# Haas grass
## *Tribolium uniolae*

Draft strategic plan for the Swan NRM Region

**December 2009**



swan catchment council

Natural Heritage Trust
Helping Communities Helping Australia

Department of Environment and Conservation

Australian Government

## ACRONYMS

DEC – Department of Environment and Conservation
DAFWA – Department of Agriculture and Food Western Australia
SCC – Swan Catchment Council
LGA – Local Government Authority
NRM – Natural Resource Management
IBRA – Interim Biogeographic Regionalisation of Australia
SERCUL – South East Regional Centre of Urban Landcare WA
NHT – Natural Heritage Trust

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# FOREWORD

Grass weeds, as a group, are highly successful and perennial grasses in particular present a serious threat to the biodiversity of the areas they invade. The South African 'hare' or 'haas' grass (*Tribolium uniolae*) as it is known in Afrikaans, is no exception. Like many of its African relatives, it has become naturalised in south-west Western Australia. Although presently restricted in distribution, it has the potential to become widespread, increase in abundance in its current range and severely impact on local native flora, plant communities and fauna.

Due to its potential to spread, it was one of a suite of environmental weeds listed in the *Candidate Species for Preventative Control* published in January 1998 (Csurhes and Edwards). Since then, surveys have given a clearer picture of its true distribution, however, the species is still poorly recognised and understood. In Western Australia it is not declared or listed as a pest plant, so there is no legal requirement for infestations to be eradicated.

Management of haas grass presents major challenges. While some infestations are small and localised, many are widespread and threaten sites with significant biodiversity value, such as those containing rare or endemic species.

As with many other weeds, it occurs across a range of tenures, making communication, coordination and cooperation integral to implementing an effective management program. Knowledge and understanding of environmental weeds and their impacts is also in its infancy.

The priority of this strategy is to coordinate and implement on-ground actions to eradicate infestations which threaten high biodiversity assets. Providing appropriate resources to achieve this goal will help provide long-term protection of the region's biodiversity.

This strategy provides information on haas grass:

- biology and ecology
- current and potential extent in Australia, Western Australia and the Swan Natural Resource Management (NRM) Region
- impacts and threats
- best practice control methods
- management.

The purpose of this strategy is to:

- facilitate, encourage and provide support to regional and local efforts to strategically control and eradicate haas grass in the Swan NRM Region
- raise awareness among land managers and the public.

# CONTENTS

# 1. CONTEXT AND PREPARATION OF STRATEGY

This strategy has been developed as an outcome of a Natural Heritage Trust-funded *Invasive Environmental Weed Project* for the Swan NRM Region. The project forms part of the *2006-2008 Swan Catchment Council Investment Plan*, and is being completed by the Department of Environment and Conservation (DEC). Among the project's outcomes are the development strategic plans for six of the region's high priority environmental weeds, including sharp rush. Each of the species presents a major threat to the region's rich biodiversity values. The six were selected to represent a range of life forms and different management objectives and approaches, so they could be used as models to develop strategies for other environmental weeds in the region and beyond.

# 2. AREA COVERED

This strategy centres on the Swan NRM Region in the south-west of Western Australia. It is made up of the swan and jarrah forest Interim Biogeographic Regionalisation of Australia (IBRA) regions and numerous, overlapping management boundaries. These include NRM sub-regions, DEC regions and districts and Local Government Authority (LGA) boundaries, as shown in Figure 1.

# 3. DESCRIPTION

## Taxonomic relationships

Haas grass belongs to the genus *Tribolium*, which derives its name from the Latin *tria* meaning three and *bolus* meaning meteor in the form of an arrow, possibly referring to the three florets encased in the bristly glumes (Watson and Dallwitz 1992). The genus consists of ten species and is a result of combining earlier genera Plagiochloa and Lasiochloa, thus the current name is synonomous with *Plagiochloa uniolae*. Triboliums are generally species of open habitats in the Fynbos and Karoo communities of South Africa and, although these species are endemic to the region, they are capable of readily spreading to new regions in South Africa (Spies *et al.* 1992).

## Features

A full description of haas grass is provided in Appendix 1. It is generally a caespitose, occasionally shortly rhizomatous, mostly glabrous (non-hairy) grass, growing roughly 0.3 to 0.6m high. It is tufted, upright and perennial and summer dormant. The inflorescence or distichous spikelets are 7cm long, with five to nine flowers and are 'wheat-like" in appearance. Green to purple flowers are produced from late spring to early summer (November to December). Leaf blades are around 3mm wide and up to 20cm long. Plants are bisexual with bisexual spikelets (Clayton *et al.* 2006).

Haas grass differs from other *Tribolium* species in having single (distichous) spikes. Haas grass itself is quite a variable taxa in its native range, with different forms (cytogenetic and morphological differences) being associated with differences in soil type and altitude under local conditions. Studies suggest this is the result of hybrization with the closely related but more restricted *T. brachystachum* (Spies *et al.* 1992).

**Figure 2:** From left to right, illustration (reproduced from *Memoirs of the Botanical Survey of South Africa* No.58, p339, reproduced with permission of the South African National Biodiversity Institute, South Africa), close-up of inflorescence, leaves and stems, seeds and spikelets, and flowering plants.

## Similar species - native and exotic

Haas grass may be confused with the native foxtail mulga grass (*Neurachne alopecuroidea)*, which co-occurs in similar habitats on the Darling Scarp and Plateau. Ribwort plantain *(Plantago lanceolata*) is another weed species, which at a distance has a similar appearance to haas grass and is commonly found in similar disturbed areas, however, ribwort plantain is a short-lived, slightly taller perennial with ribbed stems.

Another species of *Tribolium*, *T. brachystachyum*, is the most closely related *Tribolium* to haas grass but is not presently known in Australia. This species differs in that it is short, decumbent (reclining on the ground with tips pointing upwards), strongly pubescent (covered in short, soft hairs) with small infloresences and densely pubescent spikelets (Gibbs Russell *et al.* 1991). In addition to haas grass, other species of *Tribolium* have become naturalised or are known to be invasive in natural areas of Australia. *T. echinatum* has been recorded in two populations in south-western Australia. *T. obliterum* has been recorded in South Australia and California and a third species, *T. acutriflorum,* is a weed of seasonal wetlands, grassy woodlands and lowland grasslands in Victoria and South Australia (Carr *et al.* 1992).

# 3. HISTORY OF INTRODUCTION AND SPREAD

Haas grass was most likely introduced into south-west WA in the 1940's. Records from CSIRO show the species was trialled at the Kelmscott pasture testing station south-east of Perth sometime between 1943 and 1971 (Rogers *et al.* 1979). Brown and Brooks (2005) suggest the station was most likely the original source of all other infestations. Gradually radiating out from Kelmscott, the first herbarium collection was made from a naturalised population in Maddington in 1951. Collections have since been made in areas such as Brixton Street, Forrestfield, Parkerville, Darlington and Lesmurdie.

Due to its potential to spread rapidly, it was one of a suite of environmental weeds listed in the *Candidate Species for Preventative Control* (Csurhes and Edwards 1998). Since then, several more

collections have been made and it has been the subject of several local studies into its biology and management (Brown and Brooks 2005). More recently, survey efforts have provided a better understanding of its true distribution and methods of spread.

