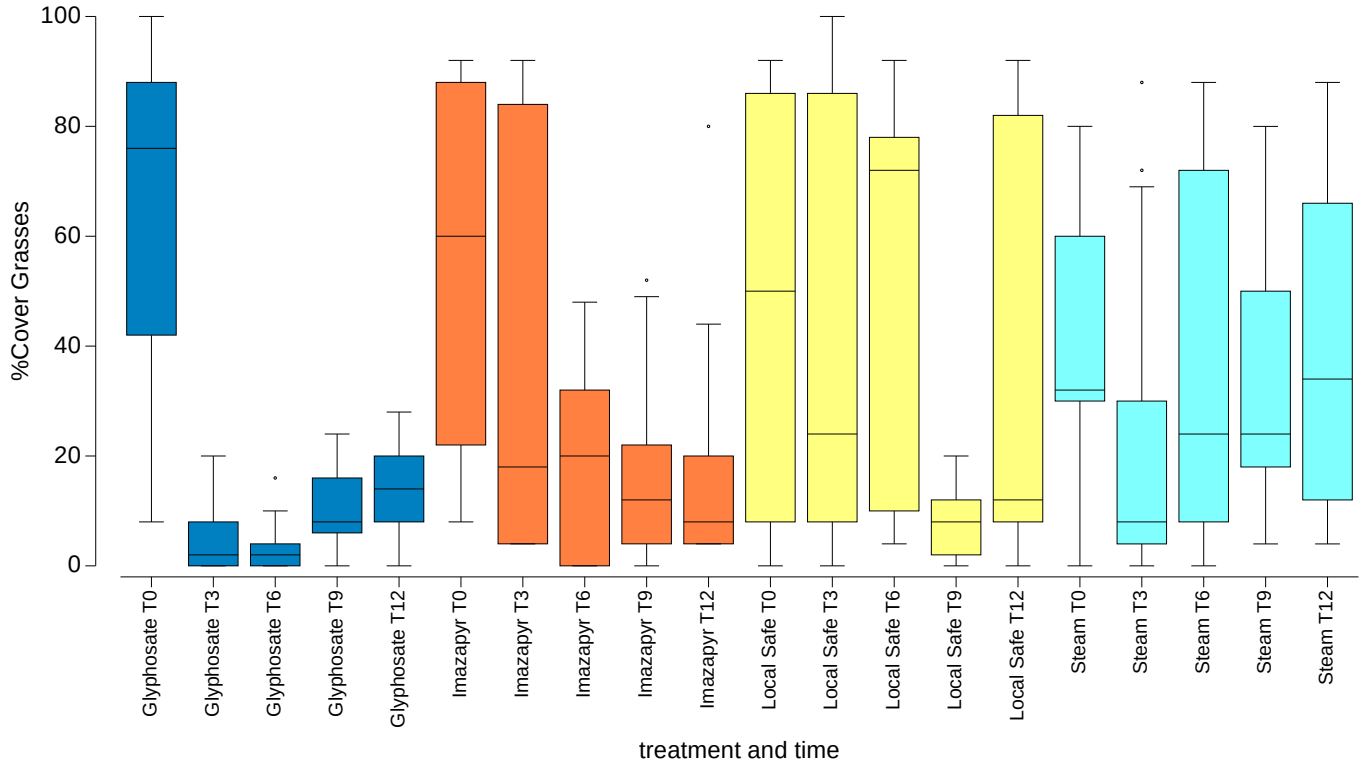


Figure 8-2 %Cover of herbs in treatments and times at all locations.

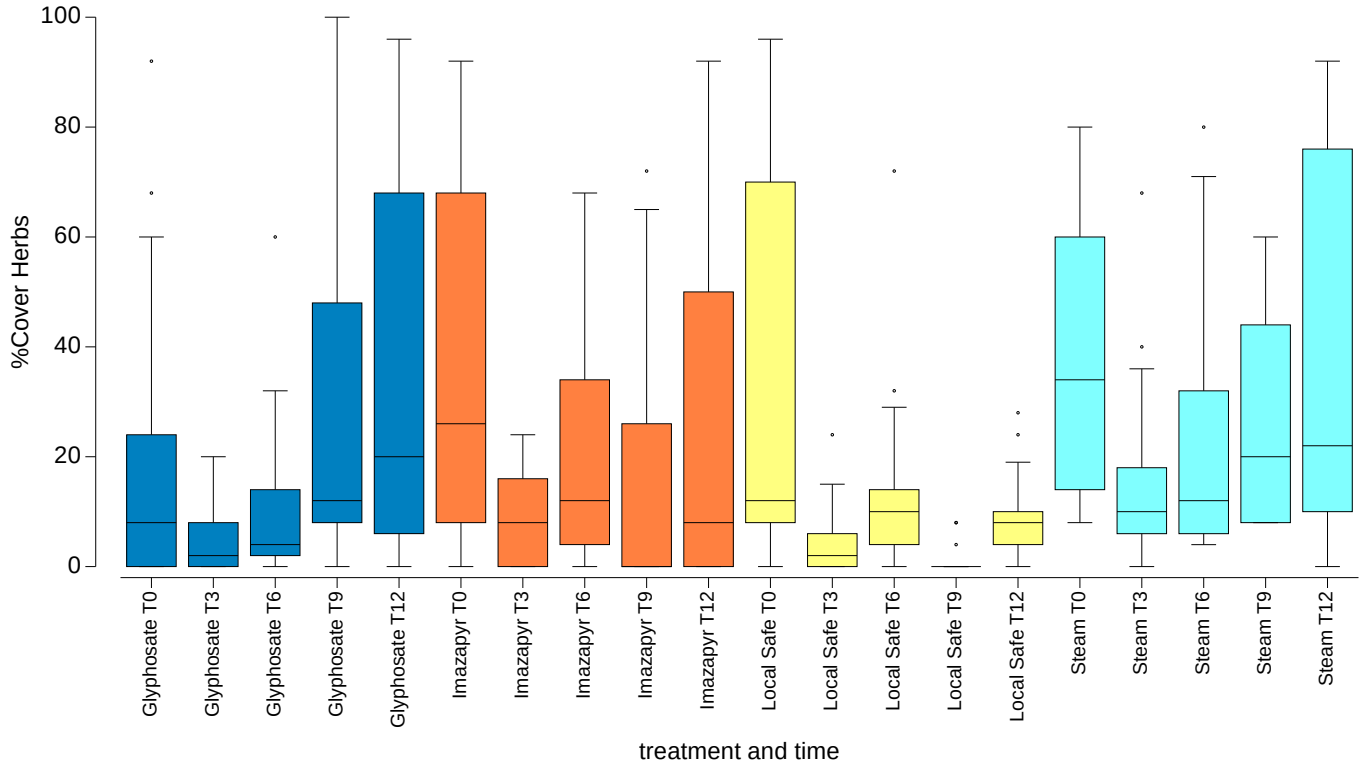


Figure 8-3 %Cover of grasses in treatments and times at all locations.

8.2 Bellingen

8.2.1 Species Summary

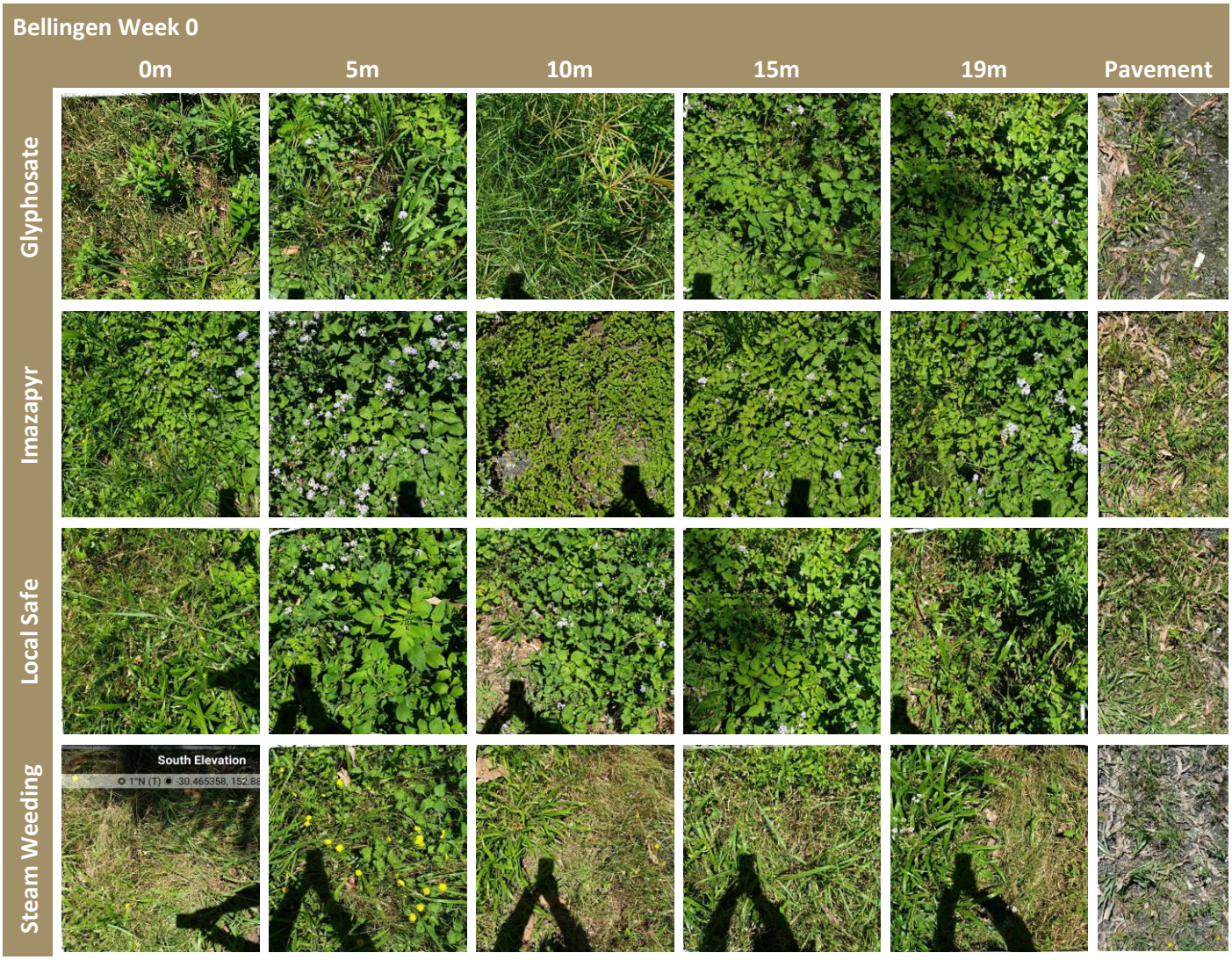
Table 8-5 Plant species (common name) and the number of quadrats (out of 5) observed in for each treatment and time for the Bellingen trial.

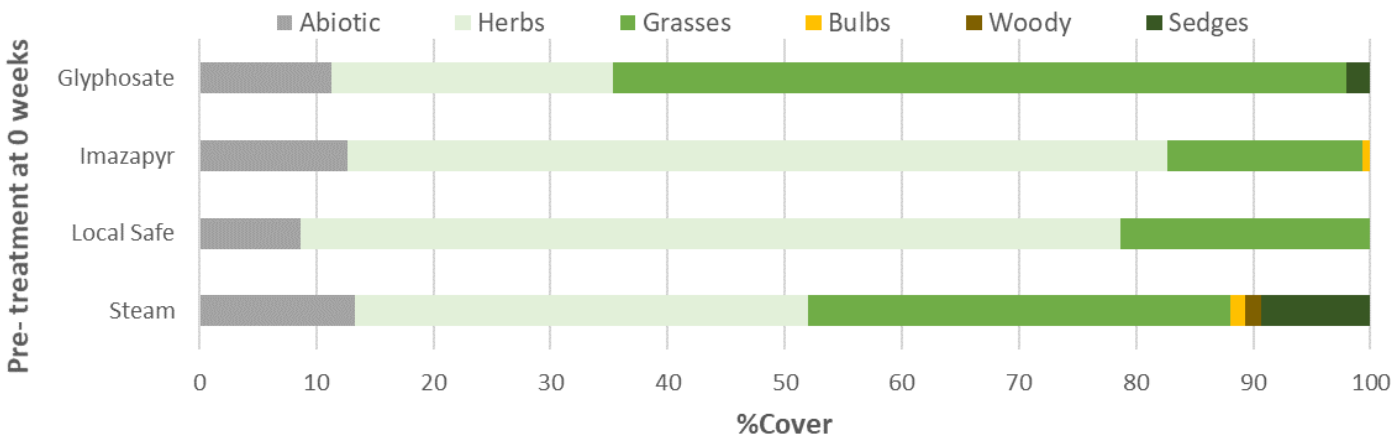
Treatments	Glyphosate					Imazapyr					Local Safe					Steam				
Time (weeks)	0	3	6	9	12	0	3	6	9	12	0	3	6	9	12	0	3	6	9	12
Bulbs																				
Creeping Oxalis						1										1				
Nut grass							1										1	3		
Grasses																				
Blown Grass			1								1		1					2		
Broadleaf Paspalum					1					1								4		5
Bromus						1	1	1												
Couch		2	1			2	1													
Crab grass					1															
Crowfoot grass															1					
Giant Paspalum	1	4	2		2	2	4	5		3	4	1	3		5	5	4	5		3
Nut grass															3					5
Prairie grass	4										1					3				
Palm grass	1	1	1		1	1														
Panic grass	1				1					1	2					2				
Paspalum																				1
Rhodes Grass	3	1	1		1	1	2	1		1						1				
Rye grass sp.																1	2	1		1
Unknown grass					2		1			1		1	1		1		4			
Herbs																				
Ageratum	5	3	5		5	5	4	2		5	4		2		1	3	1	3		6
Bidens	4	1	4		5	3	4	5		5	5		5		5	3	1	1		3
Black Nightshade											1									
Bindii																				1
Celery Weed	3					3					1					1				
Columbian Waxweed																1		1		2
Cranesbill						2					1	1						1		
Creeping Charlie																		1		

Treatments	Glyphosate					Imazapyr					Local Safe					Steam				
Cudweed															1					
Dandelion						1					1		2			2		1		2
Flatweed			1							1						1	2	2		
Fleabane	1					1					2									
Hydrocotyl																	2			2
Milk thistle			1								1		1							
Morning glory										2					1					
Phyllanthus					3													3		5
Purple Top	4					1														
Purple Verbena										1	2					1				
Ragweed	2					1												2		
Quickweed																		3		
Scarlet Pimpernel	1																			1
Spotted Spurge													1							
Tomato													1							
Virginia Copperleaf (Acalypha)		1		1			3			1					2		4		2	
Natives																				
Acacia																		1		
Commelina	2	1	2		1	2	3	2		1	1	2	1		4	2	1	1		3
Sedges																				
Cyperus sp.	2	1	1		1		2	4		1		1				2	1			
Woody																				
Tobacco bush																1				
Castor Oil		1	1	2																

8.2.2 Week 0 Photoquadrats and %Cover

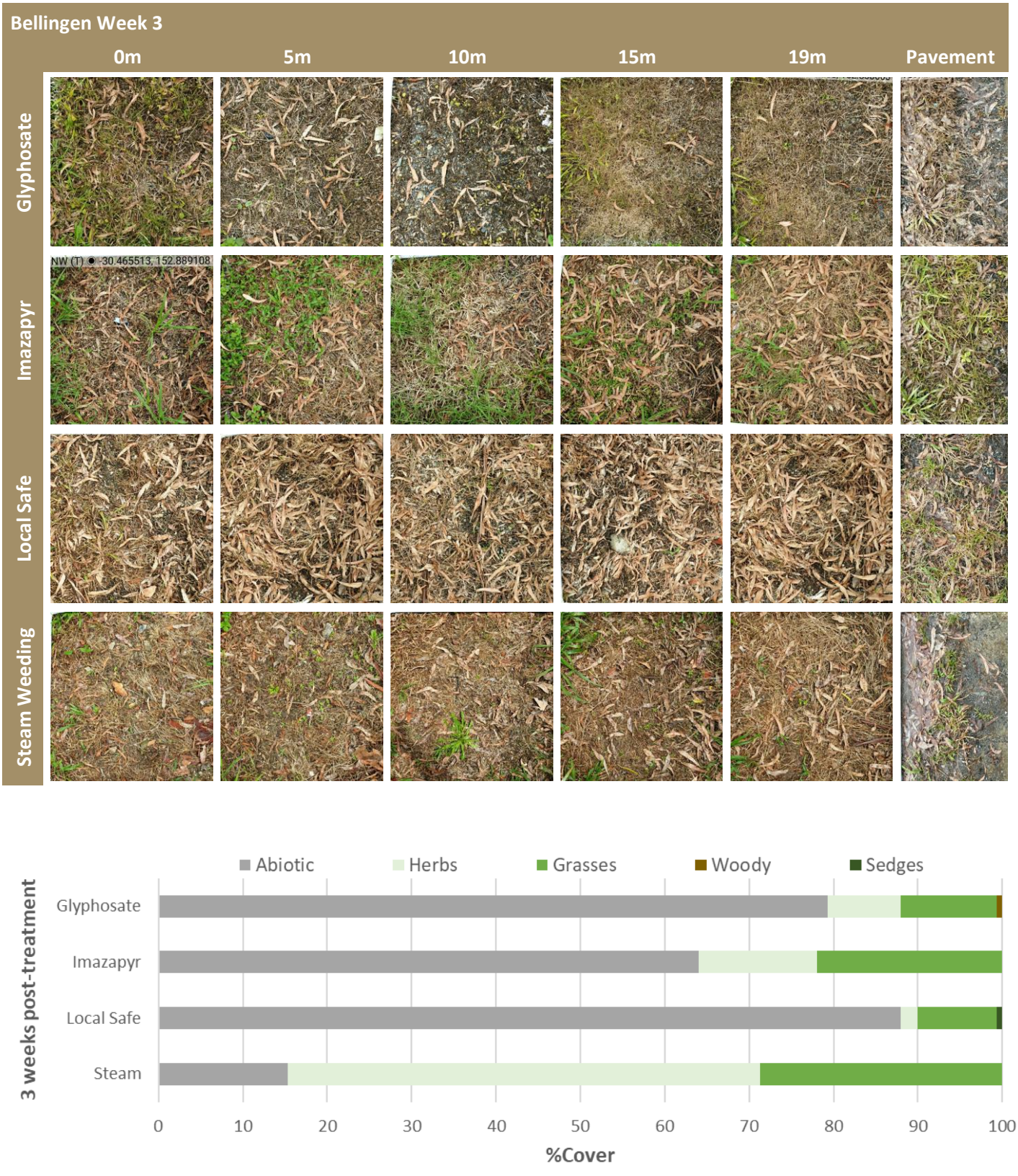
Figure 8-4 Bellingen Week 0 Photoquadrats and %Cover.





