



JURIEN BAY PYP GRASS (*Ehrharta villosa*) MANAGEMENT PLAN

Western Botanical for the Northern Agricultural
Catchments Council
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Supporting people to support the natural environment



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EXECUTIVE SUMMARY

Pyp Grass (*Ehrharta villosa*) was introduced into Australia for use in dune stabilisation. However, as an aggressive invader with biological adaptations to dry situations it is known to smother and replace native vegetation, threatening the biodiversity of the Western Australian coastal ecological communities.

The coastal dunes at Jurien Bay are a key natural asset, providing ecosystem services to the town including coastal protection and tourism

Broadly, five infestations of Pyp Grass have been located at Jurien Bay, in both foredunes and inland locations. This Management Plan details these locations and the density of the infestations and provides Management Options for their control and the re-establishment of native vegetation in affected areas. These options include (but are not limited to) spraying of affected areas and monitoring of sample quadrats placed in affected areas to assess the efficacy of control measures and the return of native vegetation.

Spraying using Verdict® 520 is presented as the primary Management Option. Other options including manual removal and 'weed wiping' are discussed and the suggestion is made that these are activities that local community groups can become involved in as a low cost option to achieve eradication. A monitoring program using NACCs Smartphone App 'Photomon' is also outlined, with suggestions for photo-monitoring points made and discussed.

Weed control activities and the area of application have been prioritised to provide a planning tool for management of Pyp Grass at Jurien Bay. A staggered program of work is outlined as a suggestion for proceeding with management.

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1. INTRODUCTION

Jurien Bay is a coastal town in the Central West region of Western Australia, approximately 220 km north of Perth. It is the seat of local government for the Shire of Dandaragan and the largest community in the Shire.

Native vegetation on coastal dunes provides stabilisation of mobile sands through the establishment of complex, deep root systems. In Jurien Bay the integrity of the indigenous dunal vegetation is being impacted by the invasion of Pyp Grass (*Ehrharta villosa*), resulting in a loss of biodiversity and degradation of native habitat.

Baseline data of areas infested with Pyp Grass was collected in 2013, with the aim of informing a Management Plan for the Jurien Bay Pyp Grass. Areas of Pyp Grass infestation were revisited in 2014, revised and updated for this Management Plan.

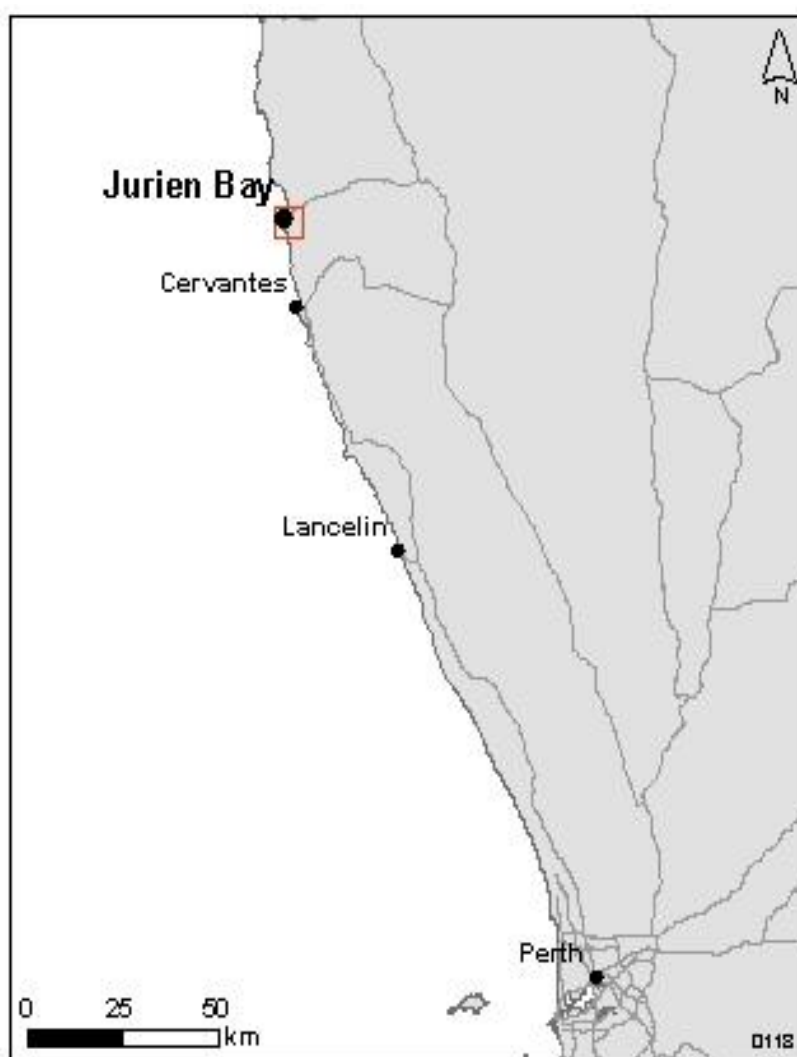


Figure 1 Location of Jurien Bay

1.1 Project Brief

The objective of this project is to develop a Management Plan, which provides clear guidance and a practical strategy to manage and remove Pyp Grass from the coastal reserves of Jurien Bay.

The Management Plan should provide a staged works program detailing the works, locations and timing required for Pyp Grass eradication as well as indicative costings to inform funding applications.

A photo-monitoring program using NACCs Smartphone App 'Photomon' should be established as part of the Management Plan, including suggestions for monitoring points to gauge the success of future eradication and rehabilitation works.

1.2 Significance of Coastal Dunes

Coastal beaches and dunes provide humans with important 'ecosystem services' such as raw materials, coastal protection, erosion control, water catchment and purification, carbon sequestration, tourism, recreation, education and research (Barbier *et al*, 2011) as well as 'non-use value' services such as wildlife habitat and biodiversity conservation.

Coastal protection is one of the most valuable services provided by sand shore ecosystems, especially in the context of extreme storms and sea level rise. Waves are attenuated by the beach slope, dissipating their energy and protecting the hinterland beyond. In the case of storms, the foredune assists this function.

Dunes provide sediment stabilisation and soil retention in vegetation root structures, thereby helping to protect beaches against coastal erosion, which in turn assists to preserve tourism-related business, general infrastructure, and wildlife habitat.

The coastal dunes at Jurien Bay provide these 'ecosystem services' to the town and its hinterland.

1.3 Pyp Grass (*Ehrharta villosa*)

Origin

Pyp Grass is endemic to South Africa, and was introduced to Western Australia for use in dune stabilisation. Its quick growth and long lateral rhizomes were thought to be ideal for fast establishment and sand binding in mobile environments.

Environmental Weed Ranking

Ehrharta villosa is rated as a Moderate environmental weed by the *Environmental Weed Strategy for Western Australia* (CALM 1999). Criteria used to assign this ranking were developed as part of the National Weed Strategy and are:

Invasiveness - possessing the ability to invade bushland in good to excellent condition, or the ability to invade waterways;

Distribution – having a wide current or potential distribution including consideration of known history of widespread distribution elsewhere in the world;

Environmental Impacts – possessing the ability to change the structure, composition and function of ecosystems, in particular an ability to form a monoculture in a vegetation community.