# 4. HABITAT AND DISTRIBUTION

## Native range - South Africa

Haas grass originates and is wide spread in the Cape Floristic Region of South Africa from 31° to 16° south and between longitude 18° and 26° east (Linder and Davidse 1997). It occurs from sea level to high elevations, up to 1,000 metres. It prefers the richer well-drained soils derived from granite, sandstone, shales or limestone and is found in all major vegetation types, especially the Fynbos and Renosterveldt. It is common in both disturbed and undisturbed ground, often found on road verges and appears to be common after scrub fires. It does not, however, tolerate grazing well. As grazing animals are generally kept off roadsides in South Africa it occurs in long extensive linear populations along roadsides, where it reproduces very successfully and spreads aggressively (Spies *et al.* 1992).

## Australia

Outside Western Australia, haas grass has only been recorded as naturalised from one population in the Jolimont railyards in Melbourne, Victoria, as shown in the map of the current distribution in Australia (Australia's Virtual Herbarium 2007), Figure 3.1. However, Climate® modeling indicates numerous areas in Australia have similar climatic parameters to that of the native range of haas grass. This suggests it has the potential to become significantly more widespread, particularly in the south-eastern region of South Australia and the south and mid-west coast of Western Australia (Figure 3.2).

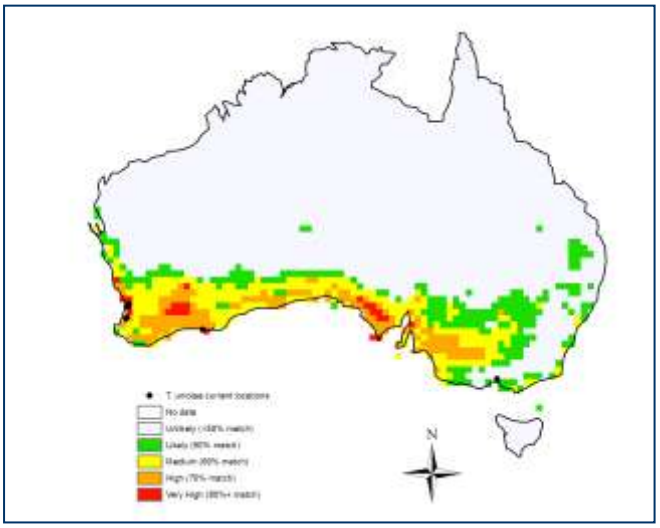


**Figure 3.1 (left):** Current distribution of haas grass in Australia based on herbarium collections (Australia's Virtual Herbarium 2007). **Figure 3.2 (right):** Map of current and potential distribution of haas grass in Australia, using Climate® modeling to predict the likelihood on invasion.

## Western Australia

Thirty-one populations of haas grass are known in Western Australia (Western Australian Herbarium 2007), with the majority of these in the south-west of the state (Figure 4.1). Its range extends from east of the Perth metropolitan area on the eastern side of the Swan Costal Plain, to Stratton in the north, Mundaring on the Darling Plateau to the east and an outlying infestation in Harvey in the south (200km

south of Perth). These populations occur on road verges, clay-based wetlands, jarrah forest and wandoo woodlands. A vast outlying population was recorded in Esperance in 1976 but this population has since not been re-located.

## Swan NRM Region

Twenty-nine of the 31 known populations of haas grass in WA occur in the boundaries of the Swan NRM Region (Figure 4.2). Region-wide, there is a strong correlation between soil types and distribution. Although haas grass can occur on sand plain, sandy clay and loams, most populations and the greatest abundance of plants occurs on the Darling Plateau. This suggests a preference for the residual-based lateritic soils associated with the Darling Plateau, followed by the colluvial soils of the Darling Scarp. In these areas it can be found on disturbed road verges, invading jarrah (*Eucalyptus marginata*) forest, herb rich shrublands and wandoo *(E. wandoo)* woodlands (Figure 5). Recent surveys have confirmed suspicions that haas grass is increasing and expanding in these habitats.


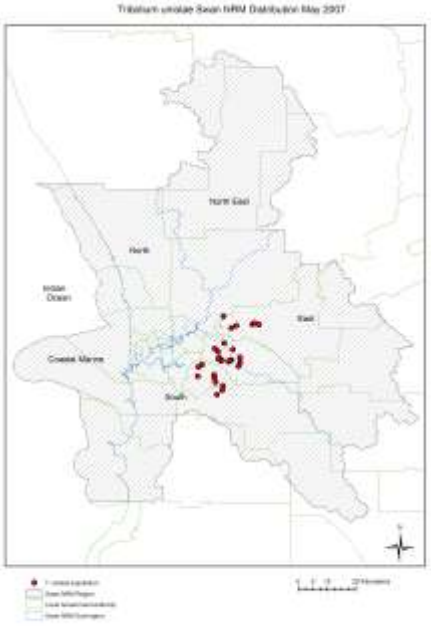

**Figure 4.1 (left):** Haas grass current distribution in Western Australia based on WA Herbarium records and recent survey (Western Australian Herbarium 2007). **Figure 4.2 (right):** Distribution of haas grass in the Swan NRM Region and sub-regions (Western Australian Herbarium 2007).

Fewer, isolated populations occur on the eastern side of the Swan Coastal Plain in clay-based wetlands and marri (*E. calophylla*) woodlands on deeper well-drained soils. An example is the Brixton Street Wetlands in Kenwick (Figure 5), where haas grass is naturalised in herb-rich shrublands on the drier flats and in marri woodlands. Isolated populations have been found in other areas near the junction of the Swan Coastal Plain and Darling Scarp, including Talbot Road Bushland at Stratton, north-east of Perth.

A summary of all population information is given in Table 1 overleaf. The list includes populations outside of the Swan NRM Region, which have been considered as they nevertheless represent a threat to the region's biodiversity values and are integral to a holistic approach to managing the species.

**Table 1:** Summary of population and site information statewide as of May 2007 (Western Australian Herbarium 2007). NB: * denotes populations outside the Swan NRM Region.

