# CLLMM Vegetation Survivorship Monitoring (2013 Plantings)

# Project Report

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NGT Consulting

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Government of South Australia

Australian Government

# EXECUTIVE SUMMARY

The Coorong, Lower Lakes and Murray Mouth (CLLMM) region is one of Australia's highest profile wetland systems, internationally recognised under the Ramsar Convention. The region provides diverse ecological, cultural, social and economic value to surrounding regions and the state of South Australia. DEWNR's CLLMM Program is conducting a 5 year restoration project to protect and enhance the region, including extensive habitat restoration plantings across the CLLMM region.

This project involved the collection, collation and provision of field data from 69 revegetation sites situated across the CLLMM region during spring 2013 and autumn 2014, to determine survivorship rates of 2013 plantings. A subset of survey sites was visited in spring 2013 (new planting sites), with a more extensive autumn 2014 (new and infill sites) monitoring event revisiting all spring sites, plus an additional suite of sites.

The results of the study indicated:

- A good overall revegetation survivorship success rate of 67.9% at the time of monitoring in autumn 2014.
- A very wide range of survivorship rates at different individual sites, ranging from as low as 13.5% up to a peak of 97.4%. This variability reflects the breadth of site variables that can affect planting success, including soil type, topography, hydrology and exposure to sun and wind, however in an encouraging overall trend, more than ¾ of all sites demonstrated survivorship rates of over 60%.
- A wide range of site preparation and planting methods, which for some sites appeared to strongly influence plant survival and health.
- Signs of inundation affecting survivorship at wetland edges, reflective of seasonal conditions and planting patterns in 2013.
- There was observational evidence that weed control and the presence of a guard were among the strongest determinants of revegetation success, providing some justification for guarding and ongoing site maintenance.

Some sites with high survivorship success and plant health had been prepared using intensive methods such as soil scalping and ripping, and planted in rows allowing for effective mechanised weed control. These activities are consciously undertaken to the detriment of a more natural structure, but were noted to achieve desirable survivorship results and substantially reduced competition with non-desirable species. It was also noted that weedy grasses and other invasive species persist across most sites, and suppression of this competition will be a major factor in longer term survivorship and subsequent restoration of more complex native habitat.

The report includes a summary of suggested site management actions, and a set of broader recommendations, including pest plant and animal management, guarding of plants, and possible directions for follow-up monitoring and analysis.

The results of this study give a comprehensive record of the survivorship of the 2013 plantings, including a detailed dataset and site photopoints, which can be referred to when conducting future assessments of revegetation success and planning for additional or infill plantings. There is also potential for this dataset to be used in more complex analysis along with other datasets such as soil survey results, site history and planting methods, in order to better identify the major determinants of revegetation success.

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# 1. INTRODUCTION

## 1.1. Objectives and background of the CLLMM program

The Coorong, Lower Lakes and Murray Mouth (CLLMM) region is an internationally significant wetland system, recognised under the Ramsar Convention, supporting a diverse range of habitats and species at the terminus of the Murray River in South Australia. The CLLMM region is highly diverse supporting freshwater, estuarine and marine ecosystems over its estimated 142,500 hectares, and is culturally significant to the local Ngarrindjeri Nation.

The Coorong, Lower Lakes and Murray Mouth region is a focal area for the Department of Environment, Water and Natural Resources (DEWNR), the lead agency responsible for the environmental management of the Ramsar site. Management and active restoration works in the region are coordinated and primarily delivered by DEWNR's Coorong, Lower Lakes and Murray Mouth (CLLMM) Program.

The five-year CLLMM Bioremediation and Revegetation Project is funded by the Australian Government's Murray Futures Program. An initial focus was emergency works in response to long-term drought conditions, but with the return of water to the Lower Lakes system in 2010 (around the time the Long Term plan for the CLLMM site was released (DEH 2010)), the emphasis shifted to habitat restoration and building ecosystem resilience. The magnitude of the CLLMM Program has resulted in restoration works that provide significant habitat benefits for the fauna and flora of the CLLMM region.

In 2013, revegetation plantings by the CLLMM Restoration Program resulted in almost 900,000 tube-stock seedlings being planted across 74 sites (approximately 370 Ha).

## 1.2. Project scope

In September 2013, NGT consulting was engaged to carry out the CLLMM Vegetation Survivorship Monitoring (2013 plantings) Project. The project involved establishing and conducting transect-based vegetation survival monitoring at a subset of the 2013 planting sites during spring 2013 (new sites only) and autumn 2014 (new sites and infill sites). This monitoring enables the density of surviving plants from the 2013 plantings to be determined and is an important part of tracking effectiveness of actions (at both site specific and program-wide scales) and ultimately improving the future delivery of similar activities in the region.

## 1.3. Project objectives

The project was split into two major components: fieldwork, followed by data entry and production of project reports.