These criteria are scored as a Yes or No. *Ehrharta villosa* scores Yes for two categories, Invasiveness and Distribution and is therefore ranked as Moderate. A species ranked as moderate “would indicate that control or research effort should be directed to it if funds are available, however it should be monitored (possibly a reasonably high level of monitoring)” (CALM 1999, Appendix 1 p58).

Following observation of densities of Pyp Grass at locations at Jurien Bay, where the grass is at greater than 50% PFC (projected foliage cover) and restricting or choking out indigenous species to form a monoculture, this Management Plan suggests that the ranking of this weed should be raised to High as it scores Yes for the third category of Environmental Impacts. A High ranking would indicate prioritising this weed for control and/or research, which is the aim of this Management Plan.

Ehrharta villosa is not a Declared Pest in Western Australia under the *Biosecurity and Agriculture Management Act 2007* (DAFWA, 2014). It is not a Weed of National Significance (Weeds Australia, 2014). As such, there is no requirement for landholders to undertake control or eradication of the weed.

Ecology

Pyp Grass is a perennial grass that colonises sandy conditions by its fast-growing rhizome system. It is adapted to warm conditions, a range of light intensities and habitats with mobile sand (WAH, 2014). Its vigorous rhizomatous habit can spread the plant up to 9 metres in one year (Harrington *et al*, 1998), but the plant rarely sets viable seed (Herbiguide, 2014).

The plant has morphological adaptations to dry environments, with sunken stomata shielded by cuticular flanges and in-rolled leaves that present only adaxial surfaces with very few stomata to the sun and wind. These adaptations help to prevent water loss from the leaf and provide a selective advantage to the plant. With these adaptations, Pyp Grass is an aggressive coloniser, out-competing indigenous species, and reducing species and habitat diversity.

Pyp Grass occurs in sandy soil close to the coast, and appears to prefer mobile environments as senescence has been noted in the species where sand movement has been reduced (FAO, 2014). This observation aligns with the experience at Jurien Bay, where *Ehrharta villosa* is observed occurring in dense *Acacia* regrowth on secondary stable dunes with no sand movement. In this habitat the plant shows signs of senescence and ‘dying back’ in older leaves, however still produces new green shoots.

Plates 1 and 2 overleaf illustrate the structure and habit of *Ehrharta villosa* to aid identification of the weed in the field



Plate 1 *Ehrharta villosa* showing structure of leaf and plant
(Flora of New Zealand, 2014)



Plate 2 *Ehrharta villosa* new growth in unconsolidated sand

1.4 Methods

Known populations of Pyp Grass in Jurien Bay were resurveyed over a two day period in May 2014. Boundaries were marked using hand-held GPS (Garmin Cx60), with notes taken of densities. Searches were also conducted near to existing populations and new populations located with boundaries mapped by the same method.

Populations were then prioritised for management based on defined criteria (Section 2.4) and assigned a treatment program and costing.

1.5 Pyp Grass in Jurien Bay

The following populations of Pyp Grass have been identified in Jurien Bay. Vegetation condition is assessed using the scale of Keighery as published in *Bush Forever* (Western Australian Government, 2000). The Scale is reproduced as Attachment 1 for reference. The Table accompanying each site's detail gives the area covered by the infestation, giving an indication of its size and of the various densities of Pyp Grass present. This information enables costing of works, especially spraying.

Reserve and UCL is shown on the accompanying maps, however land tenure includes privately owned land in some cases and the permission of the relevant landowner should be sought prior to work being undertaken. Land tenure information is available from the Western Australian Government Department Landgate under an End User licence, although similar information may be available from the LGA. Tenure is likely to be a mixture of private and government ownership, including Main Roads Western Australia.

Site 1: Seaward Drive

Composed of several different infestations around the junction of Seaward Drive and Jurien East Road. Vegetation is in variable condition, ranging from Excellent to Good, with Degraded to Completely Degraded on firebreaks and tracks. Access is generally good, although some sections are composed of dense *Acacia rostellifera* and access is restricted in these. Figure 2 (page 17) shows the extent of Pyp Grass infestation at the Seaward Drive site and the estimated densities. Plate 3 shows Pyp Grass on the southern side of Jurien Road East.

Land Tenure: Tenure of the Seaward Drive site is a mixture of Reserve and Unallocated Crown Land (UCL). Vesting of UCL rests in the Shire of Dandaragan, and permission will need to be obtained from the Shire and from DPaW for the Reserve land prior to spraying commencing.

Table 1: Pyp Grass Density and Area, Seaward Drive

Site	Density	Area Sqm	Area Ha
1	<5	28215	28.22
1	5-50	17047	17.05
1	>50	10429	10.43
Total		55691	55.70



Plate 3 Seaward Drive Pyp Grass

Site 2: Ackland Street

The infestation is between Ackland Street and Whitfield Road, facing Jurien East Road. It has increased in density and area since its initial mapping, although the bushland is still in Excellent condition except for the firebreaks and some clearing on the western side. Access is good, with firebreaks on three sides. Figure 3 (page 18) maps the extent of Pyp Grass infestation at the Ackland Street site and shows the estimated densities. Plates 4 and 5 give an overview of the site.

Land Tenure: Tenure at the Ackland Street site is a mixture of UCL and Reserve. Permission should be gained from the Shire of Dandaragan and relevant authorities.

Table 2: Pyp Grass Density and Area, Ackland Street

Site	Density	Area Sqm	Area Ha
2	<5	1890	1.90
2	5-50	1589	1.60
Total		3479	3.50



Plate 4 Ackland Street Pyp Grass, from Bashford Street



Plate 5 Ackland Street Pyp Grass from the western firebreak

Site 3: Heaton/Dalton and War Memorial

This site is composed of three infestations on the foredune facing Heaton Street and Dalton Street, and also further north near the Jurien Bay War Memorial. Vegetation here is ranked as in Good-Very Good condition, although this may change rapidly as the density of the Pyp Grass increases. Access is good, with roads and paths providing entry to the populations. Figure 4 (page 19) shows the extent of Pyp Grass infestation at the Heaton/Dalton and War Memorial site and the estimated densities. Plates 6 and 7 show various parts of the infestation.

Land Tenure: The coastal infestation at the Heaton/Dalton site is on UCL, and permission will need to be sought from the Shire prior to spraying. The smaller infestation adjacent to the War Memorial is on Reserve, and permission will need to be sought from the relevant Authority.

Table 3: Pyp Grass Density and Area, Heaton/Dalton and War Memorial

Site	Density	Area Sqm	Area Ha
3	<5	8453	8.45
3	5-50	13899	13.90
3	>50	8688	8.70
Total		31040	31.05



Plate 6 Heaton/Dalton Street Pyp Grass



Plate 7 Heaton/Dalton Street showing Pyp Grass spreading at the front of the foredune. *Spinifex longifolius* in the background.

Site 4: Shingle Avenue

The Shingle Avenue infestation occurs on the foredune towards the south-western end of Jurien Bay. The vegetation condition here is ranked as Good, with the majority of the infestation density over 50%. Access to the site is good, with roads to it and footpaths through the centre. Figure 5 (page 20) shows the extent of Pyp Grass infestation at the Shingle Avenue site and the estimated densities. Plate 8 shows a portion of the infestation.

Land Tenure: The entire Shingle Avenue infestation is on Reserve.