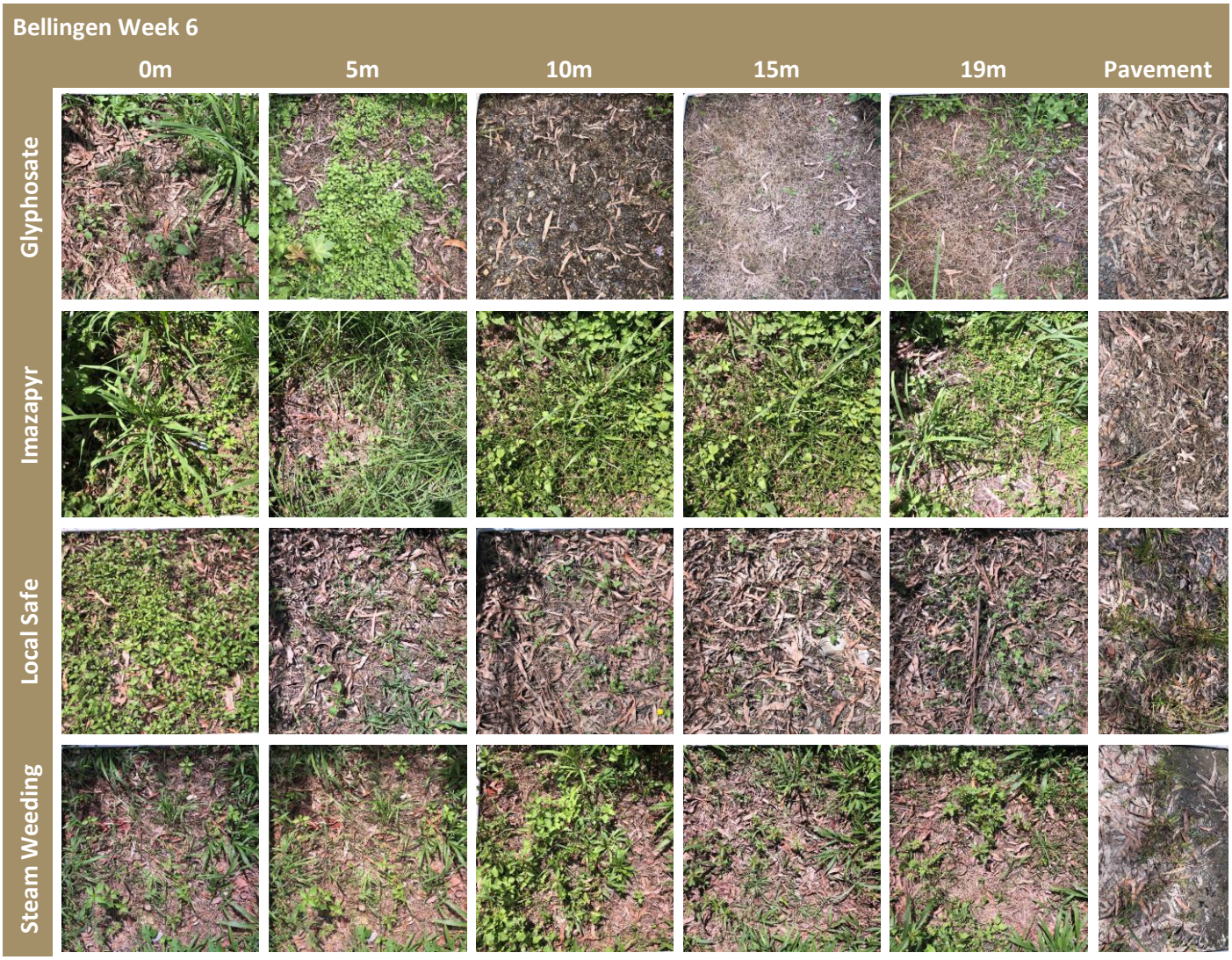
8.2.3 Week 3 Photoquadrats and %Cover

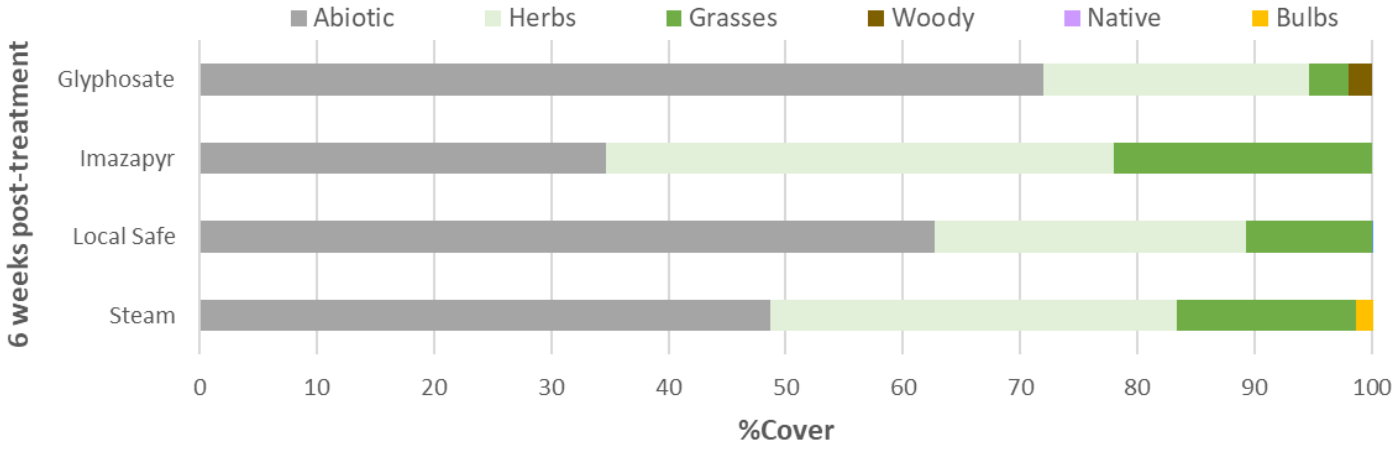
Figure 8-5 Bellingen Week 3 Photoquadrats and %Cover.



8.2.4 Week 6 Photoquadrats and %Cover

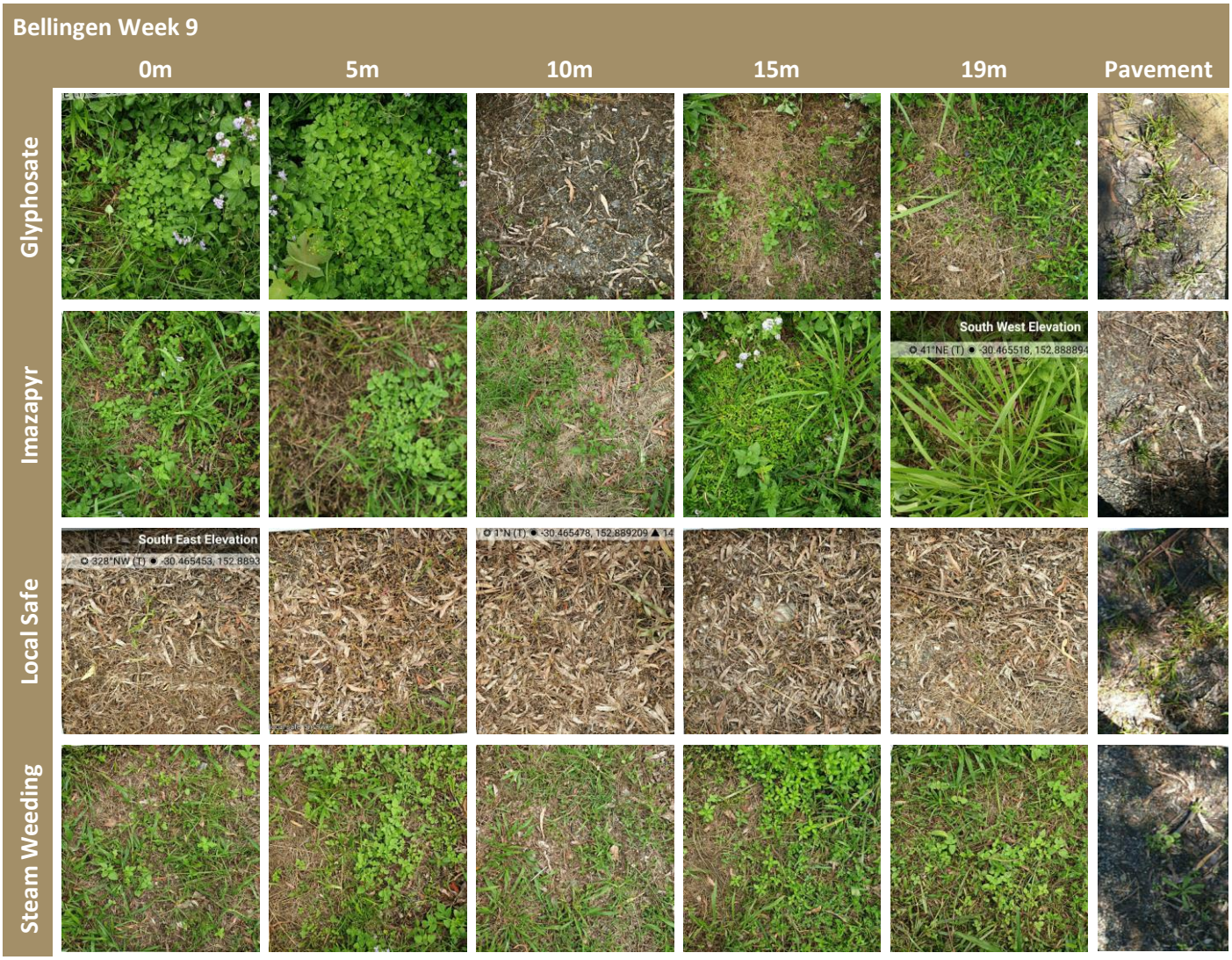
Figure 8-6 Bellingen Week 6 Photoquadrats and %Cover.

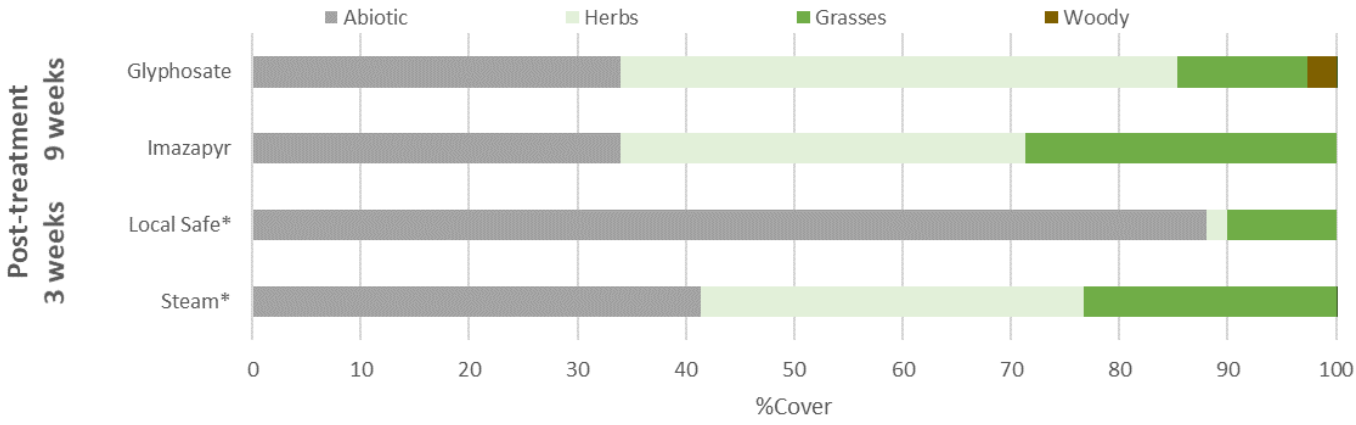




8.2.5 Week 9 Photoquadrats and %Cover

Figure 8-7 Bellingen Week 9 Photoquadrats and %Cover.

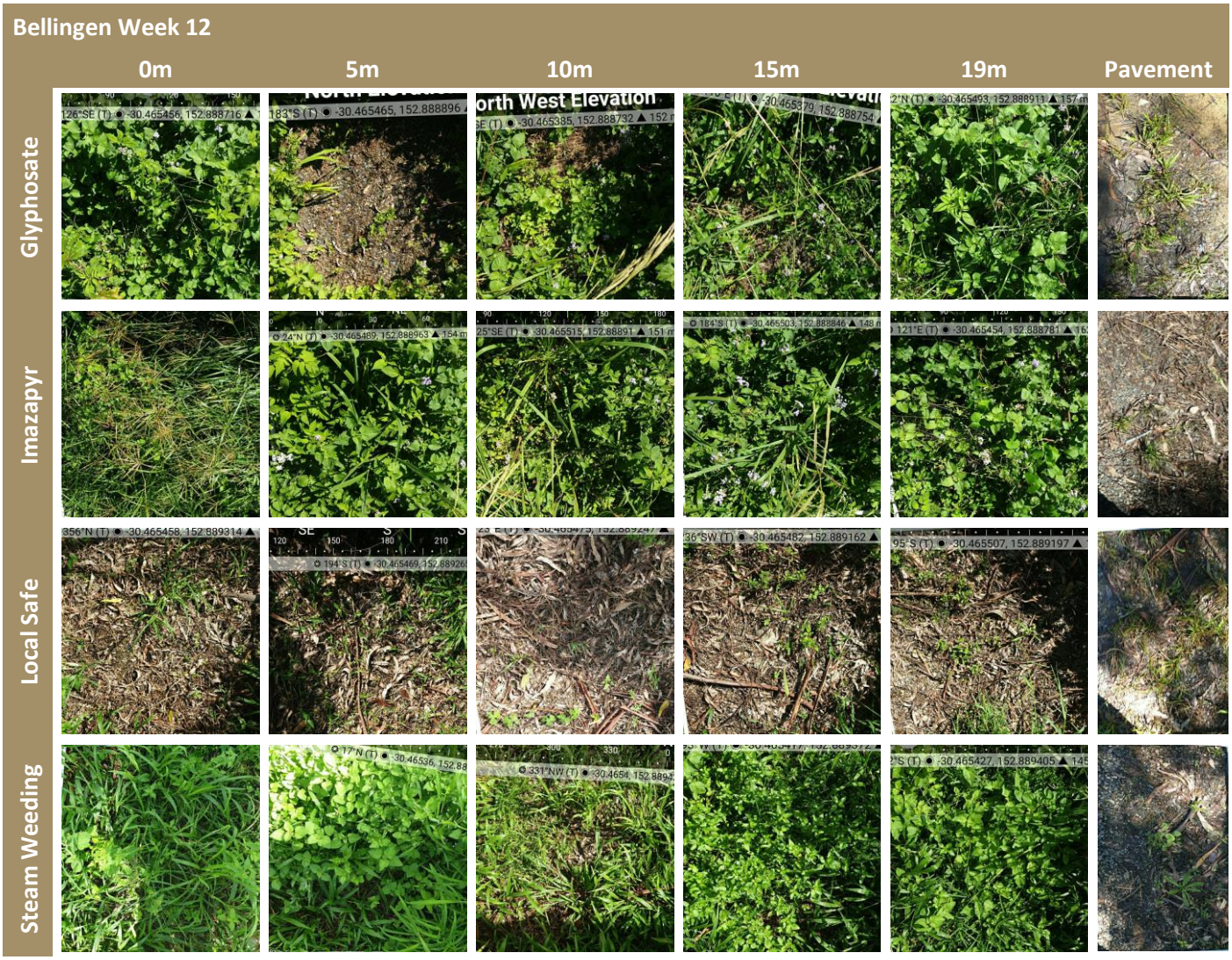


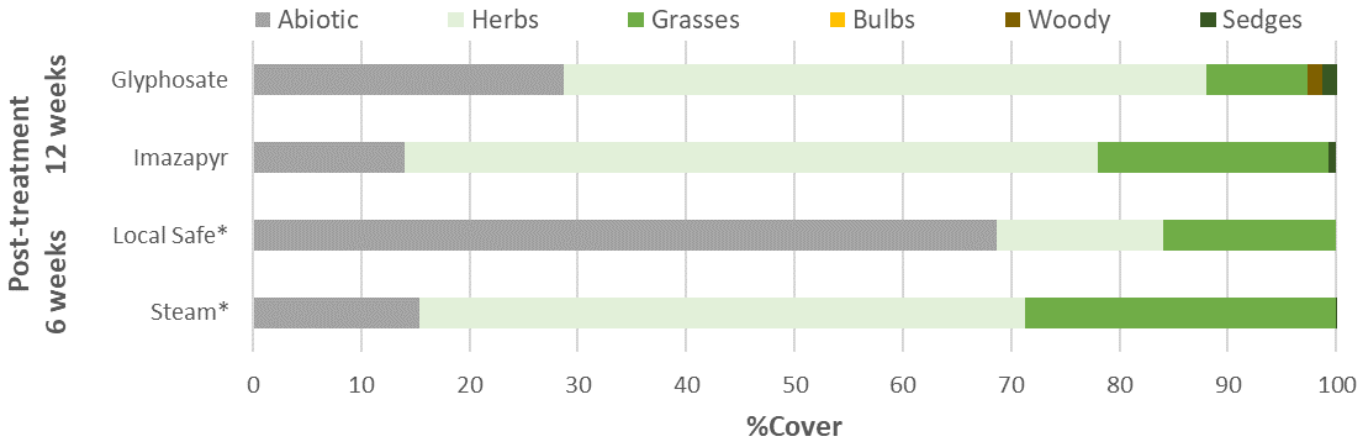


* Local Safe® and steam received a second treatment at 7 weeks.

8.2.6 Week 12 Photoquadrats and %Cover

Figure 8-8 Bellingen Week 12 Photoquadrats and %Cover.





* Local Safe® and steam received a second treatment at 7 weeks.

8.2.7 Statistical Analysis

Table 8-6 Bellingen PERMANOVA analysis on the %Cover of abiotic among treatments and time.

Source	df	SS	MS	Pseudo-F	P(perm)	Unique perms
Treatment	3	128.17	42.723	7.8001	0.001	997
Time	4	627.51	156.88	28.642	0.001	999
Treatment x Time	12	165.64	13.804	2.5202	**0.006**	999
Within level 'Glyphosate' of factor 'Time'						
			Unique			
Groups	t	P(perm)	perms			
T0, T3	5.4288	**0.004**	87			
T0, T6	4.575	**0.006**	87			
T0, T9	1.1959	0.287	32			
T0, T12	1.0626	0.31	24			
Within level 'Imazapyr' of factor 'Time'						
			Unique			
Groups	t	P(perm)	perms			
T0, T3	4.7725	**0.007**	173			
T0, T6	2.0513	0.081	153			
T0, T9	1.9046	0.108	97			
T0, T12	0.58828	0.641	16			
Within level 'Local Safe' of factor 'Time'						
			Unique			
Groups	t	P(perm)	perms			
T0, T3	8.4359	**0.004**	112			
T0, T6	5.1516	**0.005**	128			
T0, T9	8.7297	**0.004**	82			
T0, T12	7.1318	**0.003**	126			
Within level 'Steam' of factor 'Time'						
			Unique			
Groups	t	P(perm)	perms			
T0, T3	6.6383	**0.002**	84			
T0, T6	3.9217	**0.009**	109			
T0, T9	2.65	**0.019**	290			
T0, T12	0.57099	0.611	31			

Table 8-7 Bellingen PERMANOVA analysis on the %Cover of grasses among treatments and times.

Source	df	SS	MS	Pseudo-F	P(perm)	Unique perms
Treatment	3	18.28	6.0934	1.6629	0.188	999
Time	4	97.395	24.349	6.6446	0.001	999
Treatment x Time	12	135.11	11.259	3.0726	**0.002**	997
Residuals	100	366.44	3.6644			
Total	119	617.23				
Within level 'Glyphosate' of factor 'Time'						
			Unique			
Groups	t	P(perm)	perms			
T0, T3	5.3881	**0.001**	149			
T0, T6	6.7555	**0.001**	118			
T0, T9	4.2191	**0.005**	209			
T0, T12	5.2378	**0.004**	296			
Within level 'Imazapyr' of factor 'Time'						
			Unique			
Groups	t	P(perm)	perms			
T0, T3	0.8707	0.43	92			
T0, T6	0.30302	0.809	72			
T0, T9	1.5334	0.188	147			
T0, T12	0.089327	0.923	70			
Within level 'Local Safe' of factor 'Time'						
			Unique			
Groups	t	P(perm)	perms			
T0, T3	1.1935	0.226	64			
T0, T6	0.87171	0.447	78			
T0, T9	0.95827	0.353	77			
T0, T12	0.27859	0.801	73			
Within level 'Steam' of factor 'Time'						
			Unique			
Groups	t	P(perm)	perms			
T0, T3	2.8802	**0.001**	78			
T0, T6	1.8946	0.125	76			
T0, T9	0.55589	0.63	181			
T0, T12	0.43626	0.644	150			

Table 8-8 Bellingen PERMANOVA analysis on the %Cover of herbs among treatments and times

Source	df	SS	MS	Pseudo-F	P(perm)	Unique perms
Treatment	3	103.61	34.538	6.787	0.001	998
Time	4	231.7	57.924	11.383	0.001	999
Treatment x Time	12	185.61	15.467	3.0394	**0.002**	998
Residuals	100	508.89	5.0889			
Total	119	1029.8				
Within level 'Glyphosate' of factor 'Time'						
			Unique			
Groups	t	P(perm)	perms			
T0, T3	0.76072	0.412	72			
T0, T6	0.37838	0.737	126			
T0, T9	1.5084	0.166	235			
T0, T12	1.6632	0.143	316			
Within level 'Imazapyr' of factor 'Time'						
			Unique			
Groups	t	P(perm)	perms			
T0, T3	5.1791	**0.001**	195			
T0, T6	1.6055	0.163	393			
T0, T9	1.8617	0.109	374			
T0, T12	0.45958	0.706	176			
Within level 'Local Safe' of factor 'Time'						
			Unique			
Groups	t	P(perm)	perms			
T0, T3	6.0112	**0.001**	94			
T0, T6	2.3474	**0.034**	414			
T0, T9	6.0245	**0.001**	117			
T0, T12	3.6153	**0.001**	198			
Within level 'Steam' of factor 'Time'						
			Unique			
Groups	t	P(perm)	perms			
T0, T3	2.8598	**0.028**	80			
T0, T6	0.15477	0.876	111			
T0, T9	0.2301	0.756	170			
T0, T12	0.71036	0.478	127			