The key objectives of the fieldwork component included:

- Undertaking field-based survivorship monitoring at identified sites in spring and autumn.
- Estimating the survivorship of the planting at each revegetation site.
- Providing a basic photographic record of sites.
- Providing an independent check against reported works completed.

The key objectives of the data entry and project report component included:

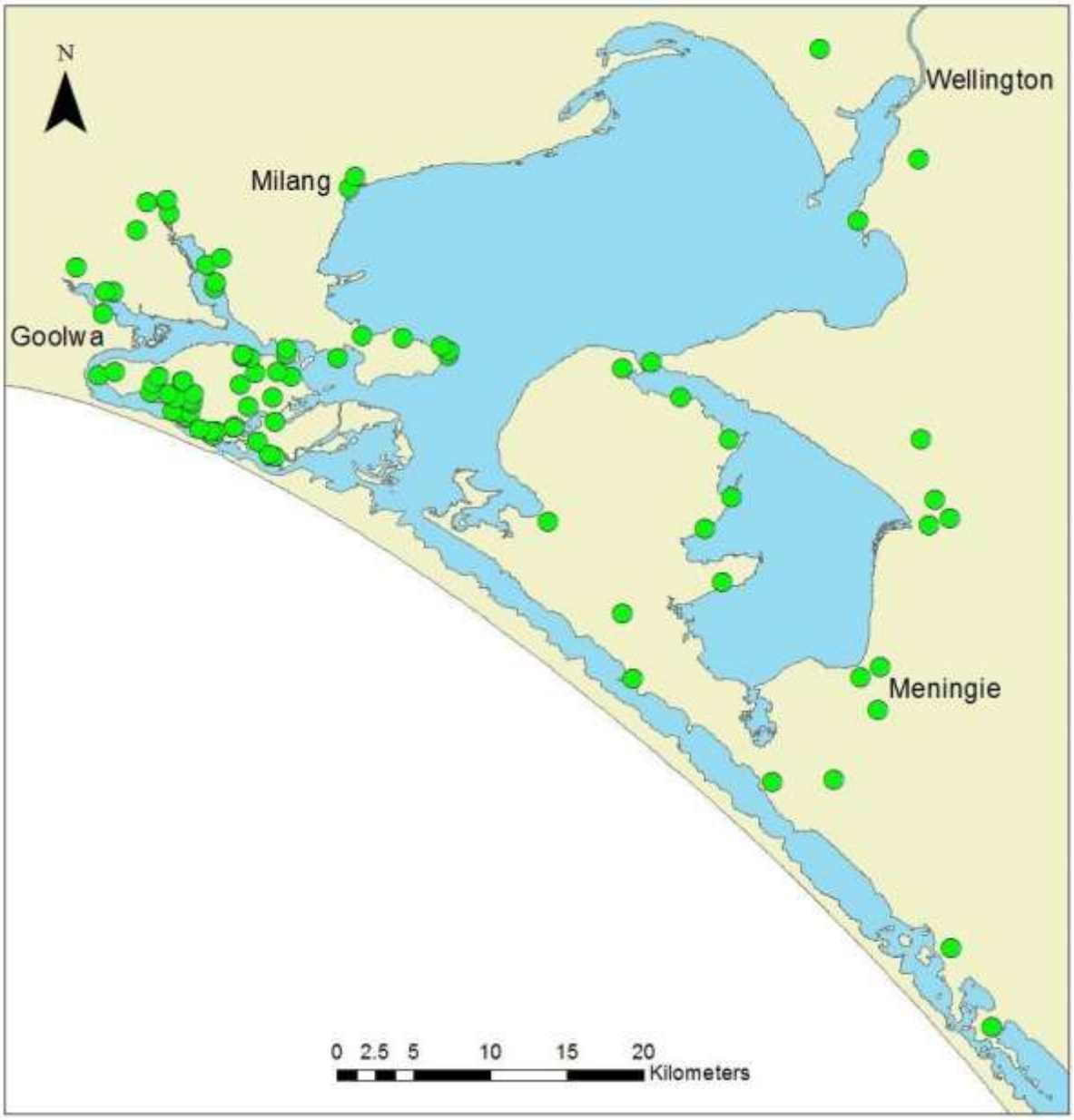
- Entering all field data from the spring and autumn monitoring into a Microsoft Access database.
- Producing a short interim report following the spring monitoring.
- Producing a final report of the spring and autumn monitoring including discussion of results.

# 2. METHODOLOGY

## 2.1. Monitoring sites

The study sites were situated within the CLLMM region, including sites around the edge of Lake Alexandrina, Lake Albert, the Finniss River, Currency Creek, Goolwa Channel, Hindmarsh Island, Mundoo Island and south along the Coorong lagoon. In total, 69 sites were visited and assessed throughout the project (refer to Figure 1).