| Popn | Location description | Suburb | Frequency | Area infested (HA) | Tenure/land class | Managing agency/owner |
|---|---|---|---|---|---|---|
| **1** | Brixton St Wetlands | Kenwick | Frequent | Within 8 | Conservation reserve | DEC |
| **2** | Ellis Brook Valley Reserve | Orange Grove | 6-20 plants | >1 | Reserve | City of Gosnells |
| **3** | Pickering Brook, Canning Rd | Pickering Brook | Scattered | 2+ | Road reserve | Kalamunda Shire |
| **4** | Welshpool Rd | Carmel | Common | <1 | Road reserve | Kalamunda Shire |
| **5** | Canning Mills Rd, Foxley Rd opp Cohuna | Roleystone | Abundant | 4+ | Road reserve, shire reserve | City of Armade, Gosnells |
| **6** | Seabourne and Hill St | Parkerville | Dense | <1 | Road reserve | Shire of Mundaring |
| **7** | Talbot Rd Bushland | Stratton | ~50 plants | 0.5 | Conservation reserve | DEC/City of Swan |
| **8** | Whistlepipe Gully, end of Lewis Rd | Forrestfield | Local, frequent | >0.5 | Reserve, freehold | Kalamunda Shire |
| **9** | Landers Rd, Lesmurdie Rd | Lesmurdie | Abundant | 4+ | Road reserve | Kalamunda Shire |
| **10** | Roland Rd, 0.5km from GEHwy | Parkerville | Common | 1 | Road reserve | Shire of Mundaring |
| **11** | Bickley | Bickley | Dense | | Unknown | Kalamunda Shire |
| **12** | Shasta Rd | Lesmurdie | Common | 2+ | Road reserve, freehold | Kalamunda Shire |
| **13** | Austin Ave, 0.5km north railway | Maddington | N/A | | Road reserve | City of Gosnells |
| **14** | Padbury Rd, edge of Greenmount NP | Greenmount | Scattered | >0.5 | Road reserve, freehold | Shire of Mundaring, DEC |
| **15** | Pitt Road, Orange Grove | Orange Grove | Common | >0.5 | Road reserve | Kalamunda Shire |
| **16** | Lloyd Hughes Reserve | Kelmscott | Abundant | 3 | Conservation reserve | City of Armade, Gosnells |
| **17** | Nan MacMillan Reserve/Darling Range RP | Greenmount | Widespread | 5 | Reserve | Shire of Mundaring, DEC |
| **18** | Greater Brixton St Wetlands | Kenwick | Isolated | >0.5 | Reserve | DPI |
| **19** | Gooseberry Hill Rd, east end, circa Quenda Reserve | Gooseberry Hill | Scattered | >0.5 | Road verge, shire reserve | Kalamunda Shire |
| **20** | Gill St and Gill Park | Mundaring | Scattered | >0.5 | Shire reserve - parkland | Shire of Mundaring |
| **21** | Circa Wolliston Primary School, Grove Rd | Walliston | Scattered | 1 | Road reserve, other reserve | Kalamunda Shire |
| **22** | Lawn Brook Rd | Bickley | Common | 3 | Road reserve | Kalamunda Shire |
| **23** | Ford Rd, Melaleuca Rd | Lesmurdie | Scattered | 1 | Road reserve, freehold | Kalamunda Shire, Private |
| **24** | Nelson Rd, cnr of High Peak Place | Lesmurdie | Common | >0.5 | Road reserve, National Park | Kalamunda Shire, DEC |
| **25** | Hawtin Rd, Maud Rd, Leschenaultia Rd | Maida Vale | Common | 1 | Road reserve | Kalamunda Shire |
| **26** | Bill Shaw Reserve | Darlington | Scattered | >0.5 | Shire reserve, road reserve | Shire of Mundaring |
| **27** | Canning Mills Rd, Douglas Rd, Kylie rd to Chevin Rd | Martin | Common | 3+ | Road reserve | City of Armade, Gosnells |
| **28** | Cnr Milleara and Connell Rd | Martin | Scattered | 1 | Road reserve | City of Gosnells |
| **29** | Mundaring Weir Rd, south of Roach Rd | Piesse Brook | Scattered | .0.5 | Road reserve | Kalamunda Shire |
| **30*** | South west Highway | N Harvey | Common | 4 | MRWA reserve, Crown reserve | DPI, Shire of Harvey |
| **31*** | Esperance | Esperance | Unknown | | Unknown | Unknown |

# 6. BIOLOGY AND ECOLOGY

Understanding the reproductive biology, dispersal and growth of haas grass is integral to effective management. A calendar of its growth, flowering, seed production and germination times is provided in Table 2. Table 2 also shows the optimum times for control measures based on its biology, dispersal and growth. In south-west WA, haas grass undergoes a dormant period over summer with active growth occurring again with autumn rains. Flowering occurs in October though to December with seed development from December onwards.

**Table 2:** Calender of biology and management.

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Active growth | | | | | | | | | | | | |
| Flowering | | | | | | | | | | | | |
| Seed production | | | | | | | | | | | | |
| Germination | | | | | | | | | | | | |
| Herbicide application | | | | | | | | | | | | |
| Physical removal | | | | | | | | | | | | |

Although plants may reproduce clonally from small perenniating buds breaking off from the base, haas grass mainly reproduces and spreads by seed. The small, lightweight yellow-brown seeds are 1-2mm long, obovate and compressed dorsiventally. The seeds are housed in fruits free from both the lemma and palea (Clayton *et al*. 2006). The seeds have no obvious features for dispersal, apart from being lightweight and a small size (Brown and Brooks 2005).

Haas grass has the ability to establish in different habitats, including both disturbed and undisturbed sites. Most populations established on road verges or on the edges of bushland suggest that seed is dispersed through machinery, such as graders, involved in roadside maintenance and in material used in road maintenance.

It is most likely spread into relatively undisturbed bushland by seed carried in water and, to a lesser extent, by wind. Run-off and sheet water flow across wetlands carries seed from path edges, facilitating movement into undisturbed bushland. On the Darling Scarp and Plateau, plants can often be found spreading down drainage lines into relatively undisturbed vegetation. Ants may also play a role in spreading seed in bushland, with seedling recruitment having been observed around numerous ant nests and occasionally around termite mounds (Figure 6).

An abundance of plants on disturbed road verges suggests germination is enhanced by soil disturbance or cultivation. Returning seed to the soil surface by disturbance may help to break dormancy and create optimum conditions of temperature, moisture and light, for germination. Although seedling emergence may be highest in these areas, seedlings can also emerge in intact vegetation, although the survival appears to be highest in wetter habitats such as creek lines.

Little is known of the viability, longevity and seed bank properties of *Tribolium* species. Grass seed in general is not known for its longevity, nevertheless any management program should aim to control seed production for several years. Grass seeds are also not known to have morphological or physical dormancy but have a great diversity of germination requirements based on local environmental conditions (Baskin and Baskin 1998). These environmental conditions or cues for germination of haas grass are not fully understood.

The number of years seed is stored in soil following fire is unknown, nonetheless fire has been observed to play a significant role in the spread of haas grass into intact bushland. Fire often results in high mortality of adult plants (over 70 per cent) but can also result in massive seedling recruitment (Figure 7). Seedlings are able to flourish in the space, light and nutrient conditions following fire, allowing them to establish early and displace regenerating native species. The haas grass plants occurring in vegetation that hasn't been burnt for several years, have large quantities of dead material with limited green shoots. As some of these older plants begin to senesce and die in dry summer conditions, seedlings have been observed germinating in between dead clumps following the onset of autumn rains (Brown and Brooks 2003).

# 6. IMPACTS AND THREATS

Haas grass is highly invasive and has the potential to seriously impact on a range of vegetation communities, particularly the limited remaining vegetation on heavier soils on the eastern side of the Swan Coastal Plain. It forms dense clumps and is particularly effective at displacing herbaceous flora. Those communities contain high numbers of annual or perennial herbs (including many significant species) and are particularly susceptible to invasion by haas grass (Brown and Brooks 2003).

In areas on the eastern side of the Swan Coastal Plain, it appears to be in the early stages of invasion, however, its ability to invade rare and restricted plant communities means it could have significant impacts. For example, in the Brixton Street wetlands it is invading the marri/*Kingia australis* woodlands and herb rich shrublands, both recognised as Threatened Ecological Communities (TEC). There are other areas of regionally significant bushland, recognised in Bush Forever sites, under threat in these areas from expansion of existing haas grass infestations.

On the Darling Plateau haas grass invades open wandoo woodland and is capable of displacing much of the native understory vegetation. Although the system of recognised regionally significant bushland, or Bush Forever sites, does not currently extend east of the Swan Coastal Plain, there are numerous sites of high biodiversity value in a range of sizes and land classifications, such as nature reserves, national parks, conservation parks, regional parks, system 6 areas and state forest. In the jarrah forest, it is found competing with a number of native herbs and grass species, including many species of Austrostipa, kangaroo grass (*Themeda triandra*) and forest rice grass (*Tetrarrhena laevis*). In many areas though, it is still mainly found only on adjacent road verges, old gravel pits and highly disturbed areas. These populations are a source of further invasion and seed source into adjoining, more intact areas, particularly following fire.