8.3 Dorrigo

8.3.1 Species Summary

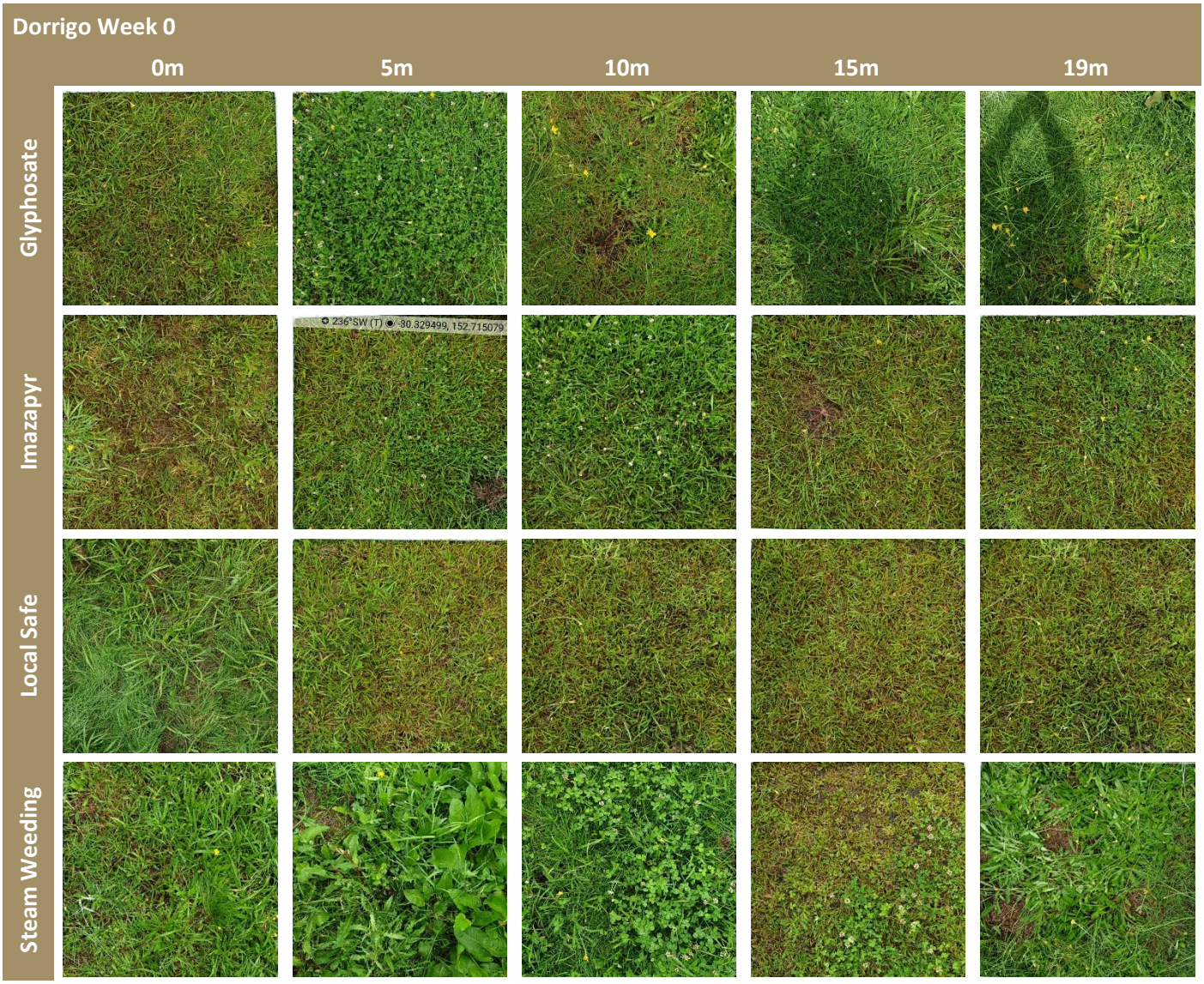
Table 8-9 Plant species (common name) and the number of quadrats (out of 5) observed in for each treatment and time for the Dorrigo trial.

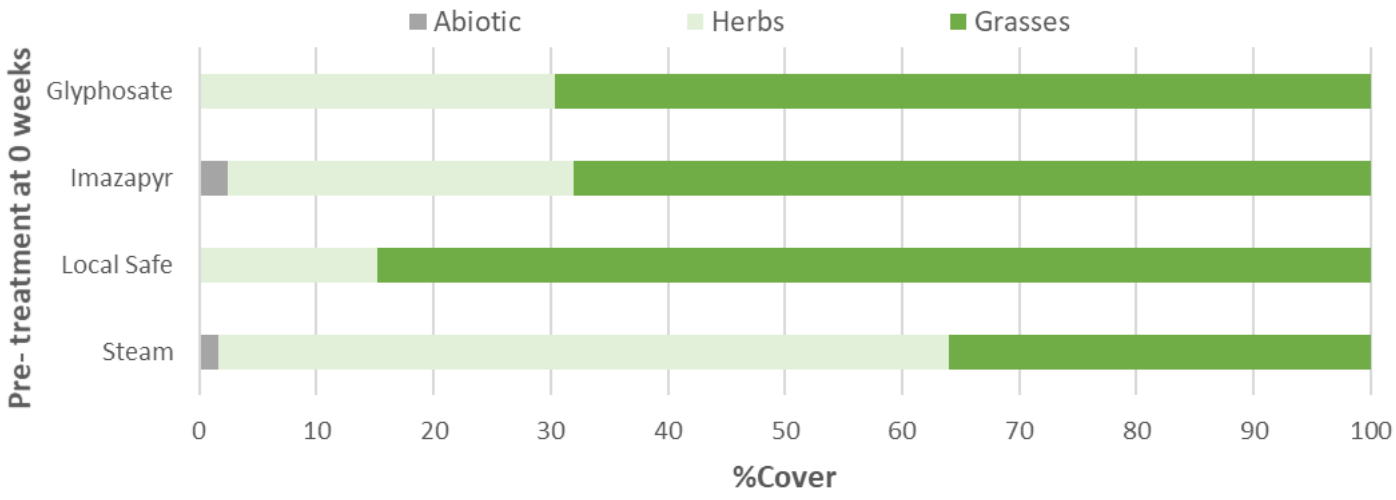
Treatments	Glyphosate					Imazapyr					Local Safe					Steam				
Time (weeks)	0	3	6	9	12	0	3	6	9	12	0	3	6	9	12	0	3	6	9	12
Bulbs																				
Creeping Oxalis				1		1										1			1	
Grasses																				
Buffalo Grass						1														
Broadleaf Paspalum	1		1								1	1	1			1	1			
Carpet Grass		1	1	2	2		5		5	5	1	5	4	5	5	1	2	1		1
Couch											1		1					1		
Crabgrass								5												
Crowsfoot Grass				1	4															
Digitaria sp.												1								
Kikuyu	5	1	4	1	2	4	4						1			3	4	4	4	3
Prairie grass																1				
Wallaby Grass											1					1				
Winter grass	1				1															
Unknown grass sp.						4			2	5	3		1		1	1			1	1
Herbs																				
Cudweed	3				5	3	4	4			4					1			1	1
Dandelion	5			2	4	4					4					5		1	3	3
Dock	4		1	1	1				2							3	1	1	2	2
Flatweed	3			2	3	1	2	1		3	1			2			4		3	
Hydrocotyl		1																		
Paddy's lucerne					1															
Milk thistle	1		1	1	1						1					4	1			
Mallow				2																
Paspalum	1			1										1	1					2
Plantain	2			1	1	1		1								2				1
Pennywort					2															
Purslane (portulaca)																		1	1	

Treatments	Glyphosate					Imazapyr					Local Safe					Steam				
Quickweed																		1		
Scarlet Pimpernel																			1	1
Sheep Sorrel	1		1	3	1														2	
White clover	4				4	2	3								1	3	2		4	4
Unknown herb sp.			3										1							
Natives																				
Wahlenbergia						1		2										4		
Sedges																				
Cyperus sp.								4			1		1							

8.3.2 Week 0 Photoquadrats and %Cover

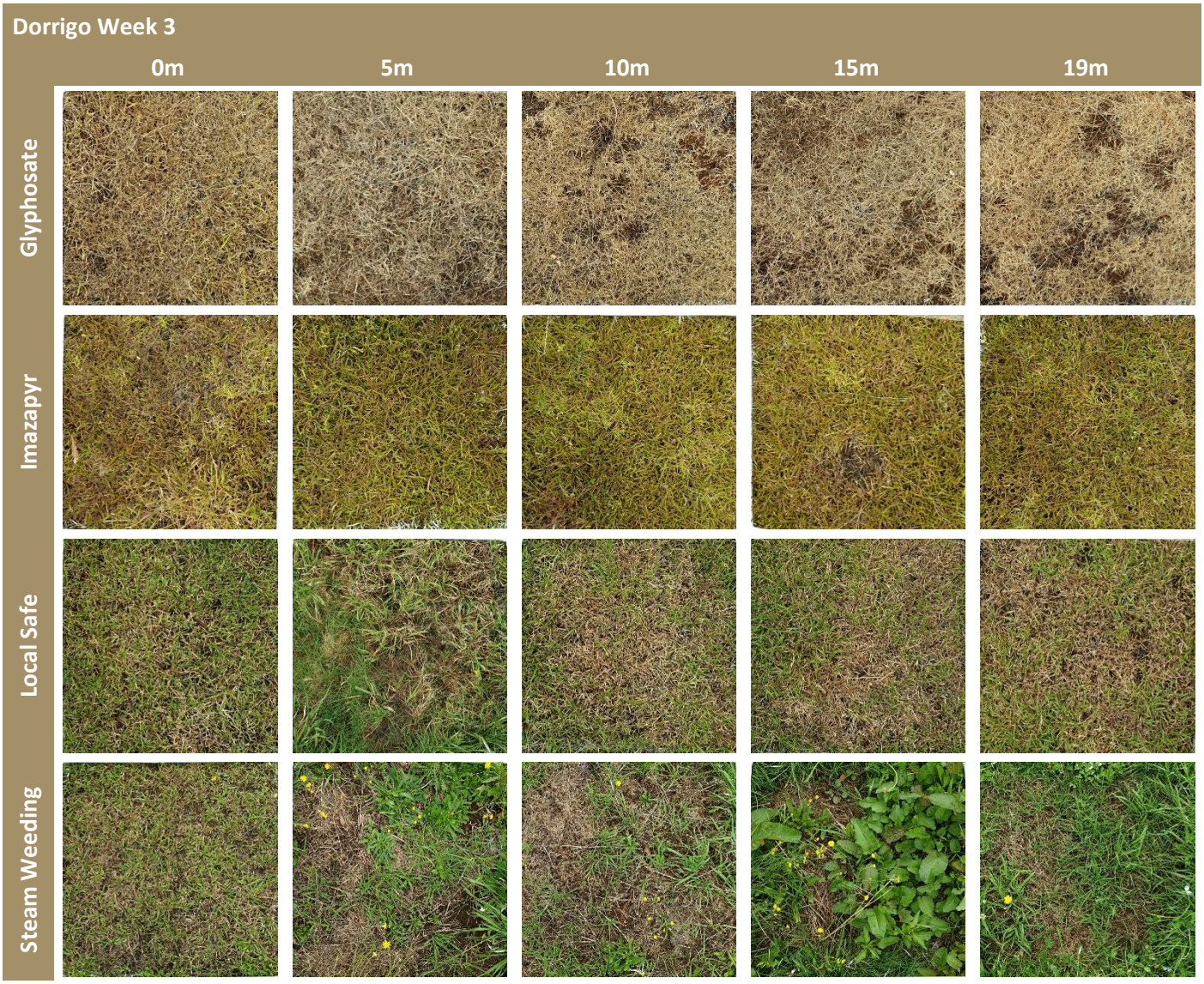
Figure 8-9 Dorrigo Week 0 Photoquadrats and %Cover.

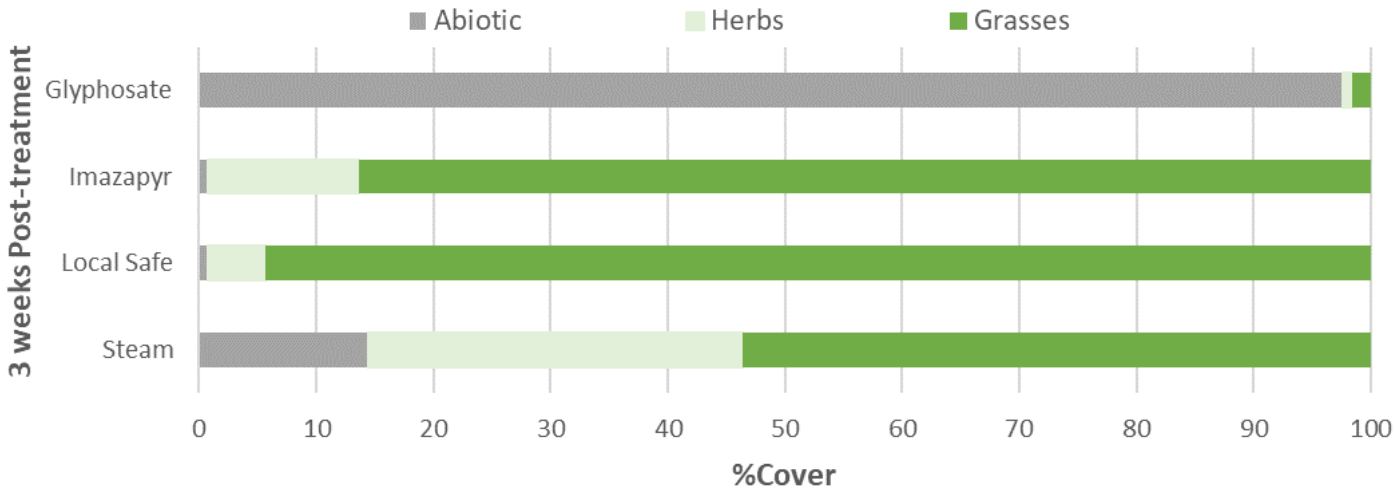




8.3.3 Week 3 Photoquadrats and %Cover

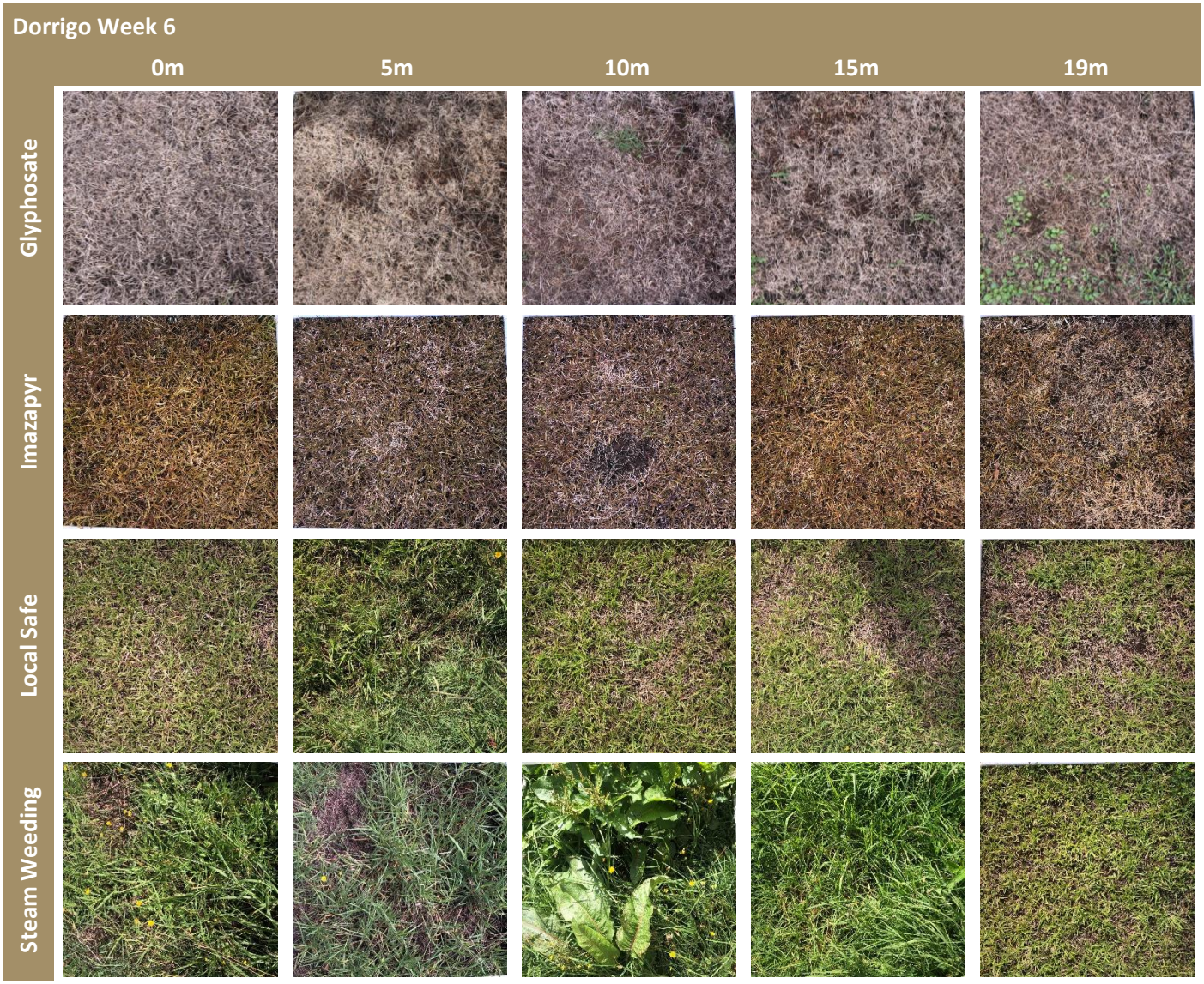
Figure 8-10 Dorrigo Week 3 Photoquadrats and %Cover.