***Figure 1 - Map of the CLLMM region showing autumn 2014 monitoring locations***




Sites were surveyed in spring 2013 (445 transects across 27 individual sites - refer to Table 1) around three months after planting, to assess survivorship due to planting technique and grazing. They were then assessed (in some cases re-assessed) in autumn 2014 (1100 transects across 69 individual sites - refer to Table 2) to assess survivorship after the plants experienced

their first summer season. Note that access to one Hindmarsh Island site (Robertson) was not possible and is not included below.

***Table 1 – Spring Monitoring sites (new planting sites)***

| Site no. | Site name |
|---|---|
| 1 | Biddle N & G Waltowa |
| 2 | Camac Rowett's Block |
| 3 | Camac Tamara |
| 4 | Davis, Robbie A |
| 5 | Feibig Waltowa |
| 6 | Griffin 2013 |
| 7 | Gunner Gemlake Fife 5 |
| 8 | Gunner Lot 2 |
| 9 | Hoopmann JE |
| 10 | Jockwar Samphire |
| 11 | Long Point |
| 12 | McClure Hwy |
| 13 | McClure Waltowa |
| 14 | Meningie Pine Removal |

| Site no. | Site name |
|---|---|
| 15 | Mundoo Middle |
| 16 | Mundoo North |
| 17 | Mundoo South-east |
| 18 | Mundoo West |
| 19 | Narrung Lifestyle Blocks |
| 20 | Rice |
| 21 | Stornoway |
| 22 | Stratland |
| 23 | Treloar ZW |
| 24 | Wellington Dairies |
| 25 | Wellington Lodge Lake Edge |
| 26 | Williams site 2 Waltowa |
| 27 | Yalkuri |

***Table 2 - Autumn Monitoring sites (new and infill sites – infill sites highlighted in blue)***

| Site no. | Site name |
|---|---|
| 1 | Biddle N & G Waltowa |
| 2 | Camac Rowett's Block |
| 3 | Camac Tamara |
| 4 | Clayton Bay Foreshore |
| 5 | Council Triangle |
| 6 | Davis, Robbie A |
| 7 | Feibig Waltowa |
| 8 | Ferrymans Reserve |
| 9 | Grey and Mundoo |
| 10 | Griffin 2013 |
| 11 | Gunner Gemlake Fife 5 |
| 12 | Gunner Lot 2 |
| 13 | Hartnett Extension |
| 14 | Hartwell |
| 15 | Hayter |
| 16 | Hindmarsh Is. (Council Reserve) |
| 17 | Hindmarsh Is. (Dredge) |
| 18 | Hindmarsh Is. (Elvish) |
| 19 | Hindmarsh Is. (Farrow) |
| 20 | Hindmarsh Is. (Gilbert) |
| 21 | Hindmarsh Is. (Hartill) |

| Site no. | Site name |
|---|---|
| 22 | Hindmarsh Is. (Hills) |
| 23 | Hindmarsh Is. (Irwin) |
| 24 | Hindmarsh Is. (Johnson) |
| 25 | Hindmarsh Is. (Lane) |
| 26 | Hindmarsh Is. (Lucas) |
| 27 | Hindmarsh Is. (Luke) |
| 28 | Hindmarsh Is. (McHugh-Innes) |
| 29 | Hindmarsh Is. (Minnis) |
| 30 | Hindmarsh Is. (Mulungushi) |
| 31 | Hindmarsh Is. (Saunders) |
| 32 | Hindmarsh Is. (Sturt Farm) |
| 33 | Hindmarsh Is. (Swan Point) |
| 34 | Hindmarsh Is. (Tarni Warra) |
| 35 | Hindmarsh Is. (Wyndgate Homestead) |
| 36 | Hoopmann JE |
| 37 | Huczko Wetland |
| 38 | Jacob |
| 39 | Jockwar Samphire 2013 |
| 40 | Long Point |
| 41 | McClure Hwy |

| Site no. | Site name |
|---|---|
| 42 | McClure Waltowa |
| 43 | McKinlay |
| 44 | Meningie Pine Removal |
| 45 | Milang Common |
| 46 | Modistach |
| 47 | Mundoo Middle |
| 48 | Mundoo North |
| 49 | Mundoo South-east |
| 50 | Mundoo West |
| 51 | Narrung Lifestyle Blocks |
| 52 | Narrung Wetland |
| 53 | Orange-bellied Feedlot |
| 54 | Point Malcolm Lighthouse |
| 55 | Rice |

| Site no. | Site name |
|---|---|
| 56 | Shadows Lagoon |
| 57 | Shadows Lagoon West |
| 58 | Shaw |
| 59 | Stornoway |
| 60 | Stratland |
| 61 | The Pulgi |
| 62 | Treloar ZW |
| 63 | Vasarelli 2013 |
| 64 | Waghorn |
| 65 | Watkins |
| 66 | Wellington Dairies |
| 67 | Wellington Lodge Lake Edge |
| 68 | Williams site 2 Waltowa |
| 69 | Yalkuri |

## *2.2. Field survey methodology*

The sampling component of the surveys consisted of a number of 50m transects, with the number of transects on each restoration site determined by, and proportional to, the size of the site. Hence for the autumn surveys, the number of transects on individual sites ranged from 2 transects on the Hartnett Extension (small) site, up to 68 transects at the Yalkuri (large) site on the Narrung Peninsula. Additionally, 144 transects were distributed across multiple sites on Hindmarsh Island.