# 7. CONTROL METHODS

A three-year study on control methods carried out by Brown and Brooks (2003) produced a lot of information on control and management of haas grass. The two main options for control are the use of herbicides at rates depending on the time of year and growth phase and physical control.

## Herbicide control

Herbicide trials have shown some success controlling haas grass with the grass selective herbicide Fusilade®. This is useful in many situations including the Brixton Street wetlands, where the grass grows closely among the native vegetation. Follow-up monitoring and spraying is required for up to 10 years and/or after disturbance events to achieve long-term eradication. Young vigorously growing plants may be controlled with Fusilade® (10ml/L + Pulse 2ml/L) if applied before flowering (August). Older senescing plants may be effectively controlled by stronger rates of Fusilade® (15ml/L + Pulse 2ml/L) when applied later in the season (Brown and Brooks 2003).

As fire offers a window of opportunity for control, resources should always be made available following any fire event. Plants resprouting after summer fires can be very effectively controlled by using Roundup® (10ml/L + Pulse) or Fusilade (10ml/L + Pulse2ml/L) applied in autumn when actively growing, when the native vegetation has not yet fully commenced active re-growth and when haas grass is highly visible.

## Physical control

Physical removal by cutting below the base with a sharp knife may be appropriate in small isolated situations when the soil is moist. However, small perennating buds which have been observed to break off and go on to produce new plants means care has to be taken during any hand removal program. In addition, the method is labour intensive, impractical on a larger scale and may be difficult when the grass is growing closely amongst native vegetation. Soil disturbance may also enhance seedling recruitment.

# 9. MANAGEMENT

## Vision

The main vision for management is *to reduce impacts, contain spread and eradicate haas grass at key sites, thereby protecting the region's high biodiversity value assets*.

## Management objectives

This vision may be achieved with the following strategies:

- Contain spread outside existing range
- Control outlying populations
- Reduce impacts at selected areas
- Control and, if possible, eradicate populations at key high biodiversity value sites
- Exclude from key high biodiversity value sites, represented in Bush Forever sites, TEC's, regionally significant remnant vegetation and areas containing significant flora and/or fauna
- Map to reveal extent of remaining populations
- Manage upstream and uphill source populations, including drain outlets
- Manage human activities, including road maintenance and housing development
- Foster and continue to develop partnerships between friends groups, land managers such as local government and community groups
- Partnership commitment– undertake discussion with partner organisations to develop a framework monitor in the long term
- Maintain a detection and surveillance program.

## Targets

To fulfill the aims of the strategy, the following targets should be met in the Swan NRM Region by 2010, unless otherwise stated:

- *No nett increase in the number of populations*
- *No nett increase in extent*
- *Information brochure produced by June 2008*
- *Eradication of mature plants at high biodiversity value sites.*

## Actions to date

Initiatives have commenced to undertake further survey of the Darling Plateau, expand the control program of key populations on the Swan Coastal Plain and Darling Scarp and make land managers aware of the weed. The intent is to eliminate populations, ensure new populations are controlled before

they establish and significantly reduce the threat of the species becoming a serious environmental weed in south-west WA. The following actions have been or are currently being implemented:

**1. Survey to understand the extent and distribution**
After gathering all herbarium collection information, field surveys were undertaken in 2006/7 to better understand the distribution and extent of populations. Reports were sought from the community and land managers on any new or previously unknown populations.

**2. Raised industry and community awareness**
Images, descriptions and general information on the species have been disseminated in a number of forms, including electronic media, public forums and print media.

**3. Liaison with land managers**
Control has been undertaken at key sites.

**4. Mapping of populations at key sites**
Mapping of haas grass has been undertaken by DEC's Urban Nature Program staff for consecutive years at two intensively-managed sites. Detailed mapping using differential GPS was undertaken at several other key sites, particularly where herbicide control was planned.

**5. Assessment of biodiversity values of sites containing each population and identification of high conservation value sites in close proximity, which could be at risk from invasion**
Locations were plotted in GIS with various data layers added, including biodiversity assets such as Bush Forever sites and TEC's (detail of this is shown in Figure 8). A full map of these layers in the region is provided in Figure 9. Bush Forever volumes one and two (Government of Western Australia 2000) were used to assess the conservation values of each site listed. Sites were also inspected and assessed in the field. These give a visual representation of spread and allow assessment of which sites are most at risk.

Each population was then assessed and rated by several criteria (described in Table 3.1 and 3.2):
- conservation value of site
- feasibility of control
- whether it is an outlying population
- threat posed to nearby biodiversity assets.

Values, ratings and management priorities are listed in Table 4. Three populations (one, seven and 18) occur in high biodiversity conservation areas and were rated 'very high' priority for management. These areas include Bush Forever sites, are in or adjacent to TEC's, and/or contain significant flora or fauna. A number of other 'high' priority populations occur in or near areas of significant conservation value such as national parks, regional parks, TEC's and/or significant areas of remnant vegetation. Outlying populations were given special consideration for management in addition to the site's conservation value.

This information allows a prioritisation of sites to manage and protect highest biodiversity assets, from which recommendations for management can then be developed.

**6. Development of an implementation plan, aimed at first eradicating small to medium-sized populations in, or in close proximity to, high conservation value sites and outlying populations.**

Specific short-term (2007-2008) and long term management recommendations have been developed for sites rated very high (VH), high (H) and moderate (M), as well as lower management priority sites (Table 5). Most of these actions involve herbicide spraying, monitoring and surveillance.

## Recommended actions

In addition, the following actions are recommended:

1. Undertake control and broker the control of plants at key sites.

2. Liaise with land managers including DEC and LGA's, as well as other NRM groups, the community and private property owners.

3. Conduct further surveys outside the known range.

4. Monitor known population sites annually and continue mapping program.

5. Establish a process of detecting, reporting and eradicating new infestations.
Early detection and eradication of small populations is important to prevent spread and escalation of threat to biodiversity.

6. Prevent further invasion and new populations appearing in bushland - remove other sources in areas such as gardens/parks before they invade natural ecosystems.

7. Obtain further biological and ecological information, particularly on seed biology. Improved knowledge will provide a scientific basis for management.

8. Maintain quarantine, prevent from spreading - prohibit propagation, cultivation and sale in Western Australia, no importation of *Tribolium*.

9. Increase understanding and awareness including land managers involved in road maintenance activities, with particular encouragement of Main Roads WA and LGA's to minimise and control infestations and prevent spread.

10. Increase awareness in the community and amonge land managers through an information brochure.

11. Keep fire and other disturbance factors out of high biodiversity value sites.

## Resourcing

This strategy will help determine funding priorities for the SCC's investment planning process. Funds have been available for control in 2006 and 2007 as part of DEC's Saving Our Species Biodiversity Conservation Initiative (BCI). For two years, $40,000 per year has enabled mapping, survey and herbicide spraying at key infestations to be undertaken, however, BCI funding will not be available after 2008. To continue the program, this funding commitment would be required for a period of five to 10 years. With the relevant expertise and, as one of the leading conservation agencies, DEC should provide resources in the form of a coordinating project officer and funds to continue implementing recommendations. As yet, other funding sources or contributions potentially available from LGA's are unknown.

## Stakeholders

Haas grass populations currently known occur on both private and public lands vested in a range of agencies. Developing partnerships with these organisations is integral to achieving the desired outcomes of the strategy. The key agencies include:

- Swan Catchment Council
- Department of Environment and Conservation
- Local governments - Shire of Mundaring, Shire of Kalamunda, City of Armadale/Gosnells, City of Swan, Shire of Harvey, Shire of Serpentine Jarrahdale;
- Main Roads Western Australia
- Water Corporation
- Department for Planning and Infrastructure
- Department of Agriculture and Food Western Australia
- Community members
- Friends groups
- Private landholders.