Table 4 Pyp Grass Density and Area, Shingle Avenue

Site	Density	Area Sqm	Area Ha
4	<5	2892	2.90
4	5-50	4802	4.80
4	>50	7806	7.80
Total		15500	15.50



Plate 8 Shingle Avenue Pyp Grass from the central path, >50% density

Site 5: Bashford Road (South)

An infestation that starts on the northern side of Bashford Road at the southern entry to Jurien Bay. Investigation in 2014 found a new infestation on the southern side of the road opposite this known population. Vegetation here is in varied condition, ranging from Excellent to Degraded. The Pyp Grass here is often in dense stands of *Acacia rostellifera*, especially to the north of Bashford Road, making access and eradication a challenge, although there are considerable stands in the open also. Figure 6 (page 21) shows the extent of Pyp Grass infestation at the Bashford Road (South) site and the estimated densities. Plates 9 and 10 show different sections of the infestation.

Land Tenure: The Bashford Street (South) infestation sits largely on private property, with parts on the road reserve through which Bashford Road passes. Permission should be sought from relevant landowners prior to any weed management taking place.

Table 5 Pyp Grass Density and Area, Bashford Road (South)

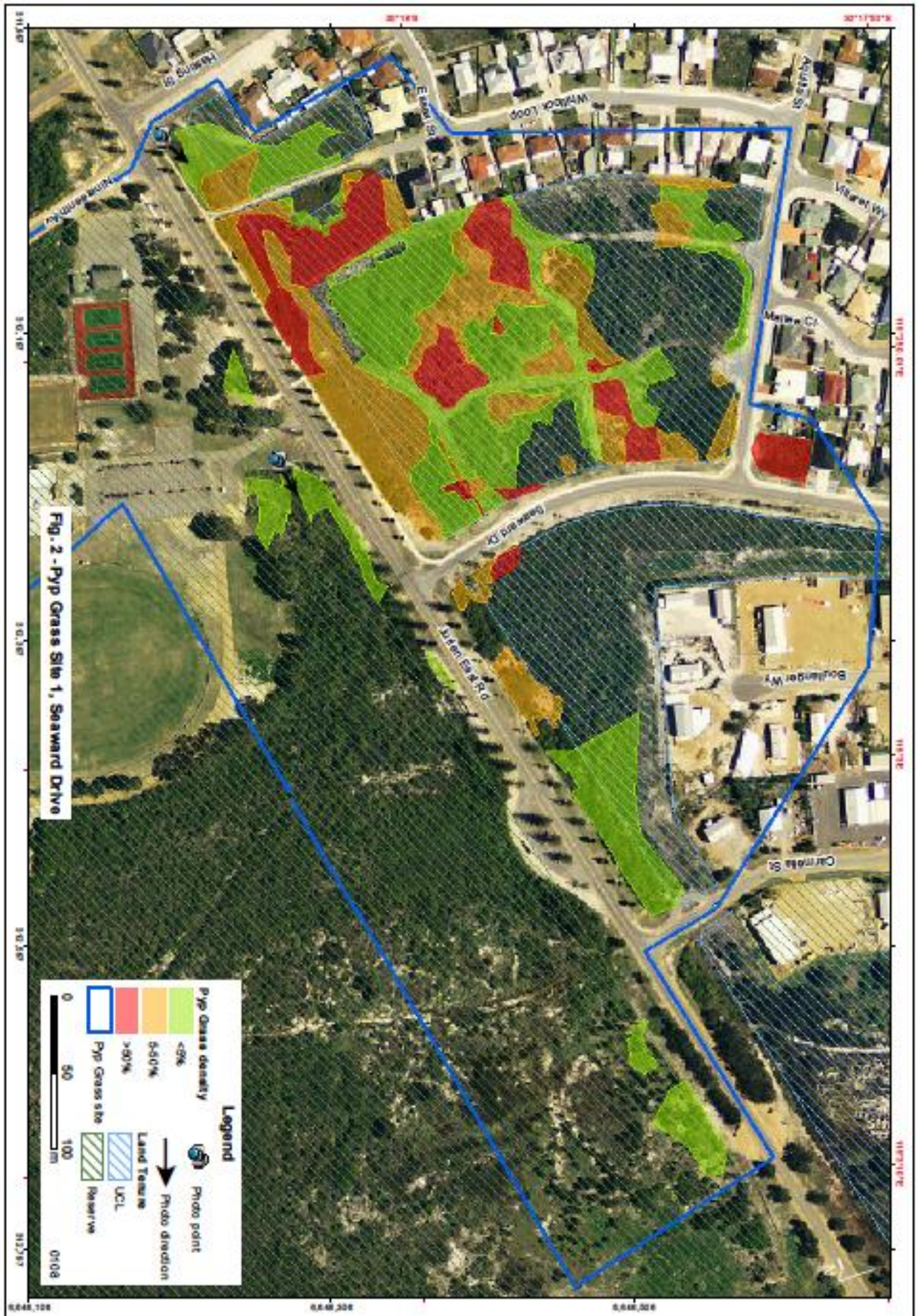
Site	Density	Area Sqm	Area Ha
5	<5	15105	15.10
5	5-50	19789	19.80
5	>50	11447	11.45
Total		46341	46.35