To ensure the robustness of the method and prevent site selection bias for transects, the starting coordinates for each site were determined by DEWNR from randomly generated points.

Plantings were implemented in distinct zones signifying differences in landform and soil types (e.g. Inundated, Lake/Lagoon Edge, Rising Ground). Transect direction was therefore determined on-site, and where possible were run only within the zone that a transect was started in (refer to ***Figure 2***).

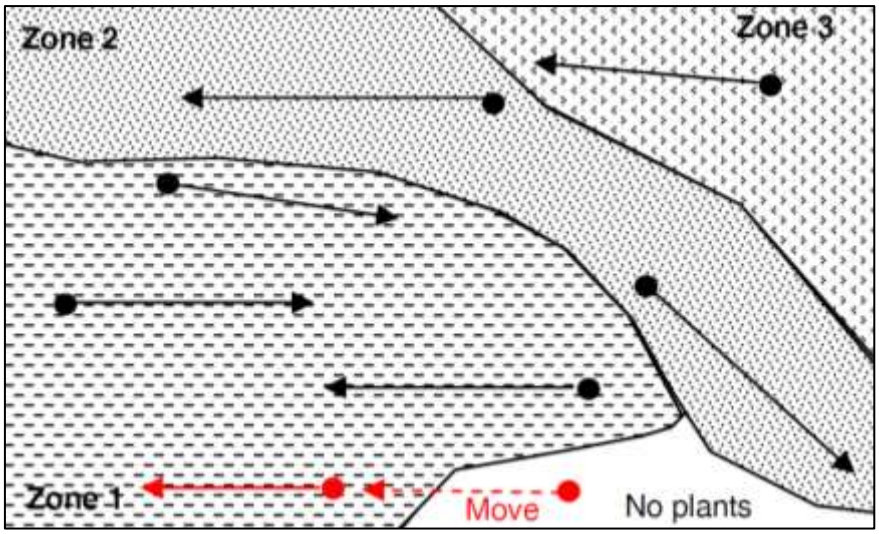



***Figure 2 - Transect direction***

Each transect consisted of a 50m line, starting at the supplied coordinates. The transect was then walked, counting all individual plants one metre to the left of the transect. At the end of the 50m transect line, the direction was reversed, and plants on the other side were counted while walking back to the starting point (refer to ***Figure 3***).

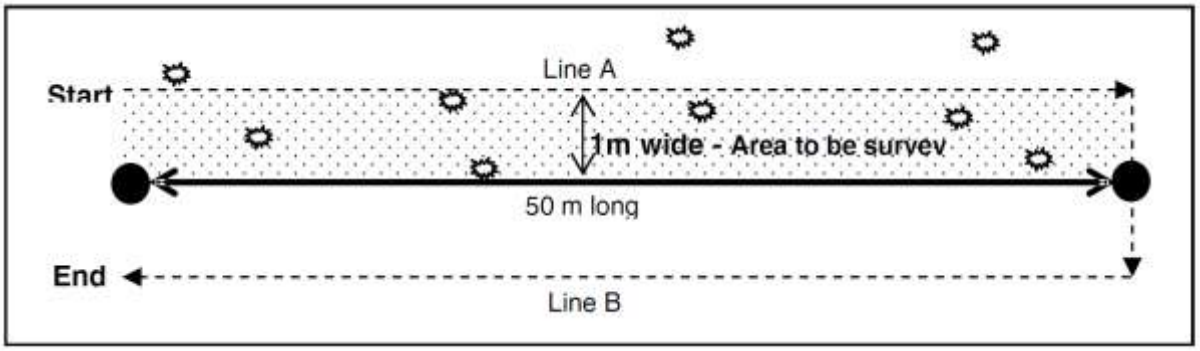



***Figure 3 - Transect area***

Each plant – either dead or alive – was identified to species level. Where species identification of a dead plant was not possible, it was counted as “Dead (unknown species)”.

## 2.3. Site photographs

At each site, at least one photo was taken at locations which reflected overall site condition. Easting and northing was recorded for each photo, along with bearing and approximate height.

## 2.4. Survivorship scoring

Each plant counted was identified to species level and recorded as either dead or alive. Where possible, dead plants were identified to species level, and where this was not possible they were recorded as “Dead (unknown species)”.