# 10. MONITORING AND EVALUATION

Monitoring and evaluation are key parts of measuring successful implementation of the haas grass strategy. New information can also provide the basis to adapt the management program. At the completion of three years (July 2010), the strategy should be reviewed and evaluated against the management targets. With baseline information already gathered, data needs to be recollected in 2010 to assess the spread/decline of haas grass and evaluate the success or progress toward management targets. Indicators to show this include:

- Mapping; spatial data can allow identifying changes in distribution and numbers of plants
- Recording of numbers of plants (separating adults, juveniles/seedlings)
- Surveying for expansions in existing populations and new populations.

As further information is gathered, the strategy may be adapted. Because of the long-lived soil seed bank, monitoring and management actions will need to be carried out for up to ten years.

# 11. CONTACTS

Department of Environment and Conservation. Phone (08) 9423 2900.

# 12. ACKNOWLEDGMENTS

Kate Brown, Greg Keighery, Karen Clarke, Dr. Lynley Stone and others who provided information on locations of populations.

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# 14. FIGURES AND TABLES

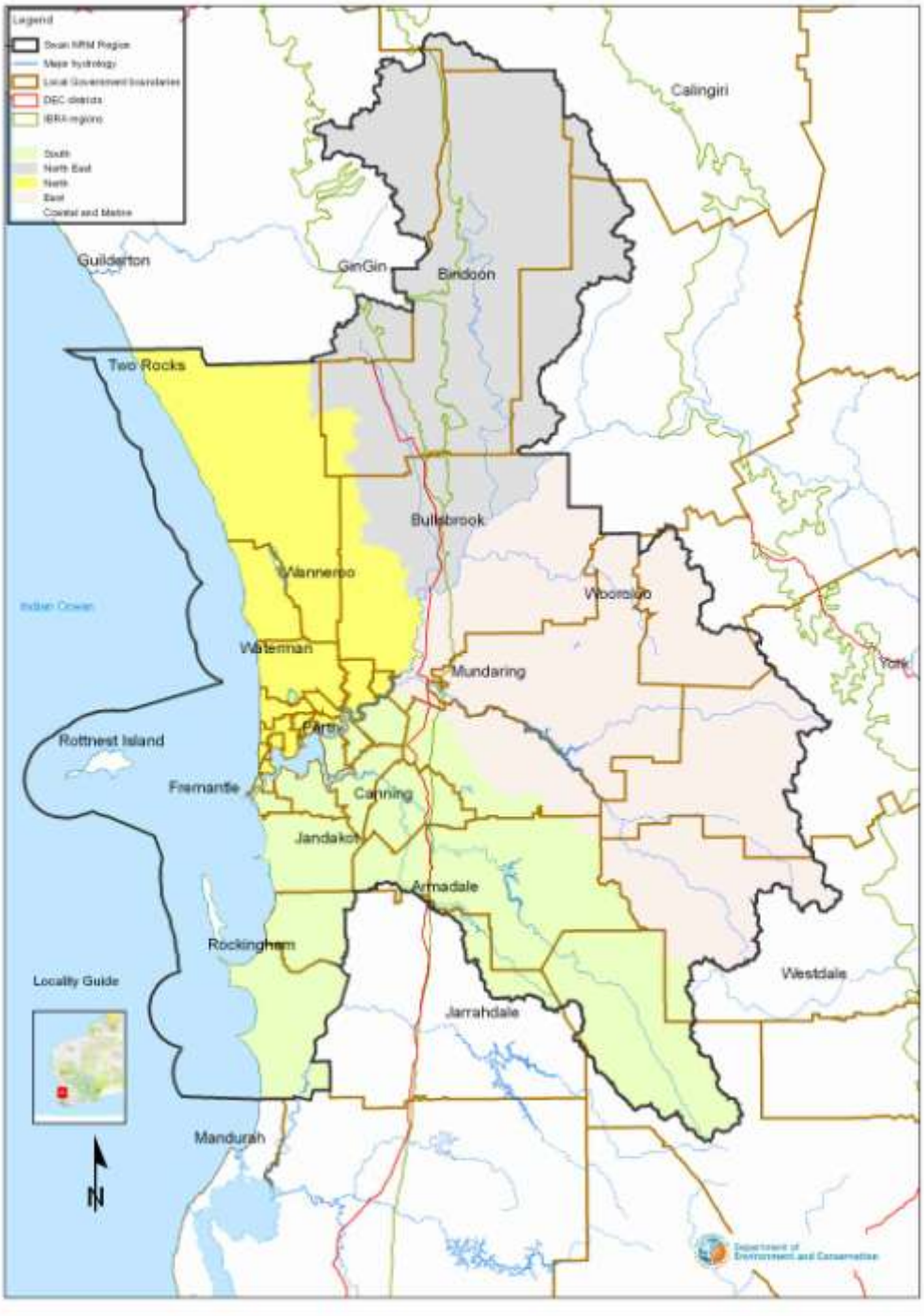


**Figure 1:** Management boundaries of the Swan NRM Region, including NRM Sub-regions, DEC Regions, Districts and Local Government Authority boundaries.

**Figure 5:** Types of habitat invaded by haas grass on the Darling Scarp and Plateau, including disturbed road verges and drainage lines (left), jarrah/marri forest (right) and (above) on the eastern side of the Swan Coastal Plain, a clay-based wetland at the Brixton Street wetlands (Photos: Kate Brown).

Figure 6: Germination of haas grass seedlings around an ant nest at Brixton Street wetlands (left) and a termite mound, Harvey (right) (Photo: Kate Brown, left).