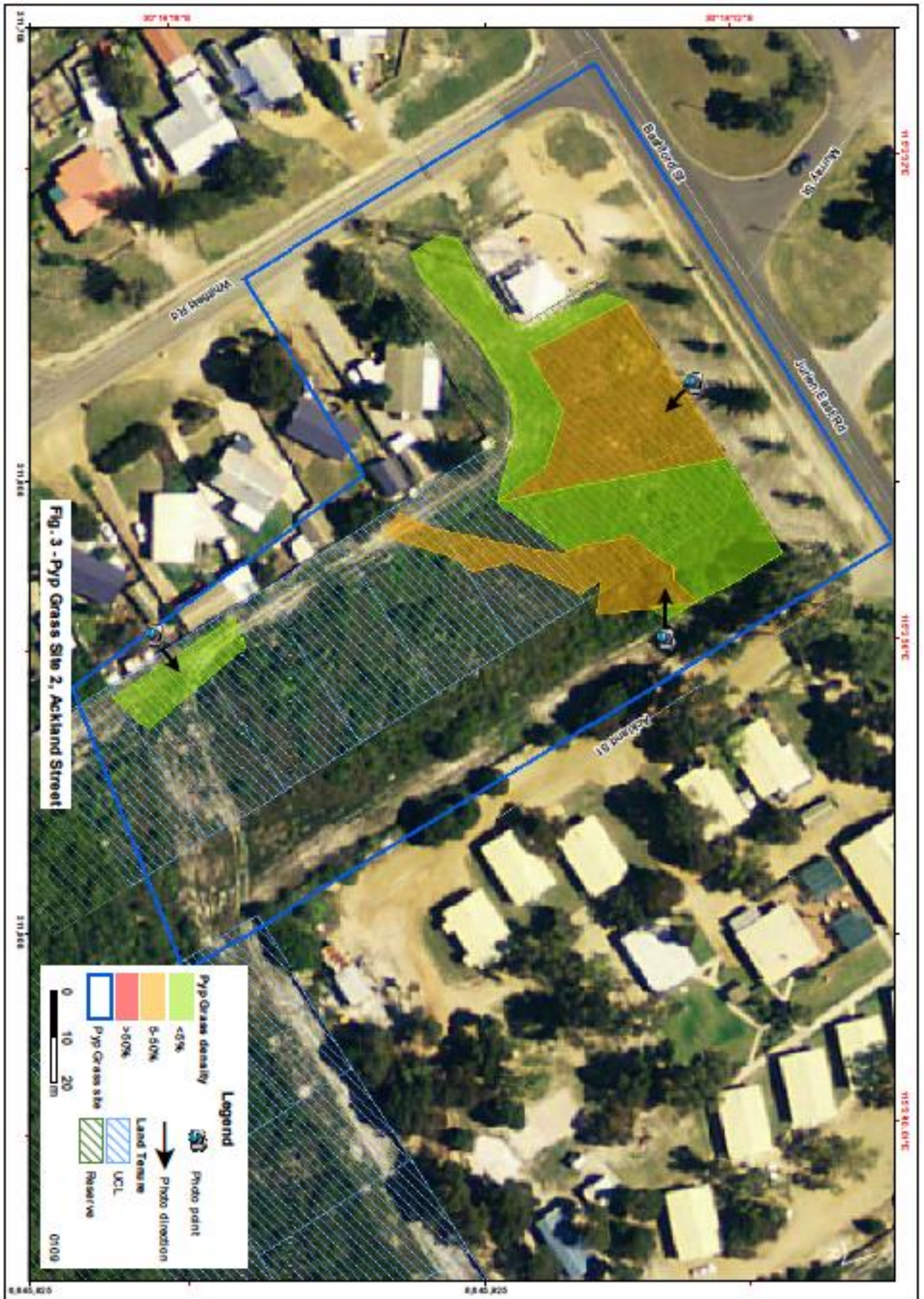


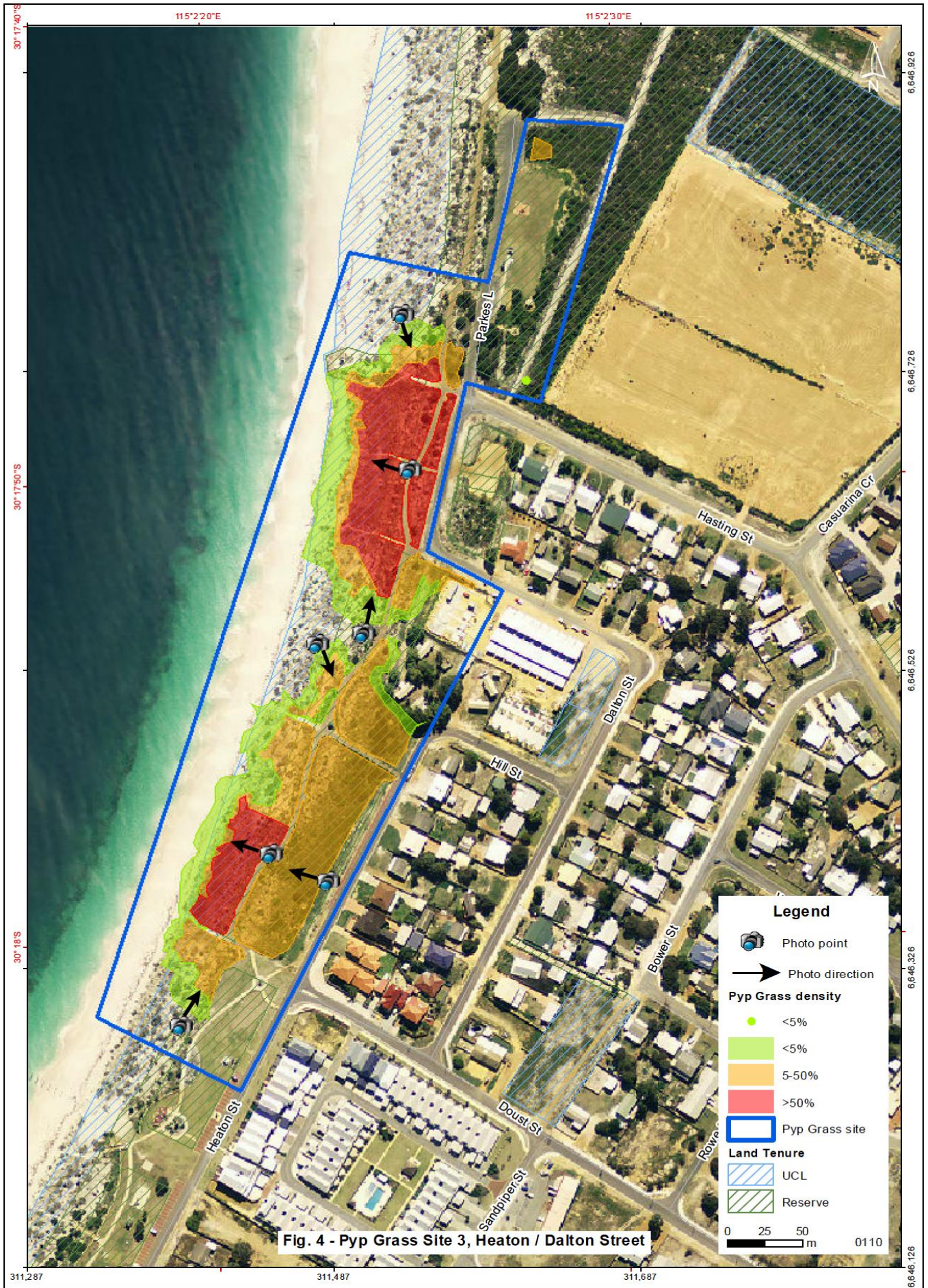
Plate 9 Pyp Grass in dense *Acacia rostellifera* scrub, Bashford Road (South).