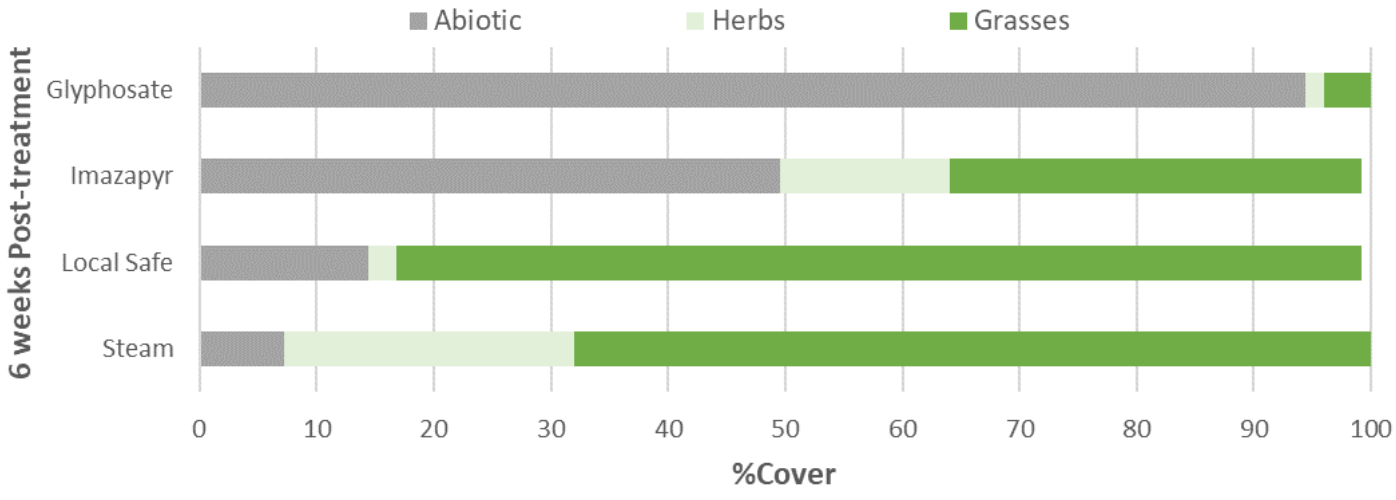




8.3.4 Week 6 Photoquadrats and %Cover

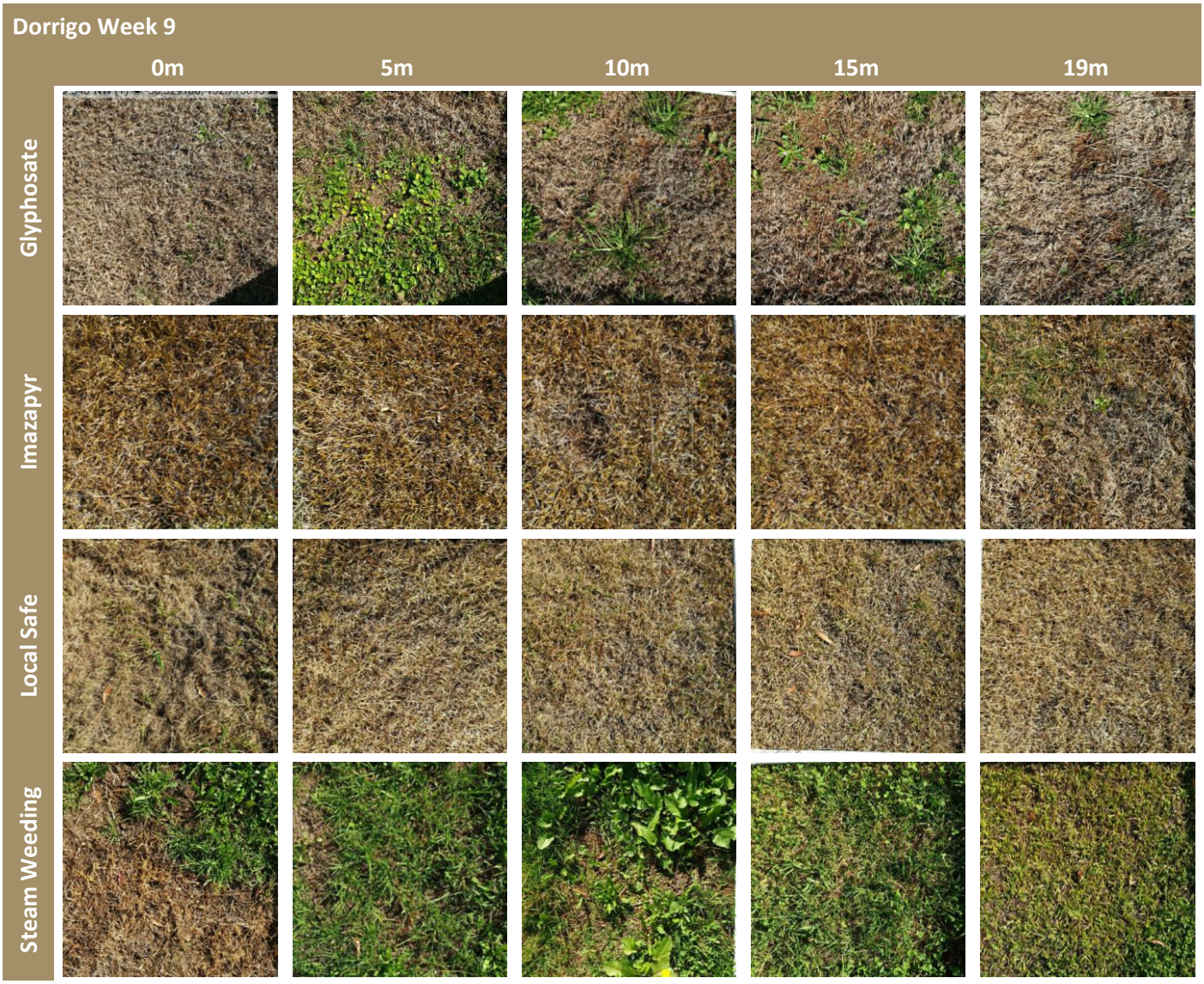
Figure 8-11 Dorrigo Week 6 Photoquadrats and %Cover.

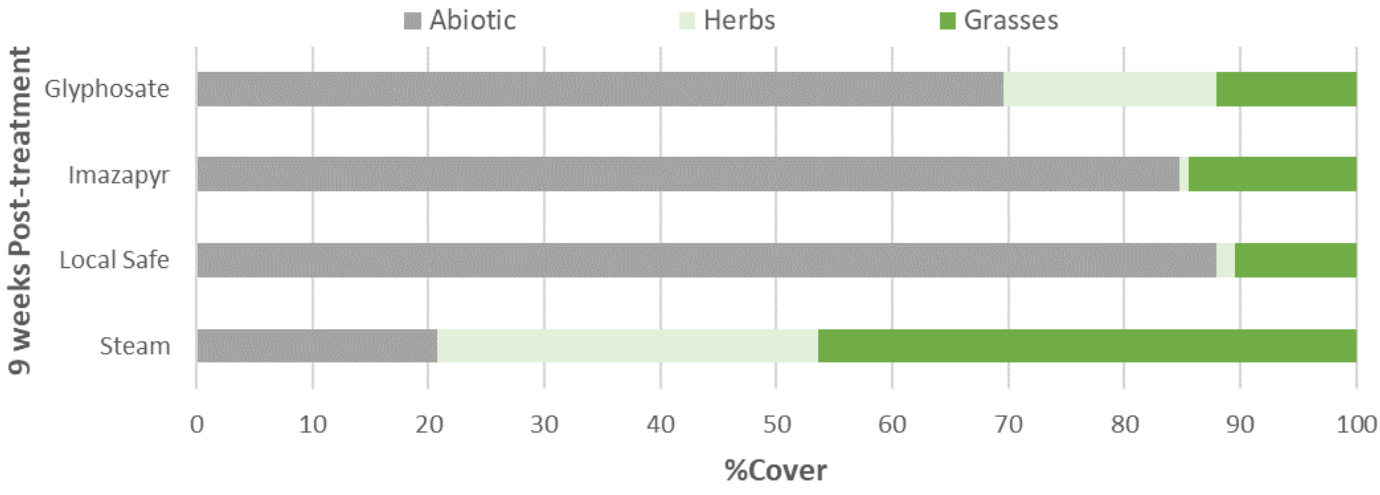




8.3.5 Week 9 Photoquadrats and %Cover

Figure 8-12 Dorrigo Week 9 Photoquadrats and %Cover.

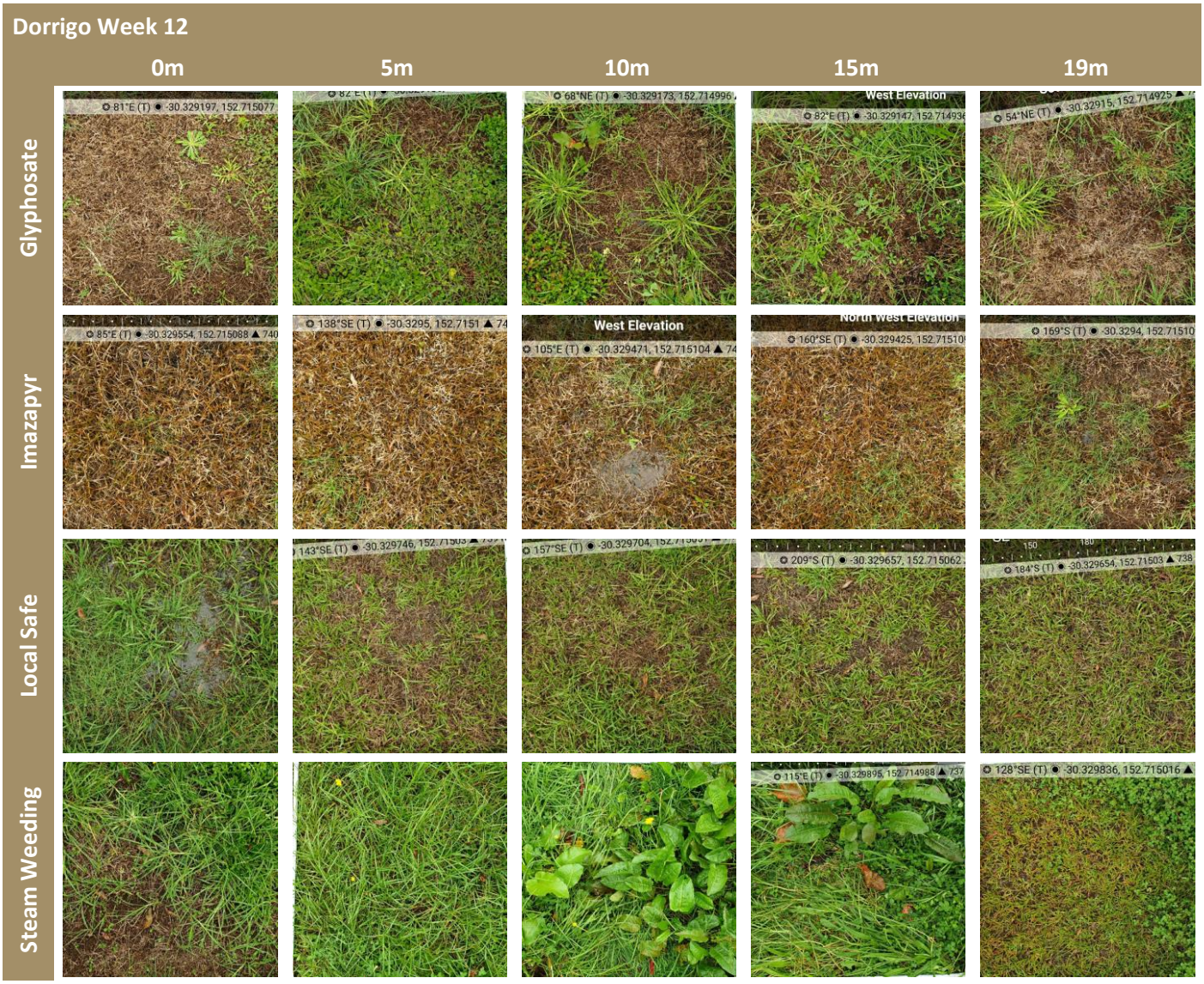


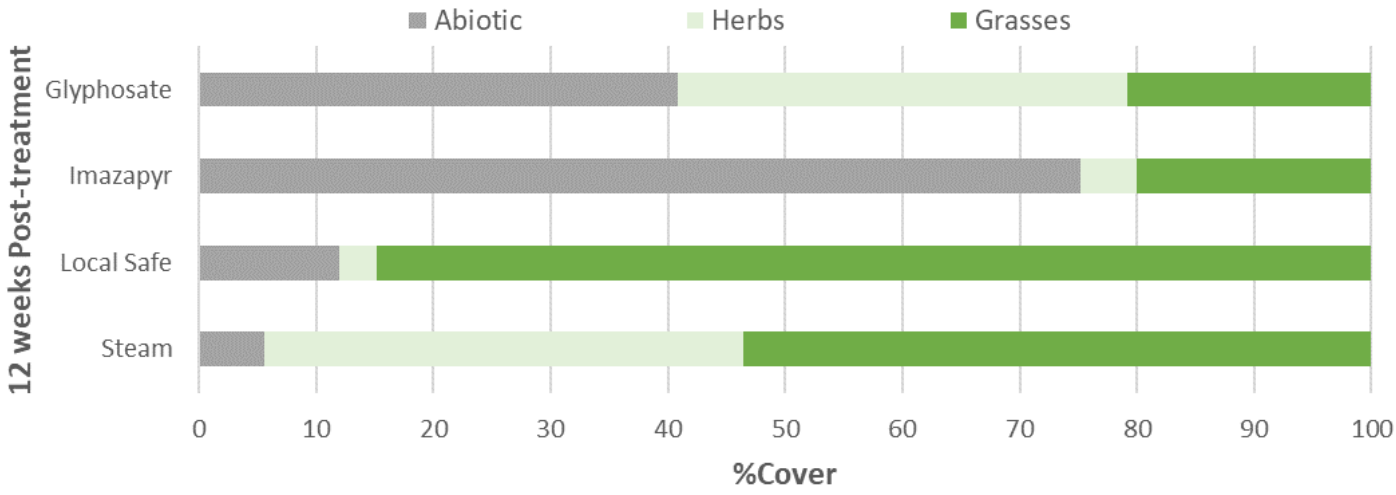


* Local Safe® and steam received a second treatment at 7 weeks.

8.3.6 Week 12 Photoquadrats and %Cover

Figure 8-13 Dorrigo Week 12 Photoquadrats and %Cover.





* Local Safe® and steam received a second treatment at 7 weeks.

8.3.7 Statistical Analysis

Table 8-10 Dorrigo PERMANOVA analysis on the %Cover of abiotic among treatments and time.

Source	df	SS	MS	Pseudo-F	P(perm)	Unique perms
Treatment	3	320.05	106.68	51.424	0.001	998
Time	4	570.95	142.74	68.803	0.001	999
Treatment x Time	12	435.16	36.263	17.48	**0.001**	998
Res	80	165.96	2.0746			
Total	99	1492.1				
Within level 'Glyphosate' of factor 'Time'						
			Unique			
Groups	t	P(perm)	perms			
T0, T3	121.11	**0.014**	8			
T0, T6	47.015	**0.003**	8			
T0, T9	14.604	**0.008**	16			
T0, T12	6.5767	**0.013**	12			
Within level 'Imazapyr' of factor 'Time'						
			Unique			
Groups	t	P(perm)	perms			
T0, T3	0.77934	0.708	3			
T0, T6	9.7507	**0.01**	41			
T0, T9	13.145	**0.006**	41			
T0, T12	11.716	**0.006**	41			
Within level 'Local Safe' of factor 'Time'						
			Unique			
Groups	t	P(perm)	perms			
T0, T3	1	1	1			
T0, T6	3.6376	0.05	6			
T0, T9	62.133	**0.01**	16			
T0, T12	7.7031	**0.006**	16			
Within level 'Steam' of factor 'Time'						
			Unique			
Groups	t	P(perm)	perms			
T0, T3	2.2949	0.104	9			
T0, T6	0.9532	0.434	4			
T0, T9	1.8839	0.124	12			
T0, T12	1.1275	0.376	6			

Table 8-11 Dorrigo PERMANOVA analysis on the %Cover of grasses among treatments and times.

Source	df	SS	MS	Pseudo-F	P(perm)	Unique perms
Treatment	291.48	97.161	56.609	0.001	999	
Time	137.73	34.432	20.061	0.001	999	
Treatment x Time	324.2	27.017	15.741	**0.001**	998	
Residuals	137.31	1.7164				
Total	890.73					
Within level 'Glyphosate' of factor 'Time'						
			Unique			
Groups	t	P(perm)	perms			
T0, T3	5.1955	**0.001**	30			
T0, T6	5.2559	**0.001**	23			
T0, T9	3.4335	**0.001**	48			
T0, T12	2.5546	**0.001**	66			
Within level 'Imazapyr' of factor 'Time'						
			Unique			
Groups	t	P(perm)	perms			
T0, T3	2.6066	**0.024**	40			
T0, T6	5.1848	**0.001**	30			
T0, T9	8.5988	**0.001**	48			
T0, T12	6.2881	**0.001**	41			
Within level 'Local Safe' of factor 'Time'						
			Unique			
Groups	t	P(perm)	perms			
T0, T3	1.2779	0.392	23			
T0, T6	0.39236	0.713	70			
T0, T9	14.253	**0.001**	66			
T0, T12	0.041179	0.902	34			
Within level 'Steam' of factor 'Time'						
			Unique			
Groups	t	P(perm)	perms			
T0, T3	1.1988	0.26	116			
T0, T6	2.0078	0.08	66			
T0, T9	0.64719	0.545	91			
T0, T12	1.0796	0.274	102			

Table 8-12 Dorrigo PERMANOVA analysis on the %Cover of herbs among treatments and times.

Source	df	SS	MS	Pseudo-F	P(perm)	Unique perms
Treatment	3	236.85	78.95	26.462	0.001	999
Time	4	132.08	33.021	11.068	0.001	999
Treatment x Time	12	127.23	10.602	3.5536	**0.001**	999
Residuals	80	238.68	2.9835			
Total	99	734.84				
Within level 'Glyphosate' of factor 'Time'						
			Unique			
Groups	t	P(perm)	perms			
T0, T3	3.6146	**0.001**	23			
T0, T6	2.723	**0.001**	23			
T0, T9	0.78135	0.426	81			
T0, T12	0.76929	0.493	66			
Within level 'Imazapyr' of factor 'Time'						
			Unique			
Groups	t	P(perm)	perms			
T0, T3	2.2252	0.054	66			
T0, T6	1.8876	0.1	58			
T0, T9	5.828	0.001	31			
T0, T12	3.5269	0.012	34			
Within level 'Local Safe' of factor 'Time'						
			Unique			
Groups	t	P(perm)	perms			
T0, T3	2.4988	**0.001**	23			
T0, T6	3.4852	**0.008**	34			
T0, T9	4.1391	**0.001**	19			
T0, T12	3.0658	**0.015**	38			
Within level 'Steam' of factor 'Time'						
			Unique			
Groups	t	P(perm)	perms			
T0, T3	2.5596	**0.039**	66			
T0, T6	2.8037	**0.001**	41			
T0, T9	2.6905	**0.032**	59			
T0, T12	1.5118	0.148	84			

8.4 Mylestom

8.4.1 Species Summary

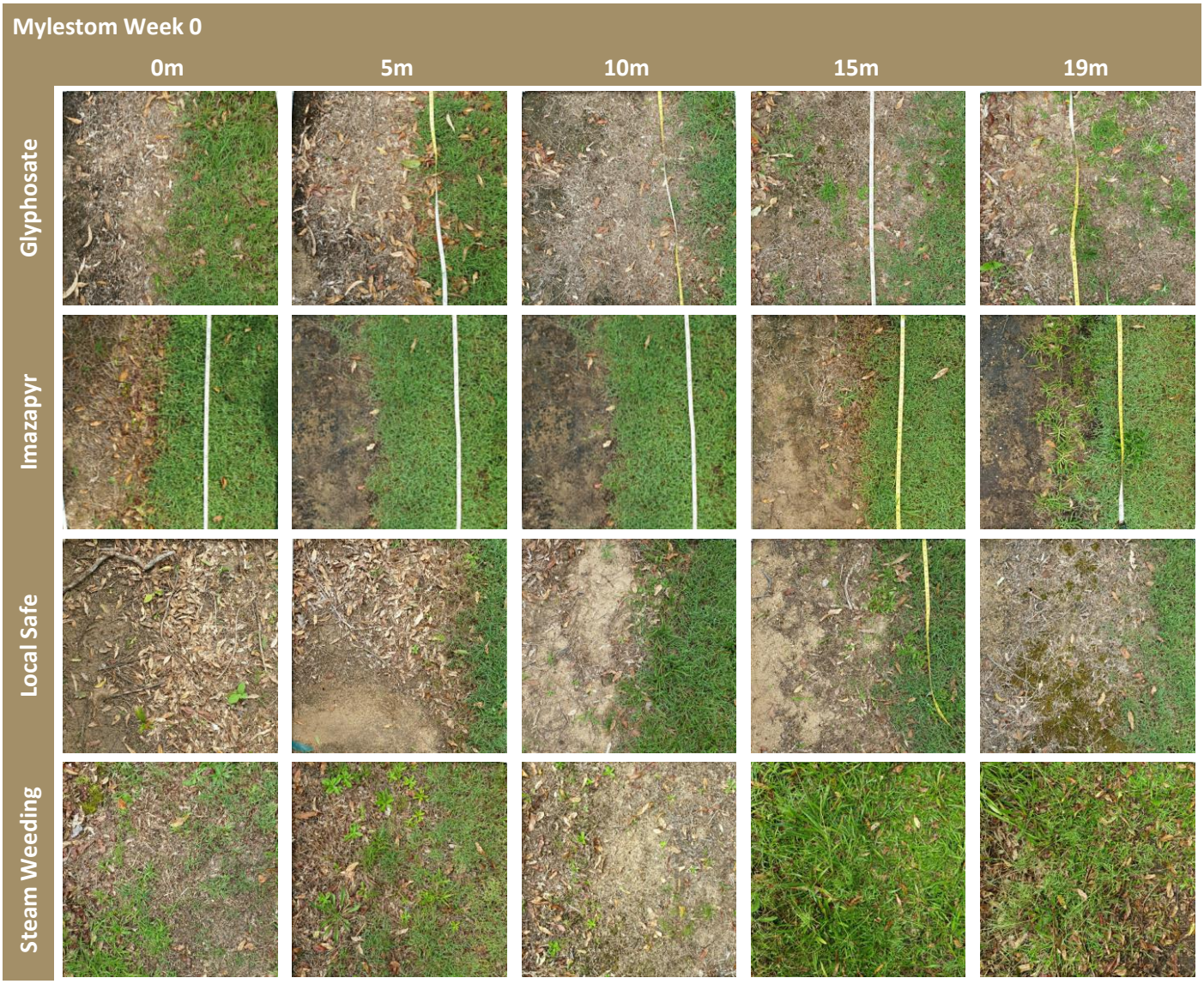
Table 8-13 Plant species (common name) and the number of quadrats (out of 5) observed in for each treatment and time for the Mylestom trial.