## *2.5. Observational notes*

Observations were taken at each site, recording overall plant health, conditions of tree guards, impacts from pest plants and animals, stock incursion, and site condition notes including site preparation and any signs of follow-up maintenance such as spraying of weeds or fence repair. Where areas were found to be unplanted, this was also recorded.

## *2.6. Data management*

All transect data was entered into a Microsoft Access database supplied by DEWNR and delivered as an electronic file.

# 3. RESULTS AND DISCUSSION

## 3.1. Overall survivorship for the 2013 plantings

Across the 69 sites that were sampled in Autumn 2014, a total of 50,800 plants were counted and assessed, with an overall average of 67.9% of these plants recorded as being alive after their first summer since planting in 2013, see Table 3.

***Table 3 - Autumn 2014 survivorship by site, with site survival percentages grouped into 5 colour-coded categories: brown (0-20%), orange (20-40%), yellow (40-60%), light green (60-80%) and dark green (80-100%).***

| Site name | Total Plants | Alive | Dead | Survival (%) |
|---|---|---|---|---|
| Biddle N & G Waltowa | 579 | 93 | 486 | 16.1 |
| Camac Rowett's Block | 2651 | 2412 | 239 | 91.0 |
| Camac Tamara | 1000 | 863 | 137 | 86.3 |
| Clayton Bay Foreshore | 486 | 315 | 171 | 64.8 |
| Council Triangle | 704 | 468 | 236 | 66.5 |
| Davis, Robbie A | 633 | 287 | 346 | 45.3 |
| Feibig Waltowa | 1641 | 1060 | 581 | 64.6 |
| Grey and Mundoo | 555 | 423 | 132 | 76.2 |
| Griffin 2013 | 168 | 140 | 28 | 83.3 |
| Gunner Gemlake Fife 5 | 1160 | 590 | 570 | 50.9 |
| Gunner Lot 2 | 2878 | 1600 | 1278 | 55.6 |
| Hartnett Extension | 117 | 114 | 3 | 97.4 |
| Hartwell | 284 | 229 | 55 | 80.6 |
| Hayter | 544 | 435 | 109 | 80.0 |
| Hindmarsh Is. (Council Reserve) | 54 | 42 | 12 | 77.8 |
| Hindmarsh Is. (Dredge) | 113 | 56 | 57 | 49.6 |
| Hindmarsh Is. (Elvish) | 119 | 62 | 57 | 52.1 |
| Hindmarsh Is. (Farrow) | 82 | 72 | 10 | 87.8 |
| Hindmarsh Is. (Ferrymans Reserve) | 231 | 160 | 71 | 69.3 |
| Hindmarsh Is. (Gilbert) | 211 | 150 | 61 | 71.1 |
| Hindmarsh Is. (Hartill) | 129 | 86 | 43 | 66.7 |
| Hindmarsh Is. (Hills) | 61 | 32 | 29 | 52.5 |
| Hindmarsh Is. (Irwin) | 142 | 90 | 52 | 63.4 |
| Hindmarsh Is. (Johnson) | 72 | 29 | 43 | 40.3 |
| Hindmarsh Is. (Lane) | 158 | 119 | 39 | 75.3 |
| Hindmarsh Is. (Lucas) | 173 | 130 | 43 | 75.1 |
| Hindmarsh Is. (Luke) | 39 | 31 | 8 | 79.5 |
| Hindmarsh Is. (McHugh-Innes) | 41 | 11 | 30 | 26.8 |
| Hindmarsh Is. (Minnis) | 158 | 128 | 30 | 81.0 |
| Hindmarsh Is. (Mulungushi) | 162 | 123 | 39 | 75.9 |
| Hindmarsh Is. (Saunders) | 127 | 37 | 90 | 29.1 |
| Hindmarsh Is. (Sturt Farm) | 161 | 113 | 48 | 70.2 |
| Hindmarsh Is. (Swan Point) | 62 | 51 | 11 | 82.3 |