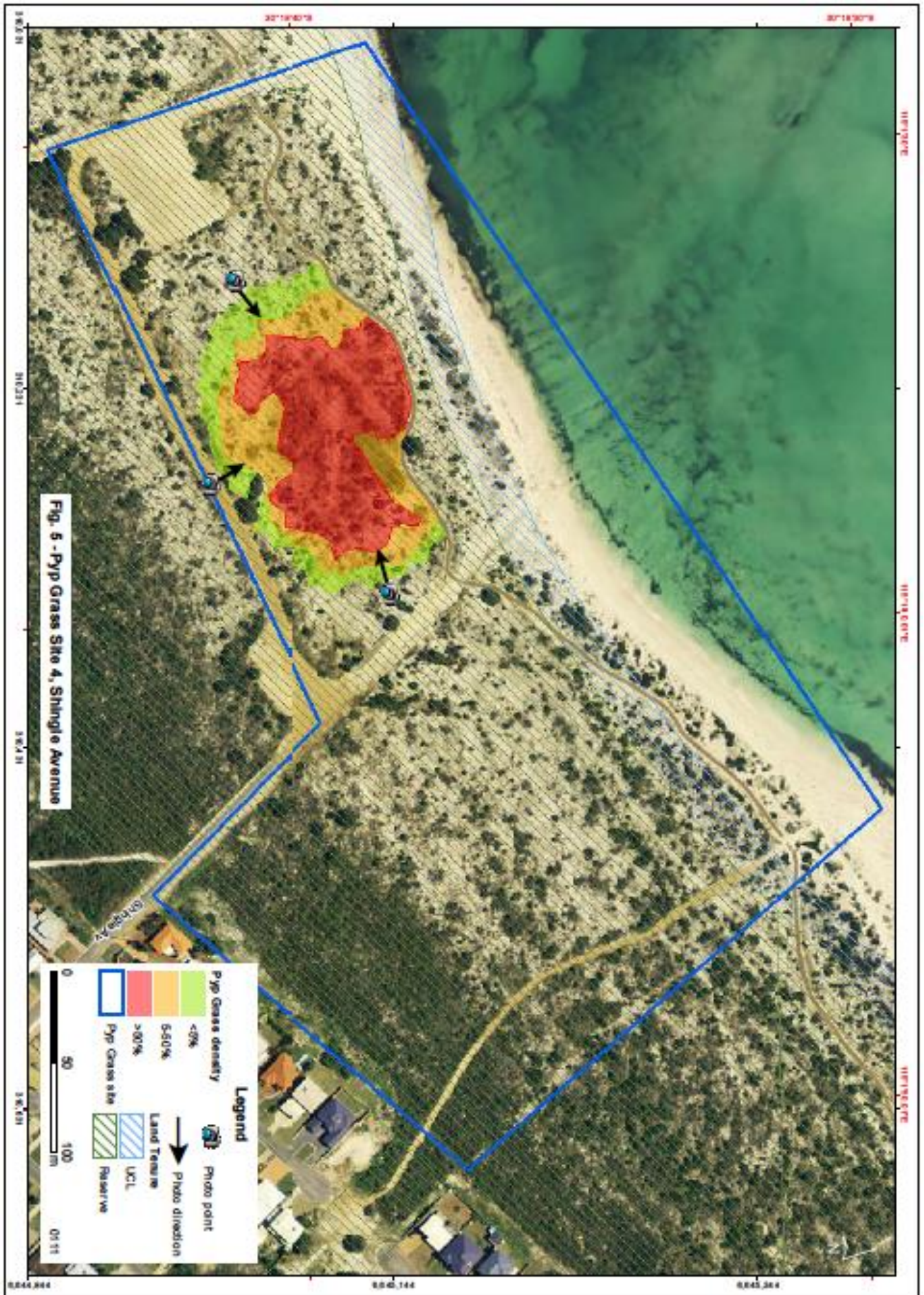


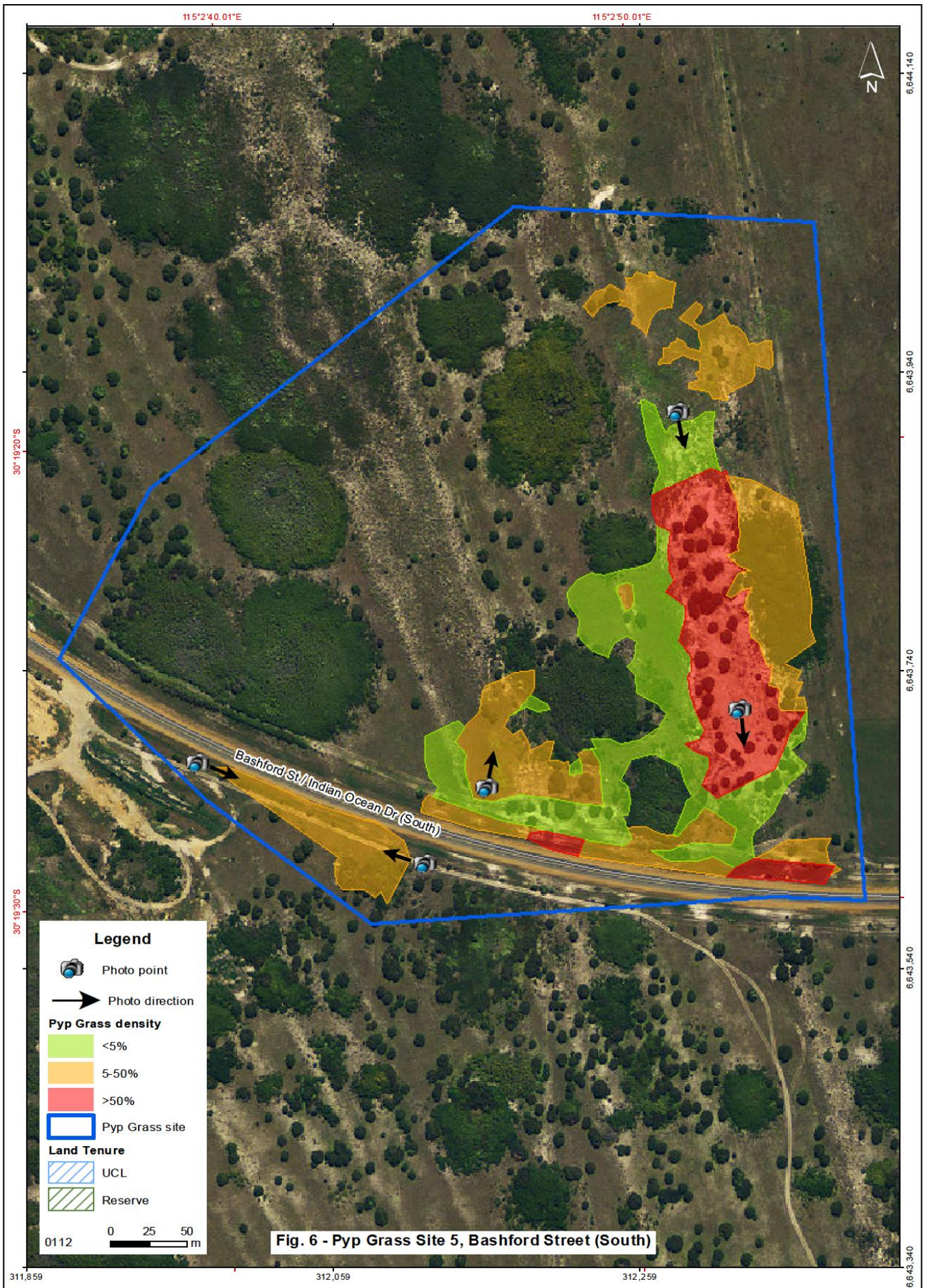
Plate 10 Pyp Grass on secondary dune, Bashford Road (South)











2. MANAGEMENT OBJECTIVES AND STRATEGIES

2.1 Management Objectives

The objectives of this Management Plan and the actions proposed therein are:

- a) to prevent the further establishment of Pyp Grass in new locations at Jurien Bay;
- b) to prevent the further spread of existing infestations of Pyp Grass at Jurien Bay;
- c) to eradicate existing populations of Pyp Grass from the dunes and hinterland at Jurien Bay; and
- d) to monitor existing populations and ensure that new infestations are recorded and allocated a treatment program.