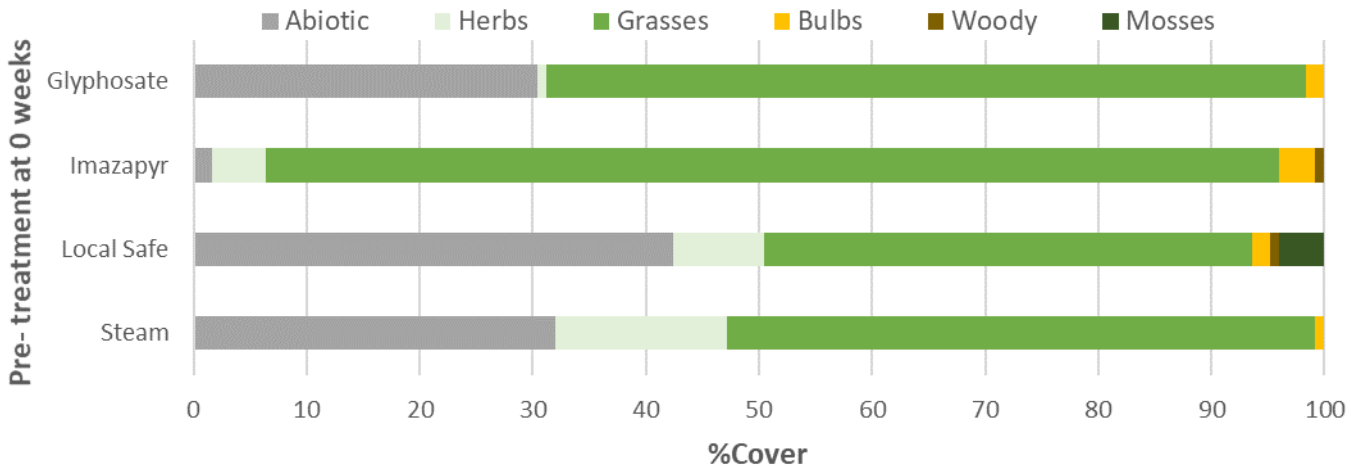
Treatments	Glyphosate					Imazapyr					Local Safe					Steam				
Time (weeks)	0	3	6	9	12	0	3	6	9	12	0	3	6	9	12	0	3	6	9	12
Bulbs																				
Gloriosa Lily	1	1	1																	
Creeping Oxalis	2	2				2					2					1				1
Grasses																				
Couch	5	5		2	5	5		1	1	4	5	5	5		4	5	1	5	5	5
Crowsfoot Grass			1	2	4	1		3	3	3	2		4					3	1	2
Carpet Grass					2															
Nut grass											1	1		1	1	1		1	1	2
Kikuyu	1	1				1					1	1				1		1		
Panic grass								1					1							
Sour grass																1		2		
Unknown grass sp.	2	2	4																	
Herbs																				
Asparagus fern																		1		
Bidens				1														1	1	1
Carrot Weed												1								
Celery weed											1									
Cudweed											1	1	1			3				1
Dandelion						1					1	1				2			3	
Flatweed																		2		2
Milk thistle																1				
Khaki Weed	2	2			1	1				1	4	4	5		2	3		2	2	1
Plantago						2										4		2	2	
Plantain																				2
Pennywort																			1	1
Petty Spurge																1				
Spotted Spurge				5	3	1				1			3			1		2	5	1
White clover						2					1		1			1		1	2	1

Treatments	Glyphosate					Imazapyr					Local Safe				Steam					
Unknown herb			3					2		3			1		1					
Natives																				
Wahlenbergia			1	5	3	2					1	1	1			3	1	1	1	1
Dianella																1				
Moss																				
Moss										2	1									
Woody (at maturity)																				
Blackberry															1					
Cocos Palm											1		1	1	2					
Glycine						1														
Lantana													1							
Phyllanthus (creeping)																			1	
Tuckeroo seedling															2			1	1	
Tobacco Bush											1	1	1							

8.4.2 Week 0 Photoquadrats and %Cover

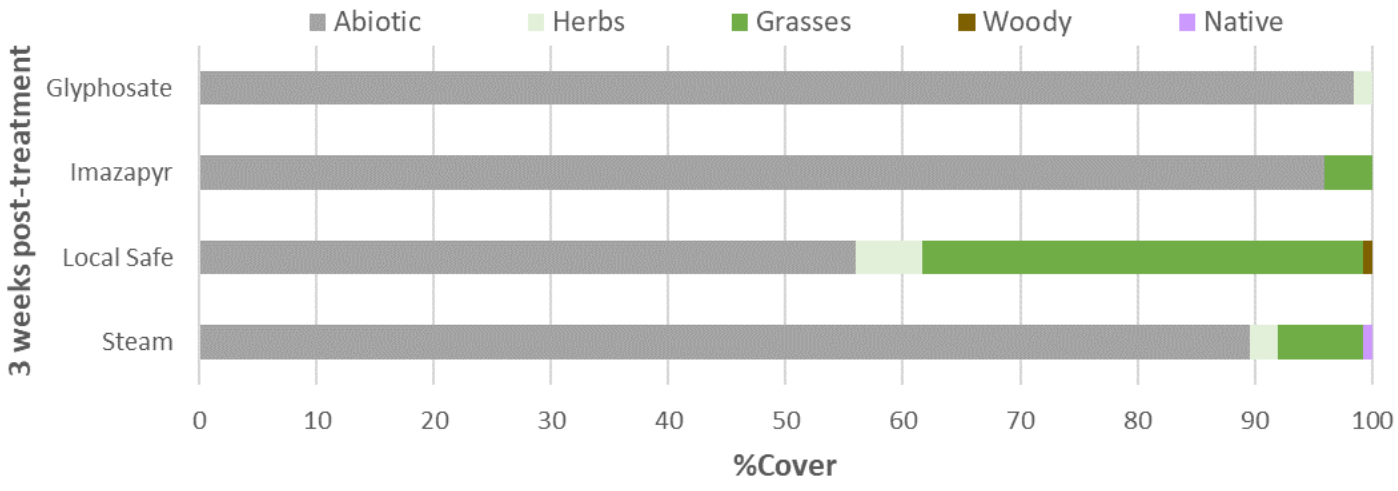
Figure 8-14 Mylestom Week 0 Photoquadrats and %Cover.





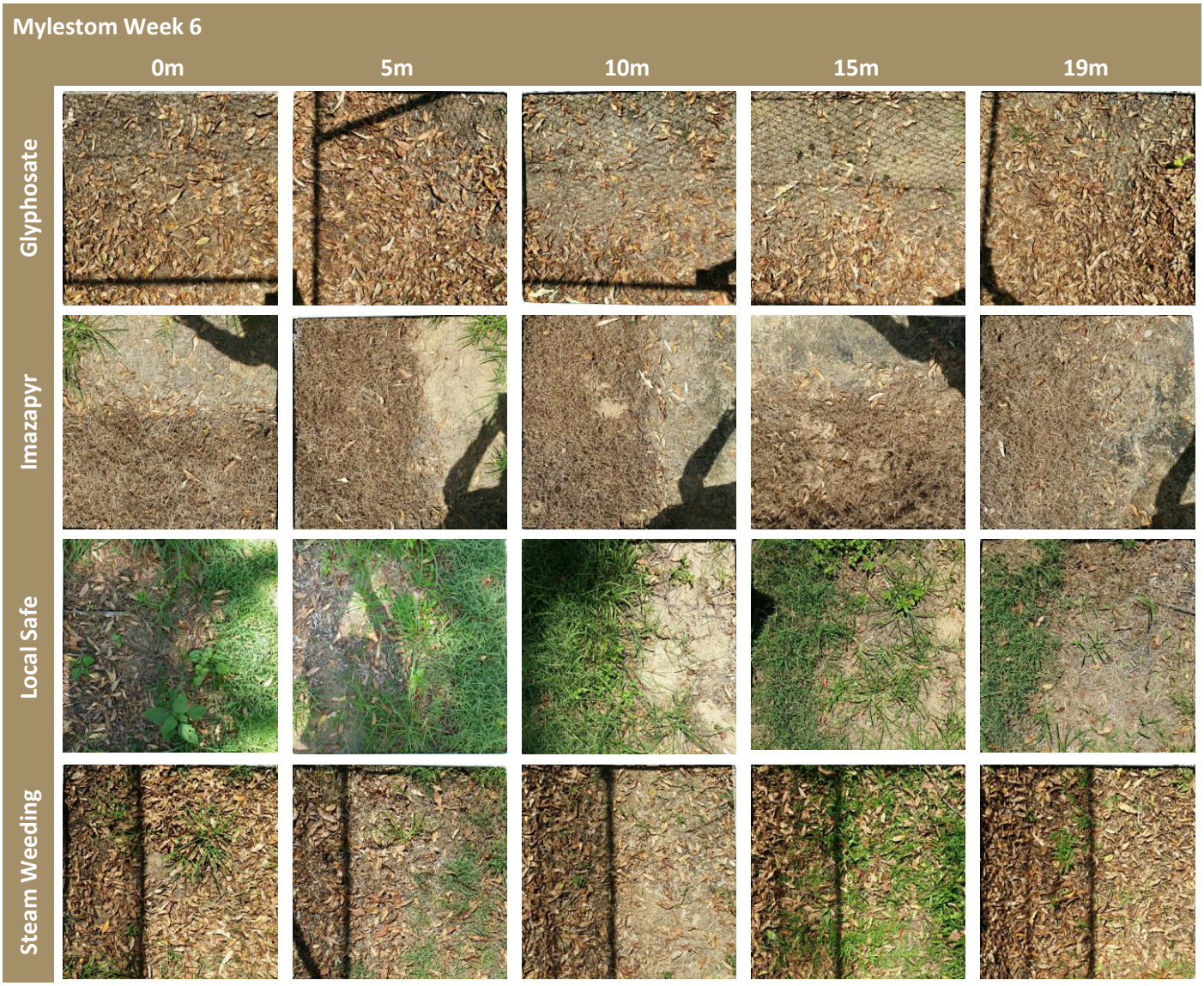
8.4.3 Week 3 Photoquadrats and %Cover

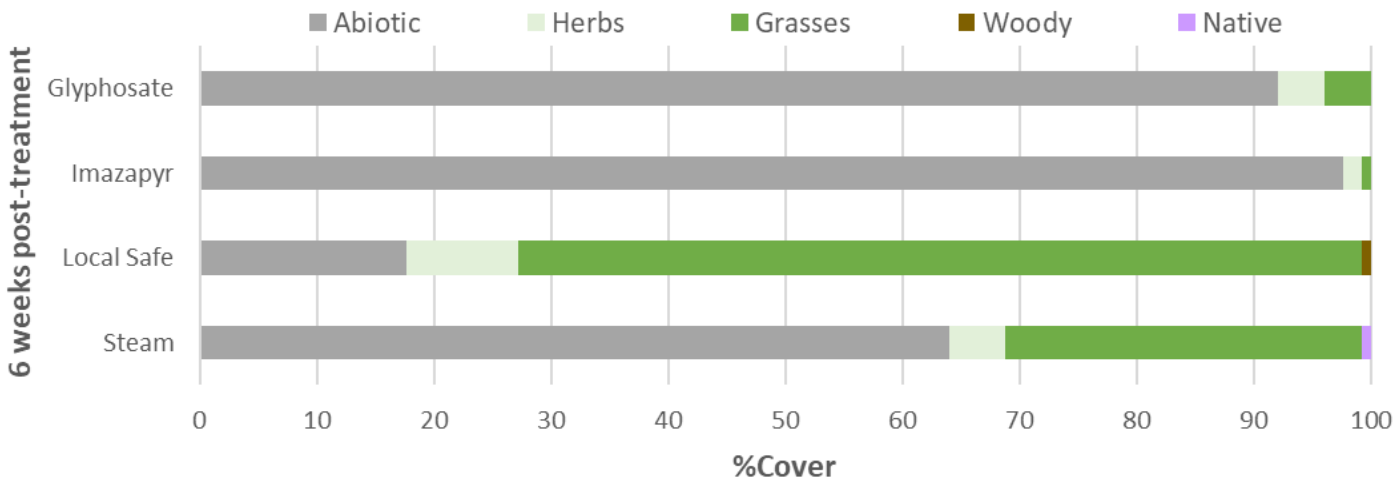
Figure 8-15 Mylestom Week 3 Photoquadrats and %Cover.



8.4.4 Week 6 Photoquadrats and %Cover

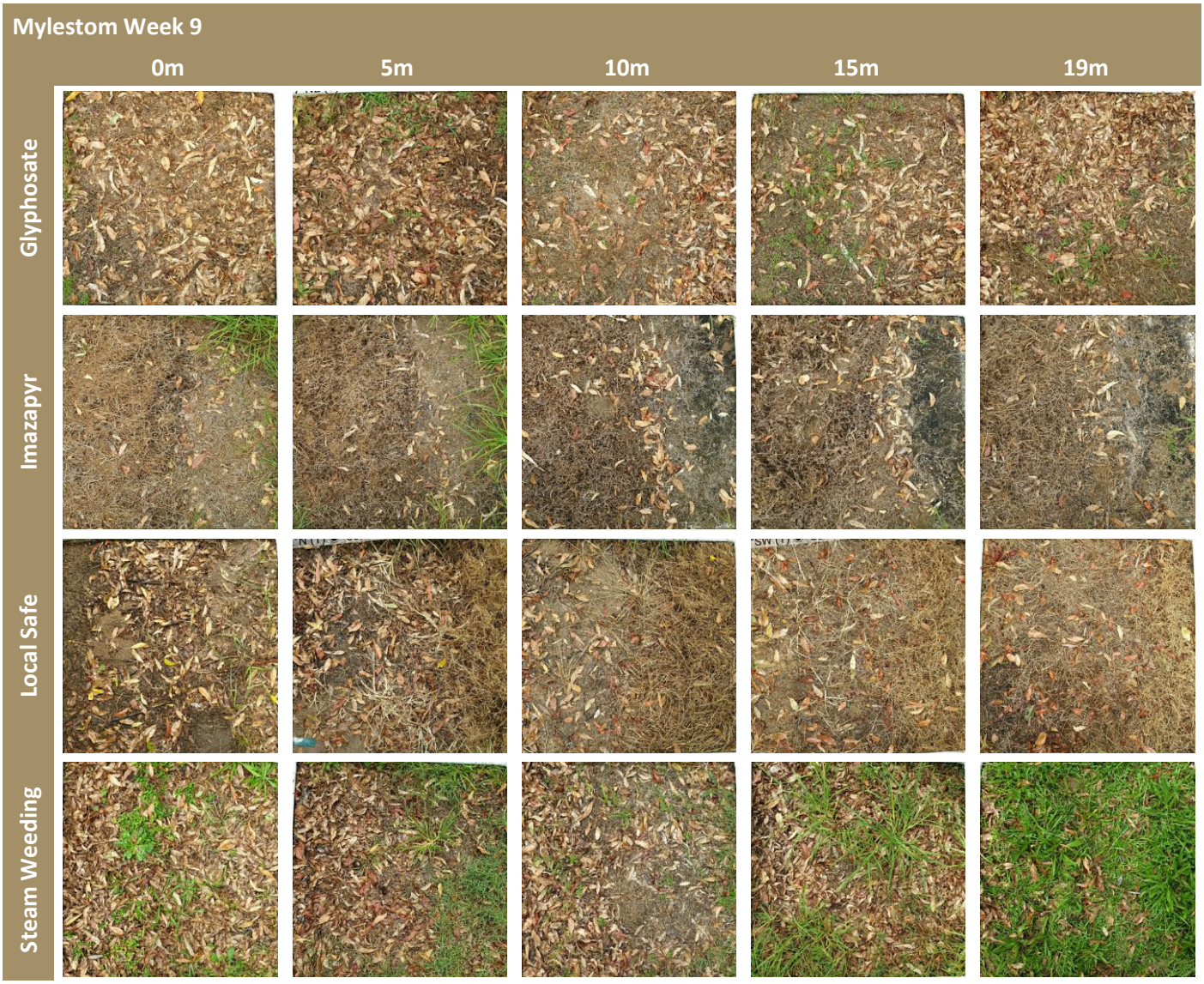
Figure 8-16 Mylestom Week 6 Photoquadrats and %Cover.

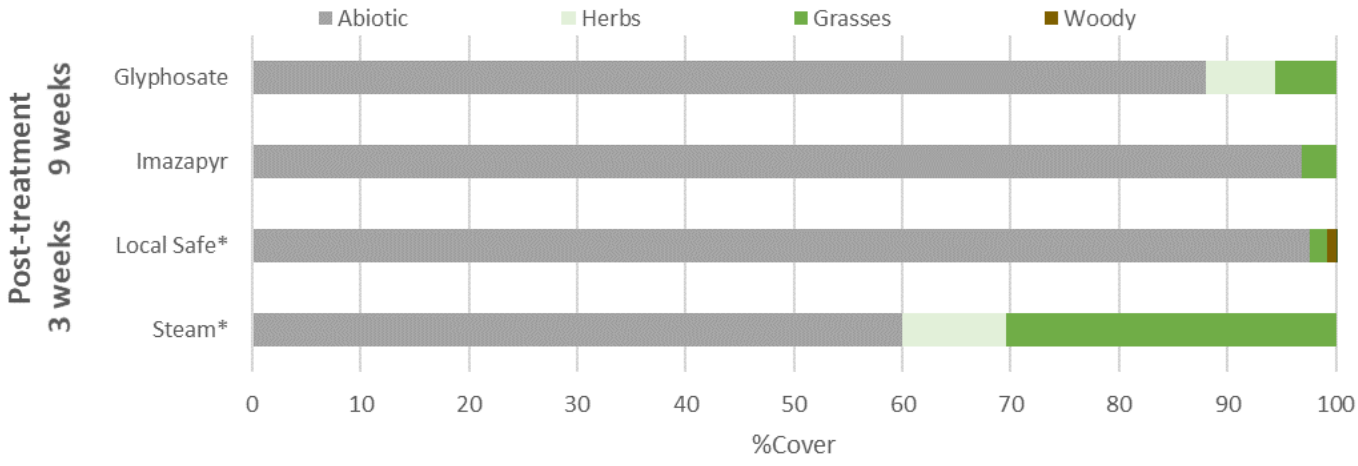




8.4.5 Week 9 Photoquadrats and %Cover

Figure 8-17 Mylestom Week 9 Photoquadrats and %Cover.