**Figure 7:** Recruitment of haas grass seedlings following a wildfire in Brixton Street wetlands (Photo: Kate Brown).

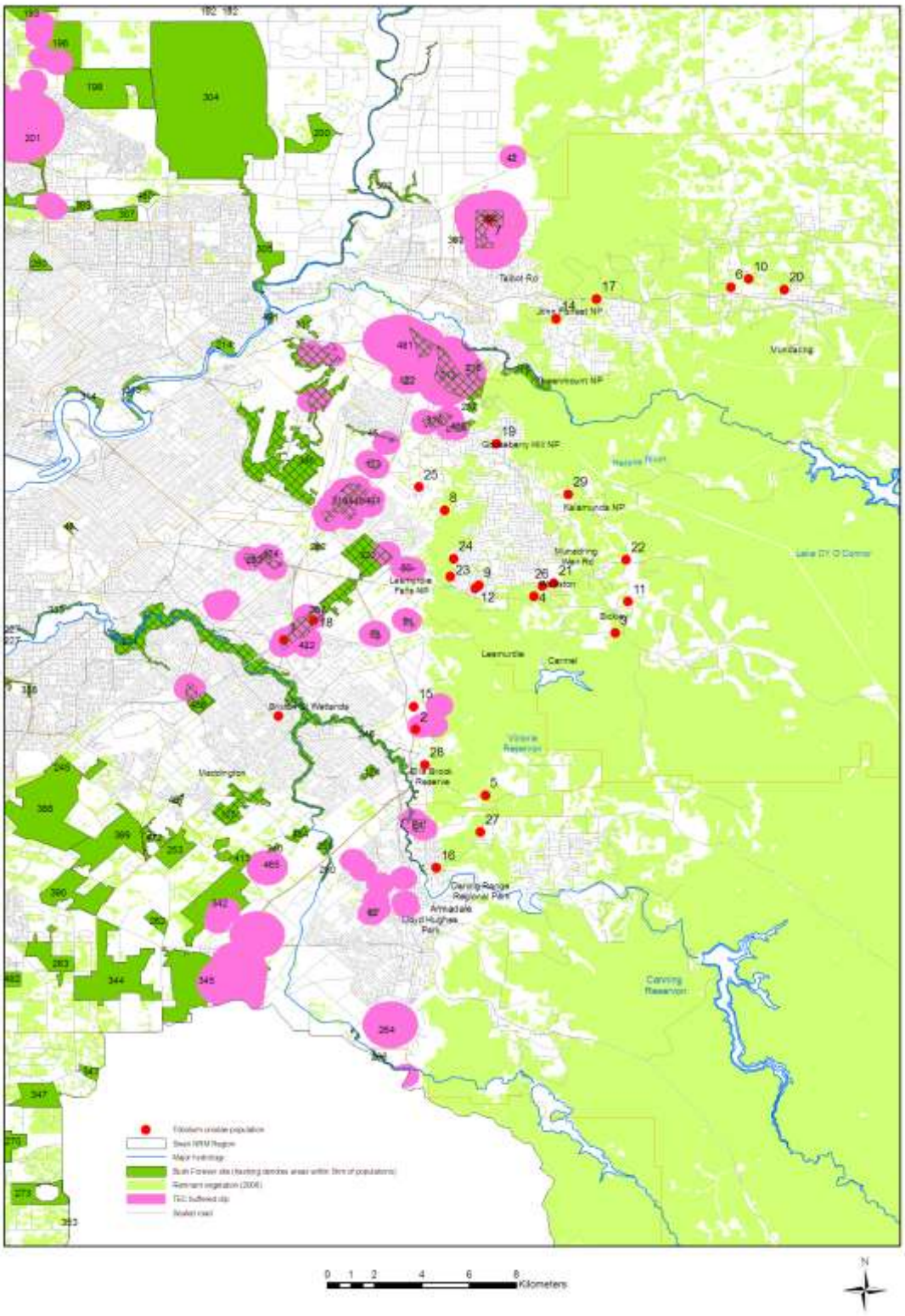


**Figure 8:** Detail of GIS mapping for the distribution of haas grass populations against high biodiversity value assets in the Swan NRM Region (Western Australian Herbarium 2007).

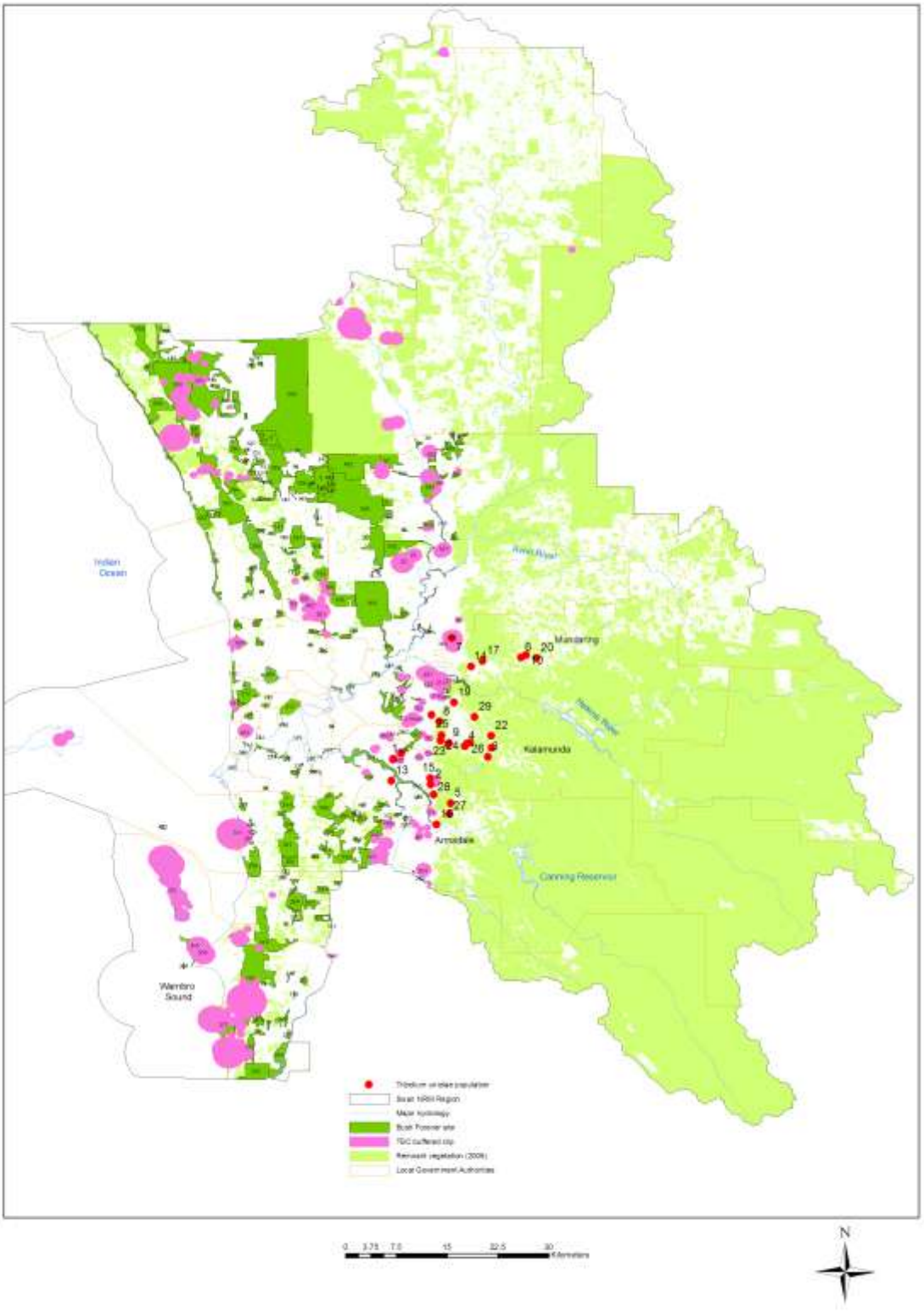


**Figure 9:** Distribution of haas grass against high biodiversity value assets across the Swan NRM Region.

Table 3.1 (below): Criteria for ranking threat to biodiversity values of site (from highest to lowest).

| Ranking | Criteria (serves as a guide only) |
|---|---|
| 1 | TEC **and/or** Declared Rare Flora (DRF) present.<br>Priority/significant flora species present.<br>Regionally significant. Bush Forever site.<br>Vegetation in good, very good to excellent condition in majority of site.<br>International/nationally significant.<br>Contains other special attributes (eg, scientific importance). |
| 2 | No TEC **or** DRF present.<br>Priority/significant flora species may be present.<br>May be regionally significant.<br>May contain other special attributes.<br>Vegetation in good to degraded condition.<br>Occurs on road verge/buffer adjoining and threatening sites ranked one or is outlier population at known extent of range. |
| 3 | No TEC, DRF or priority/significant flora species present.<br>Not recognised as regionally significant.<br>No other special attributes.<br>Vegetation degraded to poor, completely disturbed or very poor condition (vegetation structure disappeared, few if any native species, high percentage cover and abundance of weeds).<br>Does not threaten high biodiversity value sites. |