2.2 Management Options

Options available for management and treatment of Pyp Grass are:

- Physical removal;
 - Manually
A labour intensive method of weed removal. Care has to be taken not to leave rhizomes behind as these may regrow and continue the infestation. A useful method for areas in which other methods, e.g. spraying, are impractical due to the potential for damage to sensitive native vegetation. This option may be utilised by interested community groups, where the use of volunteers is more cost effective.
 - Machinery
Useful in areas of dense infestation where impacts on native vegetation are not an issue. Raises issues of importing fill to replace soil removed and potential for further weed problems. Would be best suited to large, high density infestations with little or no remaining native vegetation, and is therefore not suitable for consideration in Jurien Bay.
- Installation of root barriers;
Can be labour intensive and impact on native vegetation due to the need for trenching to install barrier. Effective if installed correctly, however needs monitoring to ensure Pyp Grass is contained and may only be effective in the short term. The use of compacted crushed limestone in trenches is suggested if this method is to be trialled.
- Physical treatment then spraying of regrowth (e.g. brushcutting)
Brushcutting, slashing or burning of Pyp Grass and then spraying of the regrowth has been suggested as a potential control measure. This option would only work in high density infestations with little or no remaining native vegetation. There is no evidence to suggest that spraying of regrowth in this situation would be any more efficacious than spraying the original plant, and this option is not considered further.
- 'Weed wiping' chemical application
This option has potential for use where Pyp Grass infestations are in stands of sensitive plants such as *Spinifex longifolius*. However, the waxy cuticle of the Pyp Grass leaf may reduce the pesticide uptake to the point where it is ineffective, and this method may need trialling. The point of entry of the pesticide to the Pyp Grass leaf is given as being at the

leaf axils where the cuticle is thinner or absent (Bright, 2012), and weed wiping may not provide sufficient chemical to ensure a 'kill'. If proved effective, this option may be suitable for use by volunteers in conjunction with mechanical removal.

- Spraying only;

Verdict[®] 520, a chemical brand with the active ingredient Haloxypop, is registered as a spray treatment for post-emergent control of a wide range of grass weed species and has been previously trialled by NACC for Pyp Grass. This option provides an effective, relatively low cost treatment but has the potential to impact native grass species occurring in the target areas. Use of this option relies on the skill, knowledge and experience of the pesticide operator and their ability to recognise susceptible native species to reduce unintended impacts.

Control by spray application is limited by the ability of the plant to absorb the chemical. DAFWA advice is that maximum uptake occurs at the base of the actively growing leaves before the waxy cuticle has developed (NACC 2012).

- Biological;

No biological control for Pyp Grass is currently known.

- Targeted Replanting;

Management of Pyp Grass may impact native vegetation through two avenues:

- **Spray drift or overspray.** When spraying, non-target species may be impacted by spray drift even in low wind conditions, or be sprayed directly despite the best efforts and skill of the spray operator.
- **Physical Removal.** When removing Pyp Grass, especially by mechanical means but also by manual techniques, adjacent native species may be damaged by, for example, root disturbance or entanglement with the weed.

In some instances it may be preferable to accept this sort of 'collateral damage' if it facilitates the primary aim of the exercise, i.e. the removal of the Pyp Grass. In this circumstance, the return of native species can be enhanced by the planting of selected species to replace the losses. Plants grown for this purpose should be propagated from locally collected seed or cutting material so as to protect the provenance of the plants and provide plants grown from stock completely adapted to the local conditions. Early planning for this activity is recommended.

- Monitoring;

Treatment should be monitored to gauge its success and inform the future management program for the Pyp Grass. The use of control and impact quadrats is suggested. NACC has also been behind the production of a Smart Phone App 'Photomon' that will be used by volunteers to monitor changes in vegetation over time.

2.3 Management Strategies

Five Management Strategies are considered for management of Jurien Bay Pyp Grass.

- 1) Spraying with Verdict® 520: this will be the prime method of control as it is the most cost-effective.
- 2) Weed wiping: will be trialled to target Pyp Grass that is in close proximity to vulnerable native species in the foredune infestations.
- 3) Manual removal: also to be used for Pyp Grass that is in close proximity to vulnerable native species in the foredune infestations.
- 4) Targeted replanting: Areas in which removal or chemical control of Pyp Grass will impact vulnerable native species will be replanted with selected native species grown from local stock.
- 5) Monitoring: Monitoring photo points will be established and marked to facilitate volunteers photo monitoring with Photomon.

2.4 Prioritisation

When deciding the order in which management of the Jurien Bay Pyp Grass infestations is undertaken, the following order was decided upon:

Foredunes: the foredunes are a sensitive habitat where Pyp Grass is able to spread swiftly in unconsolidated sand, and species of *Spinifex* are susceptible to the chemical used to control it. These are areas that may be in need of supplementary planting following chemical treatment, as well as either manual removal, weed wiping, or a combination of both.

Lower Density Pyp Grass and Higher Density of Native Species: These are areas that will provide good management results for effort spent. With a high density of native species, meaning that vegetation should be in a very good to excellent condition, recovery from chemical application should be rapid.

Higher Density Pyp Grass and Lower Density of Native Species: These are areas that will be easier for chemical application but will need ongoing treatment with supplementary planting to recover fully due to their poorer condition.

Priority 1: Site 3 Heaton/Dalton St and War Memorial

This site, currently composed of three separate infestations, has the potential to spread considerably in the unconsolidated sand of the foredune, with two of the infestations close to joining into one population. Parts of this site are complicated in their treatment by the presence of *Spinifex longifolius*, a native grass susceptible to Verdict® 520. Due to its potential for expansion, this population is suggested as the first priority for treatment.

Land Tenure: The coastal infestation at the Heaton/Dalton site is on UCL, and permission will need to be sought from the Shire prior to spraying. The smaller infestation adjacent to the War Memorial is on Reserve, and permission will need to be sought from the relevant Authority.

Priority 2: Site 4 Shingle Ave

This site faces the same problems and has the same potential as the Heaton/Dalton site but is currently smaller.

Land Tenure: The entire Shingle Avenue infestation is on Reserve.

Priority 3: Site 1 Seaward Drive

Attention should be given here firstly to the smaller populations on the eastern and western sides of Jurien East Road, then the block on the corner of Seaward Drive/Jurien East Road. Populations here are growing in denser sand than the unconsolidated dune populations and are likely to spread more slowly, and the large block is bounded by roads on three sides, which will restrict its spread. Control here is complicated by the presence of the native grass *Austrostipa elegantissima*, which is also susceptible to Verdict® 520.

Given that there is dense *Acacia rostellifera* growth in a large part of this site, the only feasible option once the accessible portions are eradicated may be a holding action targeting the edges to ensure there is no further spread of the infestation.

Land Tenure: Tenure of the Seaward Drive site is a mixture of Reserve and Unallocated Crown Land (UCL). Vesting of UCL rests in the Shire of Dandaragan, and permission will need to be obtained from the Shire and from DPaW for the Reserve land prior to spraying commencing.

Priority 3: Site 2 Ackland St

While dense at the front of the block, this infestation is bounded on three sides by a road and firebreaks. The weed 'front' is narrow and should be simple to control and eradicate.

Land Tenure: Tenure at the Ackland Street site is a mixture of UCL and Reserve. Permission should be gained from the Shire of Dandaragan and relevant authorities.

Priority 4: Site 5 Bashford St (South)

This is a problematic site. Much of it north of Bashford Road is covered by dense *Acacia* regrowth and difficult to access. Investigation revealed that the infestation was also on the south side of Bashford Road, and as this is smaller it may be eradicable if action is taken soon. This section should be given consideration for Priority 1 status, however encroaching development may overtake the site and remove the infestation.