| Site name | Total Plants | Alive | Dead | Survival (%) |
|---|---|---|---|---|
| Hindmarsh Is. (Tarni Warra) | 102 | 79 | 23 | 77.5 |
| Hindmarsh Is. (Wyndgate Homestead) | 61 | 49 | 12 | 80.3 |
| Hoopmann JE | 836 | 545 | 291 | 65.2 |
| Huczko Wetland | 203 | 148 | 55 | 72.9 |
| Jacob | 533 | 322 | 211 | 60.4 |
| Jockwar Samphire 2013 | 954 | 238 | 716 | 24.9 |
| Long Point | 635 | 279 | 356 | 43.9 |
| McClure Hwy | 3433 | 2214 | 1219 | 64.5 |
| McClure Waltowa | 462 | 214 | 248 | 46.3 |
| McKinlay | 377 | 288 | 89 | 76.4 |
| Meningie Pine Removal | 614 | 283 | 331 | 46.1 |
| Milang Common | 998 | 803 | 195 | 80.5 |
| Modistach | 103 | 64 | 39 | 62.1 |
| Mundoo Middle | 530 | 463 | 67 | 87.4 |
| Mundoo North | 928 | 668 | 260 | 72.0 |
| Mundoo South-east | 1803 | 1221 | 582 | 67.7 |
| Mundoo West | 568 | 486 | 82 | 85.6 |
| Narrung Lifestyle Blocks | 1499 | 1348 | 151 | 89.9 |
| Narrung Wetland | 796 | 629 | 167 | 79.0 |
| Orange-bellied Feedlot | 706 | 580 | 126 | 82.2 |
| Point Malcolm Lighthouse | 251 | 213 | 38 | 84.9 |
| Rice | 433 | 393 | 40 | 90.8 |
| Shadows Lagoon | 293 | 204 | 89 | 69.6 |
| Shadows Lagoon West | 658 | 629 | 29 | 95.6 |
| Shaw | 941 | 660 | 281 | 70.1 |
| Stornoway | 1149 | 969 | 180 | 84.3 |
| Stratland | 779 | 557 | 222 | 71.5 |
| The Pulgi | 434 | 347 | 87 | 80.0 |
| Treloar ZW | 4231 | 3207 | 1024 | 75.8 |
| Vasarelli 2013 | 309 | 234 | 75 | 75.7 |
| Waghorn | 366 | 299 | 67 | 81.7 |
| Watkins | 1361 | 922 | 439 | 67.7 |
| Wellington Dairies | 1208 | 948 | 260 | 78.5 |
| Wellington Lodge Lake Edge | 2443 | 1193 | 1250 | 48.8 |
| Williams site 2 Waltowa | 672 | 91 | 581 | 13.5 |
| Yalkuri | 3436 | 2134 | 1302 | 62.1 |
| **Total** | **50800** | **34472** | **16328** | **67.9** |

In Table 4, these 69 sites are grouped according to five broad (colour-coded) percentage categories of survivorship success (based on Durbridge 2012). This illustrates the fact that the vast majority (over 76%) of all sites have achieved survivorship rates of over 60%, while only 7% of sites had survivorship rates below 40%.

***Table 4 - Summary of autumn sites by survivorship percentage category (as applied in Durbridge 2012)***

| Survivorship category | | # sites | % sites |
|---|---|---|---|
| 0-20% | Very Poor | 2 | 2.9 |
| 20-40% | Poor | 3 | 4.4 |
| 40-60% | Average | 11 | 15.9 |
| 60-80% | Good | 32 | 46.4 |
| 80-100% | Excellent | 21 | 30.4 |
| **Total** | | **69** | 100 |

For the 27 sites that were visited in both Spring 2013 and Autumn 2014, the opportunity to compare the change in survivorship rates after the 2013/14 summer season, as presented in Table 5, is revealing.

***Table 5 - Change between spring and autumn survivorship for sites monitored in both rounds. NOTE: the colour-coding of "percentage change" categories has been reversed to reflect a desirable minimal change (green) through to a larger, undesirable change (brown).***

| Site name | Spring survival (%) | Autumn survival (%) | % change |
|---|---|---|---|
| Biddle N & G Waltowa | 87.5 | 16.1 | -71.4 |
| Camac Rowett's Block | 88.0 | 91.0 | +3.0 |
| Camac Tamara | 87.3 | 86.3 | -1.0 |
| Davis, Robbie A | 95.8 | 45.3 | -50.5 |
| Feibig Waltowa | 81.9 | 64.6 | -17.3 |
| Griffin 2013 | 88.8 | 83.3 | -5.5 |
| Gunner Gemlake Fife 5 | 83.2 | 50.9 | -32.3 |
| Gunner Lot 2 | 83.5 | 55.6 | -27.9 |
| Hoopmann JE | 78.9 | 65.2 | -13.7 |
| Jockwar Samphire 2013 | 87.8 | 24.9 | -62.9 |
| Long Point | 65.8 | 43.9 | -21.9 |
| McClure Hwy | 80.8 | 64.5 | -16.3 |
| McClure Waltowa | 89.8 | 46.3 | -43.5 |
| Meningie Pine Removal | 90.0 | 46.1 | -43.9 |
| Mundoo Middle | 93.0 | 87.4 | -5.6 |
| Mundoo North | 97.0 | 72.0 | -25 |
| Mundoo South-east | 97.2 | 67.7 | -29.5 |
| Mundoo West | 95.9 | 85.6 | -10.3 |
| Narrung Lifestyle Blocks | 96.3 | 89.9 | -6.4 |
| Rice | 95.5 | 90.8 | -4.7 |
| Stornoway | 88.9 | 84.3 | -4.6 |
| Stratland | 84.7 | 71.5 | -13.2 |
| Treloar ZW | 89.3 | 75.8 | -13.5 |
| Wellington Dairies | 94.0 | 78.5 | -15.5 |
| Wellington Lodge Lake Edge | 83.7 | 48.8 | -34.9 |
| Williams site 2 Waltowa | 80.6 | 13.5 | -67.1 |
| Yalkuri | 88.1 | 62.1 | -26.0 |
| **Average** | **86.5** | **67.9** | **-18.6** |