Table 3.2 (below): Criteria for ranking feasibility of control of weed species (from high to low feasibility).

| Ranking | Criteria (serves as a guide only) |
|---|---|
| 1 | Weed in low numbers and/or low density.<br>Occasional and localised/confined to a specific area of site and in low density.<br>Possibility population/s eradicated in two to three years.<br>Site easily accessible. |
| 2 | Weed in low numbers and/or low density.<br>Occasional and widespread/present in most or all of site or weed in medium densities.<br>Common and localised/confined to specific areas of site.<br>Possibility population/s severely reduced or eradicated in two to three years.<br>Site accessible/moderately accessible. |
| 3 | Weed in high density.<br>Widespread or localised and abundant.<br>Infestation difficult to control, eradication unlikely.<br>Likelihood infestation would require intensive treatment for more than three years.<br>Site may be difficult to access.<br>Site has complication for management. For example, sensitive site, permanent water. |

**Table 4:** Prioritised sites for management based on site features and biodiversity assets threatened.

| Popn | Location description | Site features and biodiversity assets | Biodiversity assets threatened in close proximity | Conserv rating | Feas of control | Outlying popn | Threats - nearby assets | Mgt priority |
|---|---|---|---|---|---|---|---|---|
| **1** | Brixton St Wetlands | BFS 422, TEC (3a, 20) | BFS 387, 224, 246, TECs | 1 | 2 | N | H | VH |
| **7** | Talbot Rd Bushland | BFS 306, TEC (3c, 20c), significant flora, mammal spp. Register national estate | | 1 | 1 | Y | M | VH |
| **18** | Greater Brixton St Wetlands | BFS 387, TEC (3a,10a,7,8), significant flora and mammal spp. | BFS 422, TEC (3a, 20) | 1 | 1 | N | H | VH |
| **2** | Ellis Brook Valley Reserve | TEC adjacent, remnant veg to east | TEC, Ellis Brook Valley Reserve | 1 | 2 | N | H | VH |
| **14** | Padbury Rd, edge of Greenmount NP | Disturbed, edge of Greenmount NP | Greenmount NP | 1 | 1 | N | H | H |
| **16** | Lloyd Hughes Reserve | Remant vegetation | Remant vegetation, Darling RRP | 1 | 2 | Y | H | H |
| **17** | Nan MacMillan Reserve/Darling Range RP | Remant vegetation | Remant vegetation, John Forrest NP | 2 | 3 | N | M | H |
| **24** | Nelson Rd, cnr of High Peak Place | Disturbed, vegetation on edge of Lesmurdie Falls NP | Lesmurdie Falls NP, BFS 50 | 2 | 2 | N | H | H |
| **27** | Canning Mills Rd, Douglas Rd, Kylie rd to Chevin Rd | Edges of Darling Range RP | Darling Range RP | 1 | 2 | N | H | H |
| **30*** | South West Highway | Disturbed, remnant vegetation | Remnant vegetation | 1 | 2 | Y | H | H |
| **5** | Canning Mills Rd, Foxley Rd opposite Cohuna | Disturbed, spreading into adjacent vegetation | Adjacent vegetation, Darling RP | 2 | 2 | N | M/H | M/H |
| **8** | Whistlepipe Gully, end of Lewis Rd | Remant vegetation | Adjacent to Lesmurdie Falls NP, Remnant vegetation | 2 | 1 | N | H | M/H |
| **3** | Pickering Brook, Canning Rd | Disturbed | Remnant vegetation | 2 | 3 | N | M | M |
| **4** | Welshpool Rd | Disturbed | Adjacent vegetation | 2 | 3 | N | M | M |
| **6** | Seabourne and Hill St | Disturbed | Adjacent vegetation | 2 | 3 | N | M | M |
| **15** | Pitt Road, Orange Grove | Disturbed, remnant vegetation | Remant vegetation | 2 | 2 | N | M | M |
| **19** | Gooseberry Hill Rd, east end, circa Quenda Reserve | Remnant vegetaion | Remnant vegetation, Gooseberry NP | 2 | 2 | N | M | M |
| **20** | Gill St and Gill Park | Disturbed, remnant vegetation | Remant vegetation | 3 | 3 | Y | M | M |
| **23** | Ford Rd, Melaleuca Rd | Disturbed | Lesmurdie Falls NP, BFS 50 | 3 | 3 | N | M | M |
| **21** | Circa Wolliston Primary School, Grove Rd | Disturbed, remnant vegetation | Remnant vegetation | 3 | 3 | N | M | L/M |
| **22** | Lawn Brook Rd | Disturbed, remnant vegetation | Adjacent vegetation | 3 | 3 | Y | M | L/M |
| **28** | Cnr Milleara and Connell Rd | Disturbed | Ellis Brook Reserve | 3 | 2 | N | M | L/M |
| **29** | Mundaring Weir Rd, south of Roach Rd | Disturbed | Kalamunda NP | 3 | 2 | N | M | L/M |
| **9** | Landers Rd, Lesmurdie Rd | Disturbed | Limited housing | 3 | 3 | N | L | L |
| **10** | Roland Rd, 0.5kms from GEHwy | Disturbed | Limited remnant vegetation | 3 | 2 | Y | L | L |
| **11** | Bickley | Disturbed | Limited remnant vegetation | 3 | 3 | N | L | L |
| **12** | Shasta Rd | Disturbed | None | 3 | 3 | N | L | L |
| **13** | Austin Ave, 0.5km north railway | Cleared | None | 0 | 0 | Y | L | L |
| **25** | Hawtin Rd, Maud Rd and Leschenaultia Rd | Disturbed | Limited remnant vegetation | 3 | 3 | N | L | L |
| **26** | Bill Shaw Reserve | Disturbed vegetation/parkland | Limited remnant vegetation | 3 | 2 | N | L | L |
| **31*** | Esperance | Unknown | | 0 | 0 | Y | U | U |