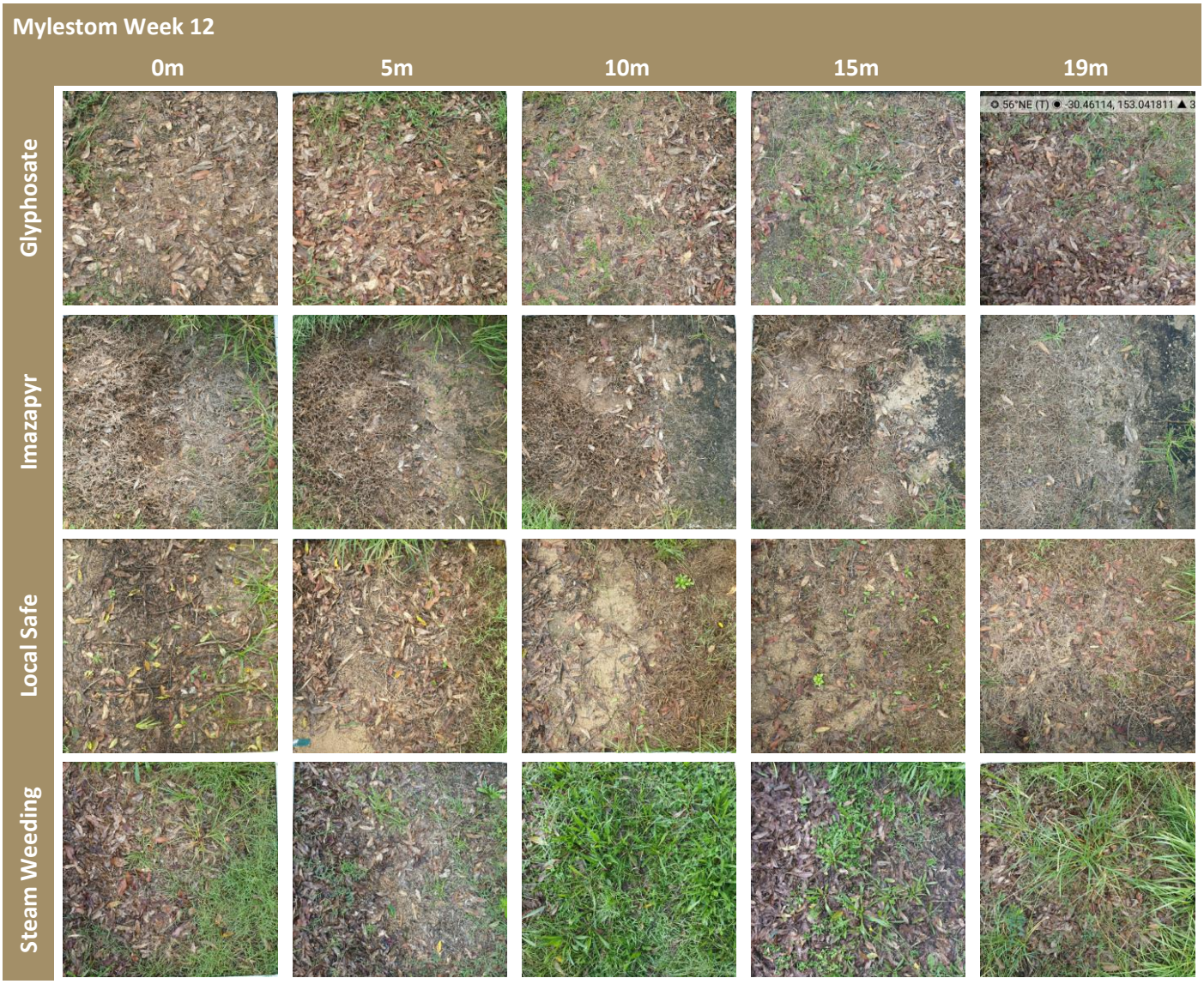


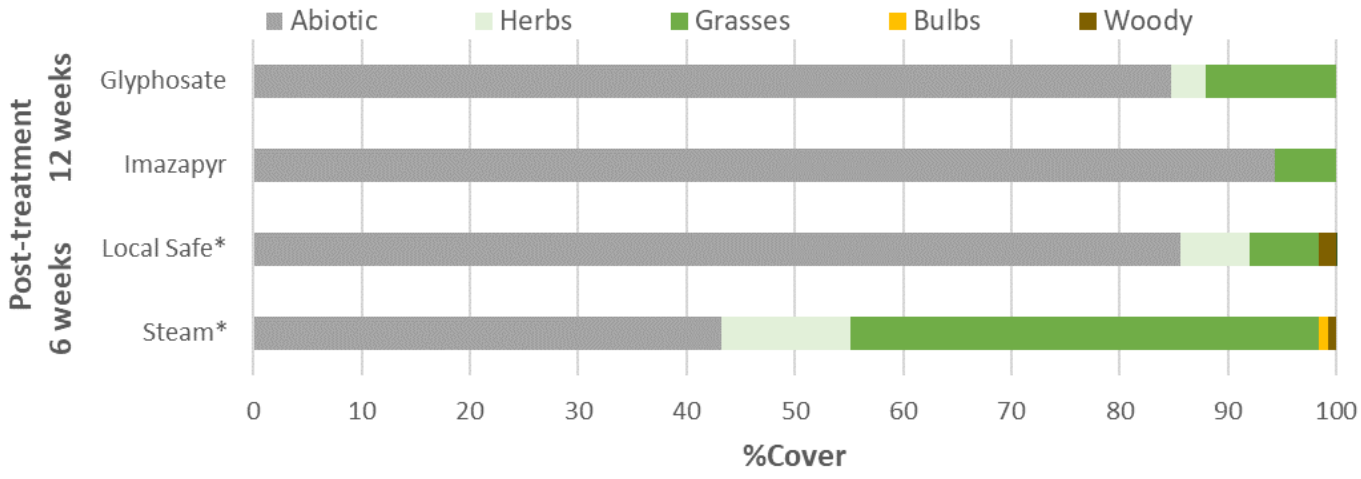


* Local Safe® and steam received a second treatment at 7 weeks.

8.4.6 Week 12 Photoquadrats and %Cover

Figure 8-18 Mylestom Week 12 Photoquadrats and %Cover.





* Local Safe® and steam received a second treatment at 7 weeks.

8.4.7 Statistical Analysis

Table 8-14 Mylestom PERMANOVA analysis on the %Cover of abiotic among treatments and time.

Source	df	SS	MS	Pseudo-F	P(perm)	Unique perms
Treatment	3	3643.7	1214.6	9.6043	0.001	999
Time	4	14629	3657.2	28.92	0.001	999
Treatment x Time	12	16365	1363.7	10.784	**0.001**	999
Res	80	10117	126.46			
Total	99	44754				
Within level 'Glyphosate' of factor 'Time'						
			Unique			
Groups	t	P(perm)	perms			
T0, T3	4.8532	**0.008**	41			
T0, T6	4.6155	**0.009**	16			
T0, T9	4.3791	**0.008**	91			
T0, T12	4.2118	**0.009**	126			
Within level 'Imazapyr' of factor 'Time'						
			Unique			
Groups	t	P(perm)	perms			
T0, T3	6.2854	**0.008**	5			
T0, T6	6.2935	**0.006**	15			
T0, T9	6.2906	**0.012**	9			
T0, T12	6.2687	**0.005**	9			
Within level 'Local Safe' of factor 'Time'						
			Unique			
Groups	t	P(perm)	perms			
T0, T3	0.91647	0.399	126			
T0, T6	1.06	0.339	66			
T0, T9	2.2768	**0.007**	31			
T0, T12	2.0456	**0.023**	66			
Within level 'Steam' of factor 'Time'						
			Unique			
Groups	t	P(perm)	perms			
T0, T3	3.7884	**0.008**	56			
T0, T6	1.984	0.068	126			
T0, T9	1.3938	0.202	66			
T0, T12	0.85724	0.463	91			

Table 8-15 Mylestom PERMANOVA analysis on the %Cover of grasses among treatments and times.

Source	df	SS	MS	Pseudo-F	P(perm)	Unique perms
Treatment	3	78.983	26.328	10.21	0.001	997
Time	4	352.83	88.208	34.208	0.001	998
Treatment x Time	12	350.52	29.21	11.328	**0.001**	998
Residuals	80	206.29	2.5786			
Total	99	988.62				
Within level 'Glyphosate' of factor 'Time'						
			Unique			
Groups	t	P(perm)	perms			
T0, T3	12.429	**0.001**	16			
T0, T6	9.3577	**0.001**	16			
T0, T9	7.0443	**0.001**	49			
T0, T12	5.8399	**0.001**	63			
Within level 'Imazapyr' of factor 'Time'						
			Unique			
Groups	t	P(perm)	perms			
T0, T3	87.626	**0.001**	8			
T0, T6	22.163	**0.001**	15			
T0, T9	19.229	**0.001**	15			
T0, T12	23.516	**0.001**	15			
Within level 'Local Safe' of factor 'Time'						
			Unique			
Groups	t	P(perm)	perms			
T0, T3	0.098294	0.966	91			
T0, T6	1.6699	0.177	90			
T0, T9	2.8612	**0.001**	31			
T0, T12	1.914	0.102	91			
Within level 'Steam' of factor 'Time'						
			Unique			
Groups	t	P(perm)	perms			
T0, T3	4.0524	**0.001**	78			
T0, T6	1.334	0.201	126			
T0, T9	1.3354	0.213	87			
T0, T12	0.52424	0.61	126			

Table 8-16 Mylestom PERMANOVA analysis on the %Cover of herbs among treatments and times

Source	df	SS	MS	Pseudo-F	P(perm)	Unique perms
Treatment	3	59.185	19.728	15.701	0.001	999
Time	4	19.069	4.7672	3.7939	0.007	998
Treatment x Time	12	53.011	4.4176	3.5157	**0.001**	999
Residuals	80	100.52	1.2565			
Total	99	231.79				
Within level 'Glyphosate' of factor 'Time'						
			Unique			
Groups	t	P(perm)	perms			
T0, T3	0.63246	0.539	8			
T0, T6	4	**0.001**	5			
T0, T9	1.6835	0.15	17			
T0, T12	0.91421	0.26	11			
Within level 'Imazapyr' of factor 'Time'						
			Unique			
Groups	t	P(perm)	perms			
T0, T3	2.4495	0.088	6			
T0, T6	1.0572	0.187	14			
T0, T9	2.4495	0.066	6			
T0, T12	2.4495	0.079	6			
Within level 'Local Safe' of factor 'Time'						
			Unique			
Groups	t	P(perm)	perms			
T0, T3	0.49604	0.505	25			
T0, T6	0.74589	0.519	23			
T0, T9	3.9017	**0.001**	9			
T0, T12	0.082321	0.89	26			
Within level 'Steam' of factor 'Time'						
			Unique			
Groups	t	P(perm)	perms			
T0, T3	4.2199	**0.009**	41			
T0, T6	4.7206	**0.001**	23			
T0, T9	1.9971	0.08	20			
T0, T12	1.0537	0.313	56			

Appendix I
Alternative Trial Weed Profiles

BSC Weed Profile Temple					
Common Name	Bidens/ Farmers Friends/ Cobblers Pegs				
Scientific Name	*Bidens pilosa*				
Indigenous Name					
Weed Significance					
Priority - Eradicate	WoNS	State/Regional Priority	GBD		
Life Cycle					
Annual	Perennial	Semi-Annual			
Plant Type					
Herbaceous	Shrub	Tree	Vine	Aquatic	

Description of growing site

Common weed of crops, fallows, orchards, vineyards, waste areas, disturbed sites and populated areas (e.g. gardens, footpaths, parks, etc.). It is also found in re-vegetation areas, forest gaps and margins, open woodlands, urban bushland, riparian vegetation and coastal environs.

Distinguishing Features

A short-lived herbaceous plant with upright stems growing up to 1.8 m tall. Stems are square in cross section and green to purplish in colour.

Leaves are paired (2.5-13.5 cm long) have toothed margins and vary in nature depending on their position on the plant. They may be either oval in shape, deeply-lobed or once-compound with 3-7 leaflets.

Flower heads are small (5-15 mm across) have numerous tiny yellow tubular flowers in the centre and sometimes also have some white 'petals' 2-8 mm long.

Its dark brown or black 'seeds' (4-16 mm long) are elongated in shape and topped with two or three barbed awns (1-4 mm long).

Description of propagules

reproduces only by seed, which readily become attached clothing and animals. The seeds may also be dispersed by vehicles, by water, and in contaminated agricultural produce.

Control: Refer to NSW weedwise for current treatment recommendations. https://weeds.dpi.nsw.gov.au/

BSC Weed Profile Temple		
Common Name	Black nightshade/ blackberry nightshade	
Scientific Name	*Solanum nigrum*	
Indigenous Name		

Weed Significance			
Priority - Eradicate	WoNS	State/Regional Priority	GBD

Life Cycle		
Annual	Perennial	Semi-Annual

Plant Type				
Herbaceous	Shrub	Tree	Vine	Aquatic

Description of growing site

A common weed of crops, pastures, orchards, vineyards, roadsides, gardens, disturbed sites and waste areas in temperate, sub-tropical, tropical and semi-arid environments.

Distinguishing Features

Stems are sparsely hairy (i.e. puberulent), or occasionally hairless (i.e. glabrous), and are rough in texture. They are green or purplish-green when young. The alternately arranged leaves (2-13 cm long and 1-8 cm wide) are borne on stalks (i.e. petioles).

The small star-shaped flowers (7-12 mm across) are borne in several-flowered clusters in the leaf forks (i.e. axils) near the tips of the branches.

The rounded fruit (i.e. globular berries) turn from green to dull black or purplish-black in colour when mature.

Description of propagules

This species reproduces mainly by seed, which are most often spread by birds and other animals that eat the fruit.

Control: Refer to NSW weedwise for current treatment recommendations. https://weeds.dpi.nsw.gov.au/

BSC Weed Profile Temple		
Common Name	Blue Billy Goat Weed/ Argeratum	
Scientific Name	*Ageratum houstonianum*	
Indigenous Name		

Weed Significance			
Priority - Eradicate	WoNS	State/Regional Priority	GBD

Life Cycle		
Annual	Perennial	Semi-Annual

Plant Type				
Herbaceous	Shrub	Tree	Vine	Aquatic

Description of growing site

A weed of gardens, roadsides, disturbed sites, waste areas, pastures, crops, wetlands and waterways in the tropical, sub-tropical and warmer temperate regions of Australia.

Distinguishing Features

softly hairy stems and leaves.

Toothed leaves are oppositely arranged at the base of the stems, but are often alternately arranged at the top of the stems.

Flower-heads are usually blue (occasionally pink or whitish) and lack any obvious 'petals'. These flower-heads have very hairy bracts and numerous long narrow projections. Flowers year round.

Description of propagules

This species reproduces by seed. The tiny, light, seeds are often dispersed by wind and water. They readily become attached to animals, clothing and vehicles and may also be spread in contaminated agricultural produce. Spreads by wind, animals (external and internal), mowing equipment, dumped garden waste, contaminated soil and clothing, sometimes in contaminated nursery pots used for revegetation.

Control: Refer to NSW weedwise for current treatment recommendations. https://weeds.dpi.nsw.gov.au/

BSC Weed Profile Temple		
Common Name	Broad leaf paspalum	
Scientific Name	*Paspalum mandiocanum*	
Indigenous Name		

Weed Significance			
Priority - Eradicate	WoNS	State/Regional Priority	GBD

Life Cycle		
Annual	Perennial	Semi-Annual

Plant Type				
Herbaceous	Shrub	Tree	Vine	Aquatic

Description of growing site

Weed of open pasture, along roadside verges and in bush margins, but also in deeply-shaded sections of forest.

Distinguishing Features

Tussocks can grow to 1 m wide and easily spread sideways. ,

Leaf blades leaves more than 10 mm wide, bright green, have a crinkled margin and a tendency to spread. The lower section, 70–100 mm of leaf is usually maroon, burgundy or brown.

Flower stems can be over 1 m tall with up to 10 flower/seed stalks growing alternately down the stem. Ripe seed heads hang at about 45° if the stem is upright.

Description of propagules

Reproduces mainly by seed, and stolons, as the stems that make contact with the soil will form roots.

Control: Refer to NSW weedwise for current treatment recommendations. https://weeds.dpi.nsw.gov.au/

BSC Weed Profile Temple		
Common Name	Buffalo Grass	
Scientific Name	*Stenotaphrum secundatum (Walter) Kuntze*	
Indigenous Name		

Weed Significance			
Priority - Eradicate	WoNS	State/Regional Priority	GBD

Life Cycle		
Annual	Perennial	Semi-Annual

Plant Type				
Herbaceous	Shrub	Tree	Vine	Aquatic

Description of growing site

Widely naturalised. Because of its dense growth and long-lived mat habit it can readily smother other species. Tolerant of a wide range of climatic conditions. Extremely shade tolerant, grows on poor soils, salt and drought tolerant, intolerant of heavy frost. Extremely tolerant of defoliation and survives under low fertility.

Distinguishing Features

Coarse leaf (rough on edges & near top), light green, strongly keeled.

Stems low lying, green to red.

Inflorescence is a flat, fleshy, thickened axis 4-10 cm long which has small spikelets embedded along each edge

Description of propagules

Reproduction by stolons, occasionally seed. Dispersal by water, plantings (lawn), occasionally livestock (seed in dung), machinery, shoes, dumped vegetation/soil, soil movement.

Control: Refer to NSW weedwise for current treatment recommendations. https://weeds.dpi.nsw.gov.au/

BSC Weed Profile Temple					
Common Name	Carpet grass (narrow or broad leafed)	 			
Scientific Name	*Axonopus sp sp.*				
Indigenous Name					
Weed Significance					
Priority - Eradicate	WoNS	State/Regional Priority	GBD		
Life Cycle					
Annual	Perennial	Semi-Annual			
Plant Type					
Herbaceous	Shrub	Tree	Vine	Aquatic	

Description of growing site

Prefers moist shaded areas. Thrives on soils of low fertility.

Distinguishing Features

Forms a coarse-textured, fairly dense low-growing turf with a distinctive dark green colour.

Leaves are green & have a shiny, waxy appearance, with crinkles in them. Has hairs along the lower margins of the blade.

It is generally quite shallow rooted, and relatively intolerant of drought.

If it dries out during the dry season, and then when it rains or it is watered, the older leaves die and do not green up. This gives the lawn a half green – half dead appearance.

Description of propagules

The species spread by short underground rhizomes.

Control: Refer to NSW weedwise for current treatment recommendations. https://weeds.dpi.nsw.gov.au/

BSC Weed Profile Temple					
Common Name	Castor Oil Plant, African Coffee Bean, Castor Bean				
Scientific Name	*Ricinus communis*				
Indigenous Name					
Weed Significance					
Priority - Eradicate	WoNS	State/Regional Priority	GBD		
Life Cycle					
Annual	Perennial	Semi-Annual			
Plant Type					
Herbaceous	Shrub	Tree	Vine	Aquatic	

Description of growing site

A weed of creek banks (i.e. riparian areas), dry riverbeds, waterways, roadsides, railways, disturbed sites, pastures, gardens, neglected suburban areas and other waste areas in tropical, sub-tropical, temperate and sometimes also semi-arid environments.

Distinguishing Features

large shrub growing 3 m or more in height.

Stems thick, hollow, hairless. Bearing large leaves up to 70 cm across.

Leaves usually have 7-9 finger-like lobes and the leaf stalk is attached to their undersides.

Separate male and female flowers in elongated clusters (8-15 cm long), with the reddish female flowers on top and the yellowish male flowers below.

Fruit capsules (10-30 mm across) are greenish to bright red when young and covered in soft, blunt spines.

Description of propagules

Reproduces entirely by seed. The seeds are explosively released when the fruit are mature, thereby aiding their spread. They are also often dispersed by floodwaters and animals (e.g. rodents and birds). Humans also spread the seeds in dumped garden waste, mud, soil and on vehicles and machinery.

Control: Refer to NSW weedwise for current treatment recommendations. https://weeds.dpi.nsw.gov.au/

BSC Weed Profile Temple				
Common Name	Celery weed/ slim lobe celery			
Scientific Name	*Cyclospermum leptophllum*			
Indigenous Name				
Weed Significance				
Priority - Eradicate	WoNS	State/Regional Priority	GBD	
Life Cycle				
Annual	Perennial	Semi-Annual		
Plant Type				
Herbaceous	Shrub	Tree	Vine	Aquatic

Description of growing site

Streamsides, wastelands, rural areas.

Distinguishing Features

Winter annual weed with leaves that can be highly dissected and variable. Up to 50 cm. The basal leaves are often wider than the uppermost leaves which can be almost hair-like. It produces tiny white flowers in umbels and fruits that appear egg-shaped.

Tap root.

Member of parsley & celery family smalls like parsley.

Description of propagules

Reproduction is by seed.

Control: Refer to NSW weedwise for current treatment recommendations. https://weeds.dpi.nsw.gov.au/

BSC Weed Profile Temple				
Common Name	Cocos Palm			
Scientific Name	*Syragrus romanzoffiana*			
Indigenous Name				
Weed Significance				
Priority - Eradicate	WoNS	State/Regional Priority	GBD	
Life Cycle				
Annual	Perennial	Semi-Annual		
Plant Type				
Herbaceous	Shrub	Tree	Vine	Aquatic

Description of growing site

A weed of roadsides, disturbed sites, waste areas, watercourses (i.e. riparian areas) and urban bushland in sub-tropical and tropical regions.

Distinguishing Features

A large palm tree with a single trunk growing up to 20 m tall.

The trunk is smooth and grey, usually about 30 cm wide with widely spaced rings.

The massive leaves can reach up to 5 m in length on mature trees

Flowering occurs mostly during spring. Flower clusters are initially in two sprays, one of which is very large and becomes woody and boat-shaped with age. The flower clusters are up to 2 m long and contain numerous small yellowish or cream-coloured flowers. Separate male and female flowers are present in these clusters.

The fruit (2.5-3 cm long and 1-2 cm wide) are crowded into very large hanging clusters. These fruit are egg-shaped (and turn from green to yellow and then orange when fully mature. The have a hard woody center and fleshy outer parts.

Description of propagules

Reproduces by seed. These seeds are spread by bats and other animals that eat the fruit. They are also dispersed by water and in dumped garden waste.

Control:

Refer to NSW weedwise for current treatment recommendations. https://weeds.dpi.nsw.gov.au/

BSC Weed Profile Temple					
Common Name	Columbian waxweed				
Scientific Name	*Cuphea carthagenensis*				
Indigenous Name					
Weed Significance					
Priority - Eradicate	WoNS	State/Regional Priority	GBD		
Life Cycle					
Annual	Perennial	Semi-Annual			
Plant Type					
Herbaceous	Shrub	Tree	Vine	Aquatic	

Description of growing site

will quickly invade degraded pastures or areas of disturbance. Often the first sightings will be along drainage lines or around stock camps.

Distinguishing Features

upright plant that can reach 60cm tall, however most are below 40cm. The stems are green or red in color and are covered densely in sticky hairs. Leaves are small 5 – 25mm wide and 10 – 60mm long, oval shaped with pointed tips, they occur in pairs along the stems, and can appear on very small stalks or may seem stalk-less.