Further, more detailed comparative analysis by percentage category is presented in Table 6. While all 27 sites showed survivorship rates of over 60% in spring 2013, by autumn 2014 the combined number of sites with survivorship rates over 60% had dropped by 10, to 17. However, only 3 sites had declined to the two lowest survivorship categories of less than 40%.

***Table 6 - summary of sites visited in both spring 2013 and autumn 2014, according to changes in survivorship percentage category***

| Survivorship category | | # sites Spring 2013 | # sites Autumn 2014 |
|---|---|---|---|
| 0-20% | Very Poor | 0 | 2 |
| 20-40% | Poor | 0 | 1 |
| 40-60% | Average | 0 | 7 |
| 60-80% | Good | 2 | 9 |
| 80-100% | Excellent | 25 | 8 |
| **Total** | | **27** | **27** |

Table 7 presents the change in survivorship percentage for the 27 sites monitored in both spring and autumn. Significantly, the majority (78%) of sites experienced a drop in survivorship of less than 40% between the two monitoring seasons.

***Table 7 - Summary of survivorship percentage change measured between spring and autumn sites***

| Survivorship percentage change | | # sites | % sites |
|---|---|---|---|
| 80-100% | Very Poor | 0 | 0% |
| 60-80% | Poor | 3 | 11% |
| 40-60% | Average | 3 | 11% |
| 20-40% | Good | 7 | 26% |
| 0-20% | Excellent | 14 | 52% |
| **Total** | | **27** | 100% |

## *3.2. Survivorship of each species identified*

The results of revegetation survivorship according to species, provides a useful overview of the composition of CLLMM 2013 revegetation works – see Table 8. However, a clear majority (61%) of dead plants were actually unable to be accurately identified to species level. This substantially limits the value of more detailed analysis of this data, by creating a significant bias (of missing data) that it is reasonably assumed would impact upon the survivorship statistics for the majority of individual species listed here.

***Table 8 - Autumn survivorship by species***

| Species | Plants | Alive | Dead | Survival (%) |
|---|---|---|---|---|
| Acacia acinacea | 9 | 0 | 9 | 100.0 |
| Acacia brachybotrya | 17 | 0 | 17 | 100.0 |
| Acacia calamifolia | 117 | 10 | 127 | 92.1 |
| Acacia cupularis | 41 | 2 | 43 | 95.3 |
| Acacia dodonaeifolia | 72 | 3 | 75 | 96.0 |
| Acacia hakeoides | 103 | 7 | 110 | 93.6 |
| Acacia leiophylla | 40 | 1 | 41 | 97.6 |
| Acacia ligulata | 60 | 0 | 60 | 100.0 |
| Acacia lineata | 20 | 8 | 28 | 71.4 |
| Acacia longifolia ssp. | 70 | 6 | 76 | 92.1 |
| Acacia longifolia ssp. sophorae | 205 | 25 | 230 | 89.1 |
| Acacia microcarpa | 17 | 3 | 20 | 85.0 |
| Acacia myrtifolia | 28 | 8 | 36 | 77.8 |
| Acacia paradoxa | 128 | 47 | 175 | 73.1 |
| Acacia pycnantha | 510 | 87 | 597 | 85.4 |
| Acacia retinodes | 30 | 0 | 30 | 100.0 |
| Acacia spinescens | 12 | 1 | 13 | 92.3 |
| Acacia uncifolia | 5 | 0 | 5 | 100.0 |
| Acaena novae-zelandiae | 85 | 0 | 85 | 100.0 |
| Adriana quadripartita | 11 | 0 | 11 | 100.0 |
| Allocasuarina muelleriana ssp. muelleriana | 16 | 3 | 19 | 84.2 |
| Allocasuarina pusilla | 34 | 15 | 49 | 69.4 |
| Allocasuarina verticillata | 1502 | 205 | 1707 | 88.0 |
| Atriplex paludosa ssp. | 1891 | 41 | 1932 | 97.9 |
| Atriplex rhagodioides | 212 | 7 | 219 | 96.8 |
| Atriplex semibaccata | 1221 | 33 | 1254 | 97.4 |
| Atriplex sp. | 1 | 0 | 1 | 100.0 |
| Atriplex suberecta | 210 | 0 | 210 | 100.0 |
| Austrodanthonia caespitosa | 391 | 115 | 506 | 77.3 |
| Austrodanthonia setacea | 132 | 47 | 179 | 73.7 |
| Austrodanthonia sp. | 27 | 5 | 32 | 84.4 |
| Austrostipa elegantissima | 74 | 21 | 95 | 77.9 |