2.5 Management Strategy 1: Spray with Verdict® 520

Following Section 2.4, priority should be given to spraying infestations in the order suggested. Spraying will be the primary management tool used under this Management Plan.

2.6 Management Strategy 2: Weed Wiping

Weed wiping is presented as an option in areas where susceptible native species are present in a proximity to Pyp Grass that would result in them being impacted during spraying operations. The efficacy of this method is not guaranteed due to the mode of entry of chemical into the plant, however there may be application in situations where the impact of spraying on native species is considered unacceptable.

This strategy is perhaps best suited to community groups and/or the Green Army supervised by NACC Officers, and can be implemented following assessment of the results of the implementation of the first Management Strategy and following appropriate trials. In order to supervise pesticide application in this manner, NACC personnel (or one of the volunteers) would need to hold a Pest Management Technician Licence under the Health (Pesticides) Regulations 2011, issued by the Western Australian Department of Health, with a Bushland/Minesite Weeds endorsement. Attainment of this Licence will require attendance at a one-day course provided by a Registered Training Organisation.

2.7 Management Strategy 3: Manual Removal

This Strategy will be labour intensive and is therefore suggested as a method volunteers from interested community groups, supervised by NACC Officers, may use. Decisions on its use should be made following assessment of the effectiveness of the first Management Strategy.

2.8 Management Strategy 4: Targeted Replanting

Species used for targeted replanting should be indigenous to the area to be planted, and sourced from seed or cutting stock local to the area. This will produce plants specifically adapted to local conditions. This Management Strategy should be used from the second year of management under this Management Plan, allowing time for assessment of first year spraying and planning of seed collection and propagation. Costs will be more easily determined at this point.

2.9 Management Strategy 5: Monitoring

Monitoring needs to be undertaken in order to measure the effectiveness of the management strategies. Two monitoring options are presented here, and it is suggested that a combination of both be used where resources will allow.

Monitoring Quadrats

Monitoring quadrats of 10m x 10m should be established and assessed in both unaffected areas (control) and affected areas (impact) prior to weed control commencing. It is suggested that at least one quadrat should be established in each Pyp Grass density at each site, but depending on resources a higher number of quadrats will provide more reliable and comprehensive data in the long term. Once weed control has been implemented, quadrats should be monitored at least annually to assess the efficacy of treatments and the re-establishment of native species.

Quadrat assessment will provide a complete species list for each quadrat, measure the projective foliage cover of each species and include edaphic data such as aspect, bare ground and leaf litter percentage. These measurements will provide data that can be statistically analysed if required at a later time.

Specific location of monitoring quadrats should be decided in consultation with NACC and stakeholders prior to establishment and following on-ground assessment.

Photo-monitoring Reference Points

Use of the Photomon Smartphone App

Photomon is a Smartphone application, currently supported by iPhone and Android platforms, which has been designed by NACC to improve the quality of data collected in environmental photo-monitoring programs. Photomon won the Digital Innovation category of the Goodness Sustainability and Innovation Awards in 2013. Funding for development of Photomon was provided by Coastwest, an initiative of Planning Western Australia.

Photomon improves the quality of photo-monitoring data by:

- The overlay of transparent reference photos (selected by the user) for a consistent Field of View in each photograph;
- Automatic labelling and uploading of monitoring photos to the NACC database, using the cellular network or wifi;
- Allowing program coordination to occur via the NACC database; and
- A reminder function to prompt regular monitoring.

In the context of Jurien Bay Pyp Grass management, the Photomon app will allow volunteers to monitor Pyp Grass management and native vegetation recovery using a Smartphone connected to the NACC database without the purchase or loan of more expensive equipment.

It is suggested that photo-monitoring points are marked with a plaque or similar device at each of the populations of Pyp Grass documented in this Management Plan. These points can then be used to monitor, at a minimum annually, the results of management options undertaken as a result of this Management Plan. Exact locations and numbers of photo-monitoring points will be selected after consultation with NACC and other stakeholders, but suggestions are made here and included in **Figures 2-6:**

Site 1 Seaward Drive

As much of this infestation is in dense bushland, options are limited in regards to the major portion of the infestation. It is suggested that photo-points are placed at:

- On the south side of Jurien East Road at the corner of the driveway into the Community Centre, looking east;
- On the northern side of Jurien East Road near the corner of Hasting Street, facing east;
- One or two further locations selected from on-ground examination, as much of the infestation occurs in dense shrubland.

Site 2 Ackland Drive

- At a point on the side of the infestation facing Bashford St;
- On the eastern boundary of the infestation looking west;
- On the firebreak on the western side, looking east.

Site 3 Heaton/Dalton Street

Splitting this infestation into two sections, a North and a South;

North:

- One point at each end of the section;
- A point along the footpath inside the infestation, targeting the >50% density infestation;
- On the corner of Dalton St and Parkes Lane, targeting the 5-50% density infestation;

South, following a similar pattern to the north section:

- One point at each end of the section;
- One point along the internal footpath targeting the >50% density;
- One point along Heaton St looking west, targeting the 5-50% density.

Site 4 Shingle Avenue

Following a similar format to Site 3:

- One point at each end of the infestation (W-E);
- One point in the centre targeting the >50% density infestation;
- One point on the seaward side showing the boundary of the >50% density infestation;
- One point adjacent to the road on the landward side of the infestation.

Site 5 Bashford South

- One point (perhaps two) monitoring the recently mapped infestation on the south side of Bashford St/Indian Ocean Dr;
- Two points at the northern tip of the infestation;
- At least one point in the centre of the major >50% density infestation;
- At least one point on the northern side of Bashford St/Indian Ocean Dr showing the 5-50% density infestation.

2.10 Costing of Management Strategies

Costing of items for this Management Plan has been restricted to Spraying and Monitoring components over 3 years. Management Strategies involving volunteers and community groups have not been costed as the extent and nature of costs is currently unknown. Targeted replanting programmes will be costed when species and numbers are known, which is expected for the second year of implementation.

Management Strategy 1: Spraying

Table 6 Costing for Spraying Works (including GST)

Priority	Location	Action	Recommended Timing	Area (ha)	Cost Estimate
1	Heaton/Dalton St and War Memorial	Spray all Pyp Grass	Autumn 2015	3.10	\$8,239.12
2	Shingle Avenue	Spray all Pyp Grass	Autumn 2015	1.55	\$2,514.26
3	Seaward Drive	Spray all Pyp Grass	Autumn 2015	5.57	\$13,398.30
3	Ackland St	Spray all Pyp Grass	Autumn 2015	0.35	\$577.16
4	Bashford St	Spray all Pyp Grass	Autumn 2015	4.63	\$15,375.68
1	Heaton/Dalton St and War Memorial	Spray all Pyp Grass	Spring 2015	3.10	\$8,239.12
2	Shingle Avenue	Spray all Pyp Grass	Spring 2015	1.55	\$2,514.26
3	Seaward Drive	Spray all Pyp Grass	Spring 2015	5.57	\$13,398.30
3	Ackland St	Spray all Pyp Grass	Spring 2015	0.35	\$577.16
4	Bashford St	Spray all Pyp Grass	Spring 2015	4.63	\$15,375.68
1	Heaton/Dalton St and War Memorial	Respray all Pyp Grass	Autumn 2016	3.10	\$5767.38
2	Shingle Avenue	Respray all Pyp Grass	Autumn 2016	1.55	\$2039.98
3	Seaward Drive	Respray all Pyp Grass	Autumn 2016	5.57	\$10778.81
3	Ackland St	Respray all Pyp Grass	Autumn 2016	0.35	\$404.01
4	Bashford St	Respray all Pyp Grass	Autumn 2016	4.63	\$10762.98
1	Heaton/Dalton St and War Memorial	Respray all Pyp Grass	Spring 2016	3.10	\$5767.38
2	Shingle Avenue	Respray all Pyp Grass	Spring 2016	1.55	\$2039.98
3	Seaward Drive	Respray all Pyp Grass	Spring 2016	5.57	\$10778.81
3	Ackland St	Respray all Pyp Grass	Spring 2016	0.35	\$404.01
4	Bashford St	Respray all Pyp Grass	Spring 2016	4.63	\$10762.98
1	Heaton/Dalton St and War Memorial	Respray all Pyp Grass	Autumn 2017	3.10	\$5767.38
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3	Ackland St	Respray all Pyp Grass	Autumn 2017	0.35	\$404.01
4	Bashford St	Respray all Pyp Grass	Autumn 2017	4.63	\$10762.98
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2	Shingle Avenue	Respray all Pyp Grass	Spring 2017	1.55	\$2039.98
3	Seaward Drive	Respray all Pyp Grass	Spring 2017	5.57	\$10778.81
3	Ackland St	Respray all Pyp Grass	Spring 2017	0.35	\$404.01
4	Bashford St	Respray all Pyp Grass	Spring 2017	4.63	\$10762.98

There is an expected 30% reduction in spraying costs after the initial year of treatment. Subsequent treatments and costings depend on efficacy of previous treatments, and may differ from those outlined in Table 6.

Management Strategy 5: Monitoring

Tables 7 and 8 below provide provisional costings for the proposed monitoring works. This costing focuses on Table 7 shows costings for the first year of monitoring, which includes time for establishment and extra costs for materials. Following discussion with members of the Jurien Bay Herbarium Group, these costings have been based on one botanist assisting and training Herbarium members. Using this model, Jurien Bay Herbarium members would take responsibility for further monitoring and data management.

Table 7 Provisional Monitoring Costs, Year One

Item	Notes	Qty	Unit	Rate	Cost
Jurien Bay Pyp Grass Monitoring Program Year One Establishment					
HSEC and Project Management	Project Manager	6	hrs	95	\$570
Field Visit	Senior Botanist	20	hrs	95	\$1,900
Mobilisation/Demobilisation	Botanist	2	hrs	90	\$180
Specimen Identifications	Senior Botanist	4	hrs	95	\$380
Data Management	Botanist	8	hrs	90	\$720
Reporting	Senior Botanist	40	hrs	95	\$3,800
Vehicle	FRCP Nissan Patrol	2	days	110	\$220
Mileage	\$0.55/km	500	km	0.55	\$275
Accommodation	Jurien Bay Caravan Park	1	allow	130	\$130
Meals	\$50 pp/day	2	ea	50	\$100
Consumables	(Stakes etc)	allow		150	\$150
Subtotal					\$8,425
GST					\$842.5
TOTAL					\$9,267.5

While the use of monitoring quadrats combined with photomonitoring will provide NACC with both concrete and observational data with which to assess the success of the works program, the ownership of each phase of monitoring by local community members will increase the skill base available for future projects. Each monitoring structure should provide evidence to support the other, ultimately providing a comprehensive record of management progress and the return of native vegetation. Use of both monitoring structures may also allow for reductions in expenditure, as it may be decided to reduce the number of monitoring quadrats installed.

2.11 Proposed Staggered Works Program

Table 9 presents a staggered work program suggested for Jurien Bay involving all management options presented in this Management Plan. Timing of various options and suggestions regarding personnel are made, with the aim of providing NACC with a program that will not require the immediate mobilisation of resources and allowing a more gradual implementation of management of the Jurien Bay Pyp Grass.

Table 8 Proposed Staggered Works Program

Year	Season	Activity	Cost	Notes
2015	Autumn	Establish and Monitor Quadrats	\$9,267.50	Encourage Community Involvement, with the aim of training community members to undertake this work
2015	Autumn	Spray Priority 1 and 2 Sites	\$10,753.38	Contractor
2015	Spring	Respray Priority 1 and 2 Sites	\$10,753.38	Contractor
2015	Spring	Manual Removal/Weed Wiping	TBA	1 spray technician assisted by volunteers
2016	Autumn	Respray Priority 1 and 2 Sites	\$7,807.36	Contractor
2016	Autumn	Spray Priority 3 and 4 Sites	\$25,391.14	Contractor
2016	Winter	Targeted Replanting	TBA	1 botanist assisted by volunteers/NACC
2016	Spring	Respray Priority 1 and 2 Sites	\$7,807.36	Contractor
2016	Spring	Respray Priority 3 and 4 Sites	\$21,945.80	Contractor
2016	Spring	Manual Removal/Weed Wiping	TBA	Volunteers supervised by NACC
2017	Autumn	Respray Priority 1 and 2 Sites	\$7,807.36	Contractor
2017	Autumn	Respray Priority 3 and 4 Sites	\$21,945.80	Contractor
2017	Winter	Targeted Replanting	TBA	1 botanist assisted by volunteers/NACC
2017	Spring	Respray Priority 1 and 2 Sites	\$7,807.36	Contractor
2017	Spring	Respray Priority 3 and 4 Sites	\$21,945.36	Contractor
2017	Spring	Manual Removal/Weed Wiping	TBA	Volunteers supervised by NACC

3. LIMITATIONS

This Management Plan has been prepared using current, publicly available knowledge regarding *Ehrharta villosa* as of 2014. Any change to this knowledge that may invalidate the information and conclusions contained within this document are not the responsibility of Western Botanical.

Costings for work undertaken under this Management Plan are offered as at current 2014 rates. These rates may change during the term of this Management Plan, and Western Botanical does not accept responsibility for subsequent variations in proposed costings.

4. REFERENCES

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ATTACHMENT 1

Keighery Vegetation Condition Scale

Condition Scale

As used in Bush Forever Vol 2, from Keighery 1994

Condition	Description
Pristine (1)	Pristine or nearly so, no obvious signs of disturbance.
Excellent (2)	Vegetation structures intact, disturbance affecting individual specie and weeds are non-aggressive species.
Very Good (3)	Vegetation structure altered, obvious signs of disturbance. For example, disturbance to vegetation structure caused by repeated fires, the presence of some more aggressive weeds, dieback, logging or grazing.
Good (4)	Vegetation structure significantly altered by obvious signs of multiple disturbance. Retains basic vegetation structure or ability to regenerate it. For example, disturbance to vegetation structure caused by very frequent fires, the presence of some very aggressive weeds at high density, partial clearing, dieback and grazing.
Degraded (5)	Basic vegetation structure severely impacted by disturbance. Scope for regeneration but not to a state approaching good condition without intensive management. For example, disturbance to vegetation structure buy very frequent fires, the presence of very aggressive weeds, partial clearing, dieback and grazing.
Completely Degraded (6)	The structure of the vegetation is no longer intact and the area is completely or almost completely without native species. These areas are often described a 'parkland cleared' with the flora comprising weed or crop species with isolated native trees or shrubs.