Flowers are a pinkish purple either singly or in small clusters at the leaf forks or tips of branches. The flowers have a green or reddish tube 4-7mm long at the base and are topped with 6 petals 1-2mm long.

https://www.lls.nsw.gov.au/__data/assets/pdf_file/0008/685385/Factsheet-Colombian-waxweed.pdf

Description of propagules

Seed is the only way Colombian waxweed reproduces. In low lying country seed is spread widely by flooding. Within a paddock or between paddocks livestock movement and machinery are the most common forms of transferring seed.

Colombian Waxweed also tolerates being cut short and usually develops a dense mat following slashing.

Control: Refer to NSW weedwise for current treatment recommendations. https://weeds.dpi.nsw.gov.au/

BSC Weed Profile Temple					
Common Name	Couch Grass				
Scientific Name	*Cynodon dactylon*				
Indigenous Name					
Weed Significance					
Priority - Eradicate	WoNS	State/Regional Priority	GBD		
Life Cycle					
Annual	Perennial	Semi-Annual			
Plant Type					
Herbaceous	Shrub	Tree	Vine	Aquatic	

Description of growing site

Documented as allelopathic, it is capable of reducing the germination and growth of other species. It is also adapted to survive extended dry periods and flooding due to a deep root system. Generally tolerant of low soil pH and high salt concentration, however is susceptible to cold temperatures. Growth slows in cold weather, in shade and/or dry soils. it easily invades adjacent bushland

Distinguishing Features

rhizomatous, prostrate perennial grass growing to about 0.3 m high.

Leaf blade is flattened with a sharp tip, and is hairy or glabrous (hairless). The leaf sheath is round and glabrous; the ligule (membranous small structure at the junction of the leaf sheath and leaf blade) has ring of hairs or a short membrane.

Flowers are produced on spikes in late spring and summer. The inflorescence consists of 3-7 slender spikes up to 60 mm long, arranged terminally on the axis. The spikelets are sessile (stalkless) and without an awn (slender bristle-like structure).

Description of propagules

It reproduces mainly by seeds, also, rhizomes and stolons.. The seedbank persists for 3-4 years. The long runners and the dumping of garden refuse also help to disperse this weed into native vegetation.

Control: Refer to NSW weedwise for current treatment recommendations. https://weeds.dpi.nsw.gov.au/

BSC Weed Profile Temple				
Common Name	Cranes bill sp			
Scientific Name	*Geranium sp. eg mole, solanderi*			
Indigenous Name				
Weed Significance				
Priority - Eradicate	WoNS	State/Regional Priority	GBD	
Life Cycle				
Annual	Perennial	Semi-Annual		
Plant Type				
Herbaceous	Shrub	Tree	Vine	Aquatic

Description of growing site

Weed of gardens, streams, roadsides, pastures, disturbed areas and occasionally in crops. Prefers moist soils and swampy areas. *G solanderi* is native.

Distinguishing Features

Spreading herb that may grow upward. Flowers are usually pale pink color and sometimes white.

The leaves on the flowering stems are opposite and *palmatisect* (leaf cut into lobes to up to more than halfway in a palmate form.

The flowers are paired (rarely solitary)

Has taproot.

Description of propagules

Flowers Sept – Jan. Reproduction is by seed.

Control: Refer to NSW weedwise for current treatment recommendations. https://weeds.dpi.nsw.gov.au/

BSC Weed Profile Temple				
Common Name	Creeping oxalis/ yellow wood sorrel			
Scientific Name	*Oxalis corniculata*			
Indigenous Name				
Weed Significance				
Priority - Eradicate	WoNS	State/Regional Priority	GBD	
Life Cycle				
Annual	Perennial	Semi-Annual		
Plant Type				
Herbaceous	Shrub	Tree	Vine	Aquatic

Description of growing site

A weed of disturbed sites, footpaths, parks, gardens, roadsides, waste areas, wetlands, watercourses (i.e. riparian habitats), open woodlands, closed forests and pastures.

Distinguishing Features

Prostrate (creeping) growth habit. Branches sparsely hairy.

Light green heart shaped leaves in 3's – similar to clover.

Flowers small bright yellow with 5 petals, most of the year but particularly in spring.

Seeds cylindrical with beaks

Redish stems can form roots at nodes. Roots fiberous and branching, sometimes with a tap root

Description of propagules

Reproductions is by large quantities of seed. When seed pods mature they dry out and explode, causing the seed to spread.

Control: Refer to NSW weedwise for current treatment recommendations. https://weeds.dpi.nsw.gov.au/

BSC Weed Profile Temple					
Common Name	Creeping Phylanthus,				
Scientific Name	*Phyllanthus virgatus*				
Indigenous Name	native				
Weed Significance					
Priority - Eradicate	WoNS	State/Regional Priority	GBD		
Life Cycle					
Annual	Perennial	Semi-Annual			
Plant Type					
Herbaceous	Shrub	Tree	Vine	Aquatic	

Description of growing site

A weed of lawns, gardens, footpaths, parks, roadsides, disturbed sites, waste areas, pastures and crops. It grows naturally in grasslands and open woodlands.

Distinguishing Features

Creeping or spreading stems 3-20 cm tall, but occasionally with upright (i.e. erect) stems growing up to 50 cm in height.The main stem is usually much-branched near its base and the branches are hairless. It has small scales and the secondary stems contain the flowers and leaves.

Leaves are alternately arranged, on very short stalks. Leaves are oval 5-20 mm long and 1.5-5 mm wide or slightly elongated in shape with entire margins. They are hairless, with bright green upper surfaces and paler green undersides. Flowers are inconspicuous, greenish-coloured with six tiny 'petals' about 1 mm long and are borne on stalks protruding from the leaf forks. Separate male and female flowers are borne on separate parts of the same plant.

Fruit is small & rounded (1.5-2.5 mm across) with three compartments, each containing a single seed (0.8-1.5 mm long). .Fruit are round green on long stalks.

Description of propagules

Reproduces by seed.

Control:

Refer to NSW weedwise for current treatment recommendations. https://weeds.dpi.nsw.gov.au/

BSC Weed Profile Temple					
Common Name	Crowsfoot grass , goosegrass				
Scientific Name	*Axonopus sp sp.*				
Indigenous Name					
Weed Significance					
Priority - Eradicate	WoNS	State/Regional Priority	GBD		
Life Cycle					
Annual	Perennial	Semi-Annual			
Plant Type					
Herbaceous	Shrub	Tree	Vine	Aquatic	

Description of growing site

A common weed of lawns, gardens, parks, footpaths, disturbed sites, waste areas, pastures, crops and orchards. It is sometimes also a weed of wetlands, riparian vegetation and coastal environs.

Distinguishing Features

Spreading or semi-upright stems growing up to 60 cm tall.

Leaf sheaths are prominently keeled and there is a membranous structure (0.5-1 mm long) at the base of the leaf blade. Its narrow leaf blades (3-35 cm long and 3-8 mm wide) are mostly hairless.

Seed-heads have 1-15 branches (3.5-15.5 cm long) that radiate outwards from the same point. Numerous flower spikelets (3.5-7 mm long) are densely arranged along these seed-head branches.

Description of propagules

This species reproduces by seed, which may be spread by water, animals or in contaminated soil and agricultural produce.

Control: Refer to NSW weedwise for current treatment recommendations.

BSC Weed Profile Temple					
Common Name	Cudweed	 			
Scientific Name	*Gamochaeta spp, Pseudognaphalium luteoalbum, Euchiton sphaericus*				
Indigenous Name					
Weed Significance					
Priority - Eradicate	WoNS	State/Regional Priority	GBD		
Life Cycle					
Annual	Perennial	Semi-Annual			
Plant Type					
Herbaceous	Shrub	Tree	Vine	Aquatic	

Description of growing site

It normally prefers freshwater areas, such as common lawn or sports turf, garden beds, but will sometimes grow on the edge of saltwater areas or swamps and disturbed areas.

Distinguishing Features

One to many basal rosettes with leaves and seedheads that are covered in distinct fine, white “woolly” fibres. The flower heads are small and each head contains many tiny flowers (Asteraceae (Daisy) family) that may be white, pink or purple..

Most Cudweed species are a glossy light green on top and have a white furry underside. Silky Cudweed can usually be distinguished by its long thin (sometimes spatulate shaped) leaves with pale green coloration on both surfaces. It has a much-branched growth habit, diffuse, pale inflorescences.

G.americanum is very woolly with hair leaves, whiles G. coarctatum has virtually no hairs on the upper surface of the leaf. Fibrous roots.

Description of propagules

Flowers October – January. Regeneration by seeds.

Control: Refer to NSW weedwise for current treatment recommendations. https://weeds.dpi.nsw.gov.au/

BSC Weed Profile Temple				
Common Name	Cyperus sedge			
Scientific Name	*Cyperus sp*			
Indigenous Name				
Weed Significance				
Priority - Eradicate	WoNS	State/Regional Priority	GBD	
Life Cycle				
Annual	Perennial	Semi-Annual		
Plant Type				
Herbaceous	Shrub	Tree	Vine	Aquatic
Description of growing site				
Some native others weedy species. Grows in gardens, parks, disturbed sites, waste areas and damp environments.				
Distinguishing Features				
rhizomatous perennial herb grass-like sedge. Leaves sometimes reduced to sheaths				
Description of propagules				
May be rhizomatous. Seeds				
Control: Refer to NSW weedwise for current treatment recommendations. https://weeds.dpi.nsw.gov.au/				

BSC Weed Profile Temple		
Common Name	Dandelion	
Scientific Name	*Taraxacum officinale*	
Indigenous Name		

Weed Significance			
Priority - Eradicate	WoNS	State/Regional Priority	GBD

Life Cycle		
Annual	Perennial	Semi-Annual

Plant Type				
Herbaceous	Shrub	Tree	Vine	Aquatic

Description of growing site

Road side, wasteland, lawns, pasture

Distinguishing Features

Leaves in a rosette, Margins toothed – 5-40 cm long, 1-10 cm wide

Flower stem hollow, 5–40 cm high.

Golden Yellow flowers

Description of propagules

Airborne seeds on white papus.

Control: Refer to NSW weedwise for current treatment recommendations. https://weeds.dpi.nsw.gov.au/

BSC Weed Profile Temple					
Common Name	Dock sp				
Scientific Name	*Rumex sp*				
Indigenous Name					
Weed Significance					
Priority - Eradicate	WoNS	State/Regional Priority	GBD		
Life Cycle					
Annual	Perennial	Semi-Annual			
Plant Type					
Herbaceous	Shrub	Tree	Vine	Aquatic	
Description of growing site					
Often found in moist to wet ground with poor drainage and at least intermittent waterlogging. Freshwater swamps and marshes are common habitats. However the exotic species, will grow readily in seasonally wet depressions, waste lands, roadsides and cultivated ground.					
Distinguishing Features					
Basal rosette of leaves. Leaves hairless. Erect branching flower stems. Flowers clustered on spikes. Thick tap root.					
Description of propagules					
Fruit is a triangular nut enclosed in the persistent valves around the stem.					
Control: Refer to NSW weedwise for current treatment recommendations. https://weeds.dpi.nsw.gov.au/					

BSC Weed Profile Temple					
Common Name	Flatweed/False dandelion/ cats ears				
Scientific Name	*Hypochaeris radicata*				
Indigenous Name					
Weed Significance					
Priority - Eradicate	WoNS	State/Regional Priority	GBD		
Life Cycle					
Annual	Perennial	Semi-Annual			
Plant Type					
Herbaceous	Shrub	Tree	Vine	Aquatic	

Description of growing site

Disturbed soils, waste areas, pastures and lawns. Particularly in wetter environments, invading native vegetation as well as disturbed areas. Appears to have some tolerance to salinity as it occurs on heavier ground around the edges of saline lakes and swamps.

Distinguishing Features

Herb to 80cm tall.

Commonly mistaken for the common dandelion as it has multiple basally clustered leaves that are irregular in shape with multiple lobes. The leaves can be up to 12 inches in length and are hairy.

Unlike the dandelion, Flatweed has multiple branching flowers stems up to 18-24 inches in height, each with a single flower. Flower-heads are 20-30 mm across on leafless and slightly scaly stems.

Description of propagules

Seeds are tipped with a circle of bristles that aid in wind distribution.

Control: Refer to NSW weedwise for current treatment recommendations. https://weeds.dpi.nsw.gov.au/

BSC Weed Profile Temple					
Common Name	Fleabane, asthma weed, flaxleaf fleabane, Conxya, horseweed.				
Scientific Name	*Conyza bonariensis*				
Indigenous Name					
Weed Significance					
Priority - Eradicate	WoNS	State/Regional Priority	GBD		
Life Cycle					
Annual	Perennial	Semi-Annual			
Plant Type					
Herbaceous	Shrub	Tree	Vine	Aquatic	

Description of growing site

A very common weed of crops, fallows, pastures, roadsides, disturbed sites, waste areas, gardens, lawns, footpaths, parks, coastal environs, riparian vegetation, forest and wetland margins, and disturbed woodlands.

Distinguishing Features

Develops a basal rosette of leaves at first.

Stems are upright & densely hairy and usually grow up to 1 m tall.

Lower leaves (4-10 cm long) are elongated in shape with bluntly toothed to deeply lobed margins. Its smaller upper leaves are usually long and narrow with finely toothed or entire margins.

Flower-heads are small (6-12 mm across) do not have any obvious 'petals' and turn whitish and fluffy as they mature. Its small 'seeds' (1.5-2 mm long) are topped with a tuft of whitish-coloured hairs about 3 mm long.

Description of propagules

Reproduces only by seed, which are easily blown and dispersed by the wind. Seeds may also be spread by machinery, water, vehicles, animals, and in clothing and contaminated agricultural produce.

Control: Refer to NSW weedwise for current treatment recommendations. https://weeds.dpi.nsw.gov.au/

BSC Weed Profile Temple					
Common Name	Giant paspalum				
Scientific Name	*Paspalum urvillei*				
Indigenous Name					
Weed Significance					
Priority - Eradicate	WoNS	State/Regional Priority	GBD		
Life Cycle					
Annual	Perennial	Semi-Annual			
Plant Type					
Herbaceous	Shrub	Tree	Vine	Aquatic	

Description of growing site

weed of disturbed sites, footpaths, parks, gardens, roadsides, waste areas, wetlands, watercourses (i.e. riparian habitats), open woodlands, closed forests and pastures.

Distinguishing Features

Tufted grass growing up to 1-2.5 m tall.

Leaf blades (10-50 cm long and 3-15 mm wide), narrowed at the base and mostly hairless.

Seed-heads usually have 6-20 branches ranging from 5-15 cm long. Its flower spikelets are arranged in pairs along the seed-head branches so that they appear to have four rows of seeds. These flower spikelets (2-3 mm long) are fringed with long silky hairs.

Description of propagules

Reproduces mainly by seed, which are dispersed by wind, water, animals, vehicles, machinery, and in contaminated soil and agricultural produce.

Control: Refer to NSW weedwise for current treatment recommendations. https://weeds.dpi.nsw.gov.au/

BSC Weed Profile Temple					
Common Name	khaki weed, Khaki burr, creeping chaff weed				
Scientific Name	*Alternanthera pungens*				
Indigenous Name					
Weed Significance					
Priority - Eradicate	WoNS	State/Regional Priority	GBD		
Life Cycle					
Annual	Perennial	Semi-Annual			
Plant Type					
Herbaceous	Shrub	Tree	Vine	Aquatic	

Description of growing site

Widely distributed throughout all the mainland states and territories of Australia, where it grows in all but the driest environments, but is predominantly found in and around towns.

It is a weed of disturbed sites, bare areas, roadsides, parks, lawns, waste areas, watercourses, turfgrasses, orchards, and occasionally also native pastures and grasslands.

Distinguishing Features

Low-growing plant that forms a dense mat over the ground surface. Its creeping stems are somewhat hairy and produce roots at their joints. Its paired leaves usually differ in size (i.e. one leaf of the pair is significantly larger than its partner). Its greenish or greenish-yellow flowers are grouped together in small clusters (8-12 mm long) in the leaf forks. Some of the flower parts become hardened and form sharp prickles as they mature.

Description of propagules

This plant reproduces mainly by seed, though stem fragments may also take root after being dislodged from a plant.The seeds are contained inside a 'burr' which readily becomes attached to animals, clothing and other objects (e.g. vehicle tyres). They may also be dispersed by water movement and in contaminated agricultural produce (e.g. fodder and pasture seed). Stem fragments can be spread by machinery, livestock or cultivation.

Control: Refer to NSW weedwise for current treatment recommendations. https://weeds.dpi.nsw.gov.au/

BSC Weed Profile Temple		
Common Name	Kykuyu	
Scientific Name	*Pennisetum clandestinum*	
Indigenous Name		

Weed Significance			
Priority - Eradicate	WoNS	State/Regional Priority	GBD

Life Cycle		
Annual	Perennial	Semi-Annual

Plant Type				
Herbaceous	Shrub	Tree	Vine	Aquatic

Description of growing site

Widespread on fertile well drained soils.

Distinguishing Features

Mat Grass to 40 cm tall – will run

Leaf sheaths hairy - leaves hairless

Flowerheads hidden inside upper leaf sheaths.

Description of propagules

Flowers spring to Autumn – flowers seen as white threads.

Control: Refer to NSW weedwise for current treatment recommendations. https://weeds.dpi.nsw.gov.au/

BSC Weed Profile Temple		
Common Name	Milk Thistle/ Milk weed/Sow Thistle	
Scientific Name	*Sonchus oleraceus*	
Indigenous Name		

Weed Significance			
Priority - Eradicate	WoNS	State/Regional Priority	GBD

Life Cycle		
Annual	Perennial	Semi-Annual

Plant Type				
Herbaceous	Shrub	Tree	Vine	Aquatic

Description of growing site

Road side, wasteland, lawns, pasture, swamps, lake edges & dunes.

Distinguishing Features

Leaves in a basal rosette, and leaves along the stem. Leaf margins lobed & irregularly toothed, up to 35cm long & 12cm wide, hairless

Stem and main veins are dark green-purple.

Golden Yellow flowers. Open only in the mornings

Description of propagules

One seeded fruit.

Control: Refer to NSW weedwise for current treatment recommendations. https://weeds.dpi.nsw.gov.au/

BSC Weed Profile Temple					
Common Name	Nut grass				
Scientific Name	*Bromus catharticus*				
Indigenous Name					
Weed Significance					
Priority - Eradicate	WoNS	State/Regional Priority	GBD		
Life Cycle					
Annual	Perennial	Semi-Annual			
Plant Type					
Herbaceous	Shrub	Tree	Vine	Aquatic	

Description of growing site

A very troublesome weed of crops, orchards, vineyards, fallows, lawns, footpaths, gardens, parks, pastures, waste areas and disturbed sites.

Distinguishing Features

Grass-like plant usually growing 20-50 cm tall. It produces a network of creeping underground stems with small tubers (10-25 mm long).

Its upright flowering stems are smooth and three-angled in cross-section its very narrow leaves (7.5-20 cm long and 2-6 mm wide) are borne in a tuft at the base of the stems.

Seed-heads have 3-8 branches of varying in length (up to 10 cm long). These branches bear several elongated reddish-brown or purplish-brown flower spikelets (10-25 mm long and 2-2.5 mm wide).

Description of propagules

This species reproduces vegetatively via its creeping underground stems (i.e. rhizomes) and tubers. The rhizomes spread laterally and can eventually form large colonies. The tubers are also dispersed during cultivation and in contaminated soil.

Control: Refer to NSW weedwise for current treatment recommendations. https://weeds.dpi.nsw.gov.au/

BSC Weed Profile Temple					
Common Name	Paddys lucern				
Scientific Name	Sida rhombifolia				
Indigenous Name					
Weed Significance					
Priority - Eradicate	WoNS	State/Regional Priority	GBD		
Life Cycle					
Annual	Perennial	Semi-Annual			
Plant Type					
Herbaceous	Shrub	Tree	Vine	Aquatic	
Description of growing site					
Weed usually confined to waste ground, such as roadsides and rocky areas, stock camps or rabbit warrens, but can be competitive in pasture, due to its unpalatability to livestock.					
Distinguishing Features					
Erect shrub to 1-1.5 m tall. Leaves are a dull green color and diamond-shaped, 2–5 cm in length. Hairy. Flowers occur singly in the axils of leaves. They are yellow and about 1 cm across. Small fruit that is 30–40 mm long. When the fruit matures it separates into eight to 12 one-seeded segments.					
Description of propagules					
Reproduces mainly by seed.					
Control: Refer to NSW weedwise for current treatment recommendations. https://weeds.dpi.nsw.gov.au/					

BSC Weed Profile Temple					
Common Name	Palm Grass/ pleated pigeon grass	 			
Scientific Name	*Setaria palmifolia*				
Indigenous Name					
Weed Significance					
Priority - Eradicate	WoNS	State/Regional Priority	GBD		
Life Cycle					
Annual	Perennial	Semi-Annual			
Plant Type					
Herbaceous	Shrub	Tree	Vine	Aquatic	

Description of growing site

Disturbed and open forest, shrubland, bare land, semi-epiphyte niches and tree roots, mainly in low-frost areas.