**Table 5:** Management recommendations for each population of haas grass.

| Popn | Location description | Managing agency/owner | Mgt priority | Management actions to date | Management recommendations - short term (2007) | Management recommendations - medium term (2008-2010) | Management recommendations - long term (2011+) |
|---|---|---|---|---|---|---|---|
| **1** | Brixton St wetlands | DEC | VH | Intensively managed since at least 2000, including herbicide trials, detailed mapping, annual spraying | Maintain herbicide spraying program. Re-map distribution to determine changes in population density | Maintain herbicide spraying program. Re-map distribution to determine changes in population density | Review spraying program |
| **7** | Talbot Rd bushland | DEC/City of Swan | VH | Managed since 2000, including mapping and annual spraying | Maintain herbicide spraying program. Regular survey for new plants. Aim to eradicate | Maintain herbicide spraying program. Regular survey for new plants | Review spraying program against eradication goal |
| **18** | Greater Brixton St wetlands | DPI | VH | Surveyed, mapped, sprayed Nov 2006 | Maintain herbicide spraying program. Regular survey for new plants. Aim to eradicate | Maintain herbicide spraying program. Regular survey for new plants | Review spraying program against eradication goal |
| **2** | Ellis Brook Valley Reserve | City of Gosnells | H | Survey | Detailed survey and mapping. Herbicide spray in 2007, plus follow-up. Check nearby areas | Maintain spraying. Contain spread. Reduce extent | Review success against goal. Monitor |
| **14** | Padbury Rd, edge of Greenmount NP | Shire of Mundaring, DEC | H | Mapped, sprayed Nov 2006 | Herbicide follow-up in 2007 onwards. Monitor spread downslope. Contact PP owners | Monitor for new recruits. Spray any germinants. Check downslope in Greenmount NP | Monitor |
| **16** | Lloyd Hughes Reserve | City of Armadale, Gosnells | H | Mapped, sprayed Nov 2006 | Maintain herbicide spraying program | Maintain herbicide spraying program. Monitor through detailed mapping. Treat new germinants | Monitor |
| **17** | Nan MacMillan Reserve/Darling Range RP | Shire of Mundaring, DEC | H | Mapped, sprayed Nov 2006 | Follow-up herbicide control. Survey areas along GE Highway into John Forrest NP | Maintain herbicide sparying program. Monitor through detailed mapping. Treat new germinants | Monitor |
| **24** | Nelson Rd, cnr of High Peak Place | Kalamunda Shire, DEC | H | Informal survey | Map extent, herbicide spray in 2007. Survey downslope | Follow-up spraying. Contact PP owners to extend control area | Monitor |
| **27** | Canning Mills Rd, Douglas Rd, Kylie rd to Chevin Rd | City of Armadale, Gosnells | H | Informal survey | Extent spreading N into park unknown. Control in 2007? | Follow-up spraying. Re-map 2009? | Monitor |
| **30*** | South West Highway | MRWA, Shire of Harvey | H | Mapped, surveyed | Liaise with MRWA and Shire of Harvey. Herbicide spray in 2007, plus follow-up. Disseminate info to region | Re-spray 2008. Remap population. Check levels of recruitment | Montior |
| **5** | Canning Mills Rd, Foxley Rd opp Cohuna | City of Armadale, Gosnells | M/H | Informal survey | Detailed survey and mapping. Herbicide spray in 2007, plus follow-up | Treat if funding available | Treat if funding available |
| **8** | Whistlepipe Gully, end of Lewis Rd | Kalamunda Shire | M/H | Survey. Plants not relocated | Re-survey winter 2007 | Monitor | Treat if funding available |
| **3** | Pickering Brook, Canning Rd | Kalamunda Shire | M | Informal survey | Monitor, herbicide application if resources available | Monitor | Treat if funding available |
| **4** | Welshpool Rd | Kalamunda Shire | M | Informal survey | Monitor, herbicide application if resources available | Monitor | Treat if funding available |
| **6** | Seabourne and Hill St | Shire of Mundaring | M | Informal survey | Monitor and map 2007 | Monitor | Treat if funding available |
| **15** | Pitt Road, Orange Grove | Kalamunda Shire | M | Informal survey | Monitor for spread toward Ellis Brook Reserve | Treat if funding available | Monitor. Continue treatment |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **19** | Gooseberry Hill Rd, east end, circa Quenda Reserve | Kalamunda Shire | M | Surveyed 300m radius | Map extent of population. Herbicide spray in 2007/2008 if resources avail | Treat if funding available | Monitor. Continue treatment |
| **20** | Gill St and Gill Park | Shire of Mundaring | M | Informal survey | Monitor | Treat if funding available | Monitor. Continue treatment |
| **23** | Ford Rd, Melaleuca Rd | Kalamunda Shire, private | M | Informal survey | Monitor | Treat if funding available | Monitor. Continue treatment |
| **21** | Circa Wolliston Primary School, Grove Rd | Kalamunda Shire | L/M | Informal survey | Monitor | Treat if funding available | Monitor. Continue treatment |
| **22** | Lawn Brook Rd | Kalamunda Shire | L/M | Informal survey | Monitor | Treat if funding available | Monitor. Continue treatment |
| **28** | Cnr Milleara and Connell Rd | City of Gosnells | L/M | Informal survey | Map extent and monitor threat to Ellis Brook Reserve | Treat if funding available | Monitor. Continue treatment |
| **29** | Mundaring Weir Rd, south of Roach Rd | Kalamunda Shire | L/M | Informal survey | Monitor | Treat if funding available | Monitor. Continue treatment |
| **9** | Landers Rd, Lesmurdie Rd | Kalamunda Shire | L | Surveyed, mapped | Monitor | Liaise with Shire, contact PP owners in view of controlling PP/road verge popns | Monitor. Continue treatment |
| **10** | Roland Rd, 0.5kms from GEHwy | Shire of Mundaring | L | Surveyed, mapped | Monitor | Liaise with Shire, contact PP owners in view of controlling PP/road verge popns | Monitor. Continue treatment |
| **11** | Bickley | Kalamunda Shire | L | | | | |
| **12** | Shasta Rd | Kalamunda Shire | L | Surveyed, mapped | Monitor | Liaise with Shire, contact PP owners in view of controlling PP/road verge popns | Monitor. Continue treatment |
| **13** | Austin Ave, 0.5km north railway | City of Gosnells | L | Surveyed 300m radius. Plants not found | Monitor outbreaks in area | Informal survey alternate years | Monitor. Continue treatment |
| **25** | Hawtin Rd, Maud Rd and Leschenaultia Rd | Kalamunda Shire | L | Surveyed, mapped | Monitor | Liaise with Shire, contact PP owners in view of controlling PP/road verge popns | Monitor. Continue treatment |
| **26** | Bill Shaw Reserve | Shire of Mundaring | L | | Monitor | Liaise with Shire to control | Monitor. Continue treatment |
| **31*** | Esperance | | U | Plants not relocated | Monitor for outbreaks | Send information to Esperance DAFWA, DEC, SCRIPT | Monitor. Continue treatment |

# 15. APPENDICES

**Appendix 1:** Full description.

**Haas grass (*Tribolium uniolae*)**

HABIT Perennial; caespitose. Culms erect; 10 to 60cm long. Leaves mostly basal. Ligule a fringe of hairs. Leaf-blades involute; 3 to 20cm long; 1 to 3mm wide; stiff.

INFLORESCENCE Inflorescence composed of racemes.

Racemes 1; single; unilateral; 0.8-7cm long. Rhachis semiterete; scaberulous on margins. Spikelet packing broadside to rhachis; crowded; regular; 2 -rowed.

Spikelets solitary. Fertile spikelets sessile.

FERTILE SPIKELETS Spikelets comprising 3-14 fertile florets; with diminished florets at the apex. Spikelets ovate to orbicular; laterally compressed; obtuse; 5-8mm long; breaking up at maturity; disarticulating below each fertile floret.

GLUMES Glumes persistent; similar; shorter than spikelet; similar to fertile lemma in texture. Lower glume ovate; 1 times length of upper glume; coriaceous; 1-keeled; 5-veined. Lower glume surface glabrous. Lower glume apex acute. Upper glume ovate; 1 times length of adjacent fertile lemma; coriaceous; 1-keeled; 5 -veined. Upper glume surface glabrous. Upper glume apex acute.

FLORETS Fertile lemma elliptic; 4-5.5mm long; coriaceous; much thinner on margins; without keel; 7 -veined. Lemma surface pilose; hairy below; with clavate hairs. Lemma margins eciliate. Lemma apex obtuse. Palea 2 -veined. Palea keels winged; narrowly winged; ciliolate. Palea surface pilose; with turgid hairs. Apical sterile florets resembling fertile though underdeveloped.

FLOWER Lodicules 2; cuneate; fleshy; ciliate.

FRUIT Caryopsis with tardily free pericarp.

(Extract from Clayton, W.D, Harman, K.T. and Williamson, H. (2006) Grassbase – The Online World of Grass Flora, http:www.kew.org/data/grasses-db.html (accessed 5 May 2007)).