| Species | Plants | Alive | Dead | Survival (%) |
|---|---|---|---|---|
| Austrostipa eremophila | 84 | 5 | 89 | 94.4 |
| Austrostipa flavescens | 45 | 7 | 52 | 86.5 |
| Austrostipa mollis | 59 | 15 | 74 | 79.7 |
| Austrostipa nodosa | 116 | 34 | 150 | 77.3 |
| Austrostipa sp. | 17 | 0 | 17 | 100.0 |
| Austrostipa stipoides | 11 | 0 | 11 | 100.0 |
| Banksia marginata | 5 | 0 | 5 | 100.0 |
| Banksia ornata | 149 | 81 | 230 | 64.8 |
| Billardiera cymosa ssp. | 148 | 2 | 150 | 98.7 |
| Bursaria spinosa ssp. | 459 | 111 | 570 | 80.5 |
| Callistemon rugulosus | 16 | 0 | 16 | 100.0 |
| Callitris gracilis | 297 | 23 | 320 | 92.8 |
| Calytrix tetragona | 23 | 10 | 33 | 69.7 |
| Carpobrotus rossii | 207 | 22 | 229 | 90.4 |
| Clematis microphylla | 23 | 0 | 23 | 100.0 |
| Correa reflexa var. | 8 | 4 | 12 | 66.7 |
| Cyperus gymnocaulos | 611 | 483 | 128 | 79.1 |
| Dead (unknown species) | 0 | 9969 | 9969 | 0.0 |
| Dianella brevicaulis | 480 | 29 | 509 | 94.3 |
| Dianella revoluta var. | 131 | 15 | 146 | 89.7 |
| Disphyma crassifolium ssp. clavellatum | 570 | 34 | 604 | 94.4 |
| Dodonaea baueri | 16 | 1 | 17 | 94.1 |
| Dodonaea viscosa ssp. | 393 | 14 | 407 | 96.6 |
| Dodonaea viscosa ssp. cuneata | 39 | 0 | 39 | 100.0 |
| Dodonaea viscosa ssp. spatulata | 150 | 8 | 158 | 94.9 |
| Einadia nutans ssp. | 232 | 20 | 252 | 92.1 |
| Enchylaena tomentosa var. | 1559 | 48 | 1607 | 97.0 |
| Enneapogon nigricans | 92 | 7 | 99 | 92.9 |
| Eucalyptus baxteri | 10 | 0 | 10 | 100.0 |
| Eucalyptus calycogona ssp. | 1 | 0 | 1 | 100.0 |
| Eucalyptus camaldulensis ssp. | 3 | 0 | 3 | 100.0 |
| Eucalyptus diversifolia ssp. diversifolia | 375 | 81 | 456 | 82.2 |
| Eucalyptus fasciculosa | 2 | 0 | 2 | 100.0 |
| Eucalyptus incrassata | 491 | 56 | 547 | 89.8 |
| Eucalyptus leptophylla | 11 | 2 | 13 | 84.6 |
| Eucalyptus leucoxylon ssp. | 79 | 4 | 83 | 95.2 |
| Eucalyptus odorata | 17 | 0 | 17 | 100.0 |
| Eucalyptus porosa | 34 | 0 | 34 | 100.0 |
| Eucalyptus socialis (NC) | 2 | 0 | 2 | 100.0 |
| Eucalyptus socialis ssp. | 19 | 0 | 19 | 100.0 |
| Eucalyptus sp. | 1 | 0 | 1 | 100.0 |
| Ficinia nodosa | 5060 | 1474 | 6534 | 77.4 |

| Species | Plants | Alive | Dead | Survival (%) |
|---|---|---|---|---|
| Gahnia filum | 1397 | 95 | 1492 | 93.6 |
| Goodenia ovata | 15 | 0 | 15 | 100.0 |
| Hakea mitchellii | 347 | 54 | 401 | 86.5 |
| Hakea vittata | 39 | 0 | 39 | 100.0 |
| Juncus kraussii | 2909 | 2181 | 5090 | 57.2 |
| Kennedia prostrata | 103 | 3 | 106 | 97.2 |
| Kunzea pomifera | 230 | 47 | 277 | 83.0 |
| Lasiopetalum baueri | 1 | 1 | 2 | 50.0 |
| Leptospermum continentale | 20 | 2 | 22 | 90.9 |
| Leptospermum coriaceum | 9 | 0 | 9 | 100.0 |
| Leptospermum lanigerum