Tolerates full sun to moderate shade, heavy to light soils, damage, hot to moderately cool temperatures, wind, salt, occasionally submersion, wet or dry spots, and is drought-tolerant when established. It is occasionally an annual in cold areas, where it is checked by heavy frost, but mature plants are cold resistant.

Distinguishing Features

to 1.5 m high with wide leaf blades. hanging palm-like leaves (30-100 x 5-8 cm) are pleated and taper to a point. Narrow, seedheads (20-30 cm) with fuzzy, foxtail-like tips on long arching stems (Dec-Mar).

has hairy stems, which can cause irritation

dense root mass and tough rhizomes with rounded stems

Description of propagules

Spreads by rhizomes and seed, occasionally aided by water movement. Slower spread occurs from gardens and through dumped garden waste.

Control: Refer to NSW weedwise for current treatment recommendations. https://weeds.dpi.nsw.gov.au/

BSC Weed Profile Temple					
Common Name	Common paspalum				
Scientific Name	*Paspalum dilatatum*				
Indigenous Name					
Weed Significance					
Priority - Eradicate	WoNS	State/Regional Priority	GBD		
Life Cycle					
Annual	Perennial	Semi-Annual			
Plant Type					
Herbaceous	Shrub	Tree	Vine	Aquatic	

Description of growing site

A common weed of gardens, lawns, pastures and disturbed areas, wherever bare ground and moisture are available. Tends to invade ryegrass, clover pastures. It can also survive with kikuyu. Can be a major weed of turf but cannot be removed from kikuyu.

Distinguishing Features

tufted grass growing up to 1-1.5 m tall.

Its leaf blades are slightly folded at the base and are usually hairless. Its seed-heads are borne at the tips of the upright flowering stems these seed-heads have 2-11 branches (2.5-11 cm long) that are alternatively arranged along a main stalk each seed-head branch bears numerous small flower spikelets that are covered with hairs.

Description of propagules

This species reproduces mainly by seed, which are dispersed by wind, water, animals, vehicles, machinery, and in contaminated soil and agricultural produce.

Control: Refer to NSW weedwise for current treatment recommendations. https://weeds.dpi.nsw.gov.au/

BSC Weed Profile Temple					
Common Name	Pennywort				
Scientific Name	*Hydrocotyle acutiloba*				
Indigenous Name					
Weed Significance					
Priority - Eradicate	WoNS	State/Regional Priority	GBD		
Life Cycle					
Annual	Perennial	Semi-Annual			
Plant Type					
Herbaceous	Shrub	Tree	Vine	Aquatic	

Description of growing site

Grows naturally in wetlands, swamps, riparian vegetation and the margins of wetter forests. It is also a weed of gardens, footpaths, lawns and other turfed areas.

Distinguishing Features

Herbaceous plant with creeping stems.

stems are slender hairy and take root at the joints.

Leaves are small (1.2-3 cm across) on stalks 1-10 cm long and have three to seven toothed lobes.

Flowers are densely arranged in small clusters on stalks about 1.5 cm long.

Fruit small rounded about 1 mm across and split in two when mature.

Description of propagules

Reproduces vegetatively via runners (i.e. stolons) and also via seed.Stem fragments (i.e. stolons) and seeds are dispersed by water movement and in mud attached to animals, boats and vehicles.

Control:

Refer to NSW weedwise for current treatment recommendations. https://weeds.dpi.nsw.gov.au/

BSC Weed Profile Temple					
Common Name	Petty Spurge/ Radium weed/ cancer weed				
Scientific Name	*Euphorbia peplus*				
Indigenous Name					
Weed Significance					
Priority - Eradicate	WoNS	State/Regional Priority	GBD		
Life Cycle					
Annual	Perennial	Semi-Annual			
Plant Type					
Herbaceous	Shrub	Tree	Vine	Aquatic	

Description of growing site

A weed of gardens, footpaths, lawns, parks, roadsides, disturbed sites and waste areas. It prefers moist, shady locations, but will grow and spread in most disturbed areas.

Distinguishing Features

Growing to about 30-40cm. It is a small, branched, upright plant with pale green foliage and stems.

Petty Spurge produces distinctive bracts (modified leaves) below small, pale green flowers.

It contains natural insecticides, but the sap is poisonous and an irritant.

Description of propagules

plants are prolific seed producers and emerge beginning in the cool weather of fall and continue through late spring.

Seed has elaiosomes (fleshy appendages) allowing them to be dispersed by ants. Reproduction is by seed that is dispersed by ants, water and soil movement.

Control: Refer to NSW weedwise for current treatment recommendations. https://weeds.dpi.nsw.gov.au/

BSC Weed Profile Temple		
Common Name	Long Stalked Phylanthus, Mascarene Island Leaf flower	
Scientific Name	*Phylanthus tenellus*	
Indigenous Name		

Weed Significance			
Priority - Eradicate	WoNS	State/Regional Priority	GBD

Life Cycle		
Annual	Perennial	Semi-Annual

Plant Type				
Herbaceous	Shrub	Tree	Vine	Aquatic

Description of growing site

Occurs in disturbed areas, greenhouses, turf areas, landscape beds, and nursery containers. It is found most often in sunny locations that are irrigated or remain moist. Once established, long-stalked phyllanthus can become more drought tolerant and survive in drier locations.

Distinguishing Features

Herbaceous or woody depending on age. Upright with a single stem growing up to 70cm tall but usually 10-30 cm.

The main stem has small scales and the secondary stems contain the flowers and leaves. Flowers mainly in summer. Flowers are inconspicuous star shaped about 2mm wide found in the leaf axils.

Fruit are round green on long stalks.

Description of propagules

Reproduces by seed. Fruits are explosively dehiscent and expel seeds over 3 feet when ripe.

Control:

Refer to NSW weedwise for current treatment recommendations. https://weeds.dpi.nsw.gov.au/

BSC Weed Profile Temple				
Common Name	Lambs tongue/ Plantago/ Narrow leaf plantain/ Ribwort			
Scientific Name	*Plantago lancolata*			
Indigenous Name				
Weed Significance				
Priority - Eradicate	WoNS	State/Regional Priority	GBD	
Life Cycle				
Annual	Perennial	Semi-Annual		
Plant Type				
Herbaceous	Shrub	Tree	Vine	Aquatic
Description of growing site				
Common weed of turf, lawns, gardens and wasteland. Low fertility, drought and acid tolerant.				
Distinguishing Features				
Rosette forming leaves. Leaves with distinct ribs, hairy & narrow. White flowers with seed head at end of stork Persistent tap root.				
Description of propagules				
dense, brown, cylindrical seed heads that often have white anthers sticking out of them				
Control: Refer to NSW weedwise for current treatment recommendations. https://weeds.dpi.nsw.gov.au/				

BSC Weed Profile Temple		
Common Name	Prairie Grass, Brome grass, Rescue Grass	
Scientific Name	*Bromus catharticus*	
Indigenous Name		

Weed Significance			
Priority - Eradicate	WoNS	State/Regional Priority	GBD

Life Cycle		
Annual	Perennial	Semi-Annual

Plant Type				
Herbaceous	Shrub	Tree	Vine	Aquatic

Description of growing site

Weed of roadsides, rotation crops, perennial crops, grasslands, disturbed areas, orchards and gardens. Prefers shady situations.

Distinguishing Features

A luxuriant annual or perennial grass with almost hairless leaves and an open, drooping seed heads and very flattened, awnless spikelets.

Leaf Blade - Parallel sided to the middle then tapers to a fine point. 50-420 mm long by 2-12 mm wide. Hairless or sparsely hairy on the upper surface only or young leaves may be covered in short hairs. Rough to touch especially on the upper side, edges and ribs. Flat.

Description of propagules

This species reproduces by seed. Grows rapidly during the winter to spring period.

Control: Refer to NSW weedwise for current treatment recommendations. https://weeds.dpi.nsw.gov.au/

BSC Weed Profile Temple					
Common Name	Purpletop				
Scientific Name	*Verbena sp.*				
Indigenous Name					
Weed Significance					
Priority - Eradicate	WoNS	State/Regional Priority	GBD		
Life Cycle					
Annual	Perennial	Semi-Annual			
Plant Type					
Herbaceous	Shrub	Tree	Vine	Aquatic	

Description of growing site

A common weed of roadsides, pastures, grasslands, open woodlands, riparian vegetation, crops, orchards, gardens, disturbed sites and waste areas.

Distinguishing Features

Stems are square in cross-section (quadrangular) and roughly hairy and sometimes develops a slightly woody base.

Leaves are opposite and are stalkless with bases that slightly clasp the branches. They have elongated (lanceolate), narrowly oval (elliptic) or oblong blades (4-22 cm long and 6-70 mm wide) with pointed tips. Their margins are irregularly toothed, particularly towards the tip of the leaf blade. The upper surfaces of the leaves, are coarsely hairy and rough to touch, while their undersides are densely softly hairy.

Flowers are numerous, small & tubular. Densely arranged into branched, finger-like, clusters at tips of the stems. Each flower has five small sepals (2.5-3.5 mm long) that are fused together at the base into a tube (calyx tube). The five bluish, purple or lavender-pink petals are also fused together into a tube about twice as long as the sepals (6-7 mm long), but their tips are separated into five spreading petal lobes (about 2 mm long). Flowering occurs mainly during the rainy seasons. The small fruit separate into four brown 'seeds' when mature. These 'seeds' (1.5-1.8 mm long) and are elongated in shape.

Description of propagules

Reproduces mainly by seed and self-seeds readily. The seeds may be dispersed by animals, wind, or in water including storm water in urban areas. They may also be spread in contaminated agricultural produce and farm implements. It has a long-lived seedbank.

Control: Refer to NSW weedwise for current treatment recommendations. https://weeds.dpi.nsw.gov.au/

BSC Weed Profile Temple		
Common Name	Ragweed/ Ambrosia/ Annual ragweed	
Scientific Name	*Ambrosia artemisiifolia*	
Indigenous Name		

Weed Significance			
Priority - Eradicate	WoNS	State/Regional Priority	GBD

Life Cycle		
Annual	Perennial	Semi-Annual

Plant Type				
Herbaceous	Shrub	Tree	Vine	Aquatic

Description of growing site

common weed of pastures, open woodlands, roadsides, disturbed sites, waste areas, creek banks and riparian vegetation, and is occasionally also found growing in cultivation.

Distinguishing Features

Upright to 2 m tall.

Forms a basal rosette of leaves during the early stages of growth. Its rounded stems bear deeply divided leaves that are fern-like in appearance.

Separate male and female flower-heads are formed on the same plant. The drooping male flower-heads are borne in elongated spike-like clusters (up to 20 cm long) at the tips of the branches. The inconspicuous female flower-heads are borne in the upper leaf forks.

Description of propagules

reproduces mainly by seeds. The seeds are spread by animals, water, the movement of soil, and in contaminated agricultural produce (e.g. fodder and pasture seed).

Control: Refer to NSW weedwise for current treatment recommendations. https://weeds.dpi.nsw.gov.au/

BSC Weed Profile Temple					
Common Name	Rats tail/African Paramatta grass				
Scientific Name	*Sporobolus africanus*				
Indigenous Name					
Weed Significance					
Priority - Eradicate	WoNS	State/Regional Priority	GBD		
Life Cycle					
Annual	Perennial	Semi-Annual			
Plant Type					
Herbaceous	Shrub	Tree	Vine	Aquatic	

Description of growing site

Widespread along roadsides & in disturbed or degraded areas.

Distinguishing Features

Erect tufted (tussock) grass to 40-90cm tall

Hairless except leaves hard to break. Bases flattened.

Flowerheads very thin and elongated in appearance 10-18cm long, branches pressed against stem. Flowers summer – autumn.

Description of propagules

This species produces large quantities of tiny seeds. Seeds are sticky when wet and readily become attached to animals, clothing and vehicles. They may also be dispersed by water, in mud, and in contaminated agricultural produce. Very light, wind dispersed seeds, or bird dispersed seeds, or has edible fruit that is readily eaten by highly mobile animals

Propagules viable for 3–10 years

Control: Refer to NSW weedwise for current treatment recommendations. https://weeds.dpi.nsw.gov.au/

BSC Weed Profile Temple					
Common Name	Rhodes Grass				
Scientific Name	*Chloris gayana*				
Indigenous Name					
Weed Significance					
Priority - Eradicate	WoNS	State/Regional Priority	GBD		
Life Cycle					
Annual	Perennial	Semi-Annual			
Plant Type					
Herbaceous	Shrub	Tree	Vine	Aquatic	

Description of growing site

A weed of roadsides, railways, disturbed sites, parks, gardens, footpaths, orchards, vineyards, cultivation (e.g. plantation crops, cotton, sown pastures and summer crops), grasslands, open woodlands, floodplains and waterways (i.e. riparian areas)

Distinguishing Features

Large grass with upright flowering stems (up to 1.5 m tall) as well as creeping stems.

Leaves very elongated (8-28 cm long and 2-10 mm wide) are mostly hairless.

Greenish-brown seed-heads are borne at the tops of the stems. Each seed-head has several branches (5-10 cm long) that radiate from the same point. The branches have numerous flower spikelets, which leave two small bracts behind when they fall off.

Description of propagules

This species reproduces by seed and also vegetatively via its creeping stems (i.e. stolons). The seeds may be spread by wind and water, and may also become attached to clothing, animals, vehicles and machinery. They may also be spread by slashers, graders, and in contaminated agricultural produce (e.g. pasture seed). Plants can spread laterally and colonise nearby areas via their creeping stems (i.e. stolons). It is also deliberately spread as a pasture grass and planted on road margins as a soil stabiliser.

Control: Refer to NSW weedwise for current treatment recommendations. https://weeds.dpi.nsw.gov.au/

BSC Weed Profile Temple				
Common Name	Scarlet Pimpernel			
Scientific Name	*Anagallis arvensis*			
Indigenous Name				
Weed Significance				
Priority - Eradicate	WoNS	State/Regional Priority	GBD	
Life Cycle				
Annual	Perennial	Semi-Annual		
Plant Type				
Herbaceous	Shrub	Tree	Vine	Aquatic

Description of growing site

Commonly found on bare ground. It can quickly colonise any bare areas of soil.

Distinguishing Features

A sprawling plant growing up to 600 mm wide, and 200 mm high.

Stems are square in cross section.

Leaves are paired, the pairs being at right angles to each other. The first leaves are 5 to 10 mm long, hairless, and initially sessile though as they age a short petiole develops. There are usually black spots present on the under surface of the early leaves.

Flower has 5 petals and is usually bright orange in colour, although occasionally it is deep blue to purple.

Description of propagules

Seed falls from the parent plant and may be moved short distances by wind and water, and with any soil movement. Seed germinates from spring through to autumn.

Control: Refer to NSW weedwise for current treatment recommendations. https://weeds.dpi.nsw.gov.au/

BSC Weed Profile Temple				
Common Name	Sheep Sorrel			
Scientific Name	*Acetosella vulgaris*			
Indigenous Name				
Weed Significance				
Priority - Eradicate	WoNS	State/Regional Priority	GBD	
Life Cycle				
Annual	Perennial	Semi-Annual		
Plant Type				
Herbaceous	Shrub	Tree	Vine	Aquatic

Description of growing site

weed of crops, pastures, gardens, footpaths, roadsides, coastal areas, wetlands, heathlands, grasslands, open woodlands and alpine areas.

Distinguishing Features

a small clump-forming herbaceous plant with an extensive underground root system.

its stalked leaves are distinctively arrowhead-shaped, with two basal lobes.

its tiny green or reddish flowers are borne in branched clusters at the top of upright flowering stems.

separate male and female flowers are borne on separate plants.

its tiny fruit (1-1.5 mm long) are three-sided and remain hidden inside the remains of the flowers.

Description of propagules

reproduces by seed and vegetatively via its creeping underground stems (i.e. rhizomes).

Control: Refer to NSW weedwise for current treatment recommendations. https://weeds.dpi.nsw.gov.au/

BSC Weed Profile Temple					
Common Name	Spotted Spurge/ caustic weed				
Scientific Name	*Chamaesyce maculata*				
Indigenous Name					
Weed Significance					
Priority - Eradicate	WoNS	State/Regional Priority	GBD		
Life Cycle					
Annual	Perennial	Semi-Annual			
Plant Type					
Herbaceous	Shrub	Tree	Vine	Aquatic	

Description of growing site

A weed of gardens, footpaths, lawns, parks, roadsides, disturbed sites and waste areas.

Distinguishing Features

A small, short-lived (i.e. annual) herbaceous plant with several creeping (i.e. prostate) to semi-upright (i.e. ascending) stems growing up to 30 cm long. Plants may form a dense mat of vegetation over the soil surface or grow 10-17 cm tall.

Stems are often reddish in colour and are covered in small, soft hairs (i.e. they are villous). The stems and leaves contain a milky sap (i.e. latex). The leaves are paired and borne on very short stalks

Description of propagules

This species reproduces only by seed, which are dispersed by wind, water, vehicles, in soil and in contaminated agricultural produce.

Control: Refer to NSW weedwise for current treatment recommendations. https://weeds.dpi.nsw.gov.au/

BSC Weed Profile Temple		
Common Name	Trad	
Scientific Name	Tradescantia fluminensis (albiflora)	
Indigenous Name		

Weed Significance			
Priority - Eradicate	WoNS	State/Regional Priority	GBD

Life Cycle		
Annual	Perennial	Semi-Annual

Plant Type				
Herbaceous	Shrub	Tree	Vine	Aquatic

Description of growing site

A weed of forests, forest margins, urban bushland, open woodlands, riparian vegetation, roadsides, ditches, waste areas, disturbed sites and gardens. It prefers damp and shaded areas

Distinguishing Features

Spreading fleshy leafed plant with leaves culminating in a point.

The white flowers (about 2 cm across) are borne in small clusters near the tips of the branches.

Stems are somewhat fleshy (i.e. semi-succulent) in nature, branched, and produce roots (i.e. adventitious roots) at each of the swollen joints (i.e. nodes). The glossy leaves are alternately arranged and their bases form short sheaths (5-10 mm long)

Can cause skin irritation in humans and dogs.

Description of propagules

Easily grows from vegetive fragments, garden waste

Control: Refer to NSW weedwise for current treatment recommendations. https://weeds.dpi.nsw.gov.au/

BSC Weed Profile Temple				
Common Name	White Clover			
Scientific Name	*Trifolium repens*			
Indigenous Name				
Weed Significance				
Priority - Eradicate	WoNS	State/Regional Priority	GBD	
Life Cycle				
	Perennial	Semi-Annual		
Plant Type				
Herbaceous	Shrub	Tree	Vine	Aquatic

Description of growing site

Widespread and commonly sown species pastures. Weed in lawns, cultivated areas and waste ground. Indicative of fresh-water habitats and has some waterlogging tolerance.

Distinguishing Features

Prostrate growth.

Leaves with 3 lobes, finely toothed, hairless.

Flowers white or sometimes yellowish or pinkish, with more than 20 flowers, in globular heads

Description of propagules

regeneration by seedling recruitment and vegetative perennation through the stolon system. White clover seeds can be dispersed long distances by human activities and through the digestive tract of birds and grazing animals. Alternatively, short distance dispersal may occur by dehiscence, stock trampling, worms, ants, and to a small extent by wind.

Control: Refer to NSW weedwise for current treatment recommendations. https://weeds.dpi.nsw.gov.au/

BSC Weed Profile Temple					
Common Name	Winter Grass				
Scientific Name	*Anagallis arvensis*				
Indigenous Name					
Weed Significance					
Priority - Eradicate	WoNS	State/Regional Priority	GBD		
Life Cycle					
Annual	Perennial	Semi-Annual			
Plant Type					
Herbaceous	Shrub	Tree	Vine	Aquatic	

Description of growing site

A common weed of gardens, lawns, pastures and disturbed areas, wherever bare ground and moisture are available. Essentially a fresh-water species, it may appear as an ephemeral annual on saline land over the colder and wetter months but usually disappears once soils dry out and conditions become more saline.

Distinguishing Features

Small annual grass to from 2-30 cm tall with flat, smooth, often pale green leaves to 12 cm long and 5 mm wide with a boat-shaped tip. Flower-heads are open and spreading panicles to 10 cm long and 6 cm wide. Each spikelet contains 3-6 green or purplish florets which are hairy in their lower halves.

Description of propagules

Germinates by seed.

Control: Refer to NSW weedwise for current treatment recommendations. https://weeds.dpi.nsw.gov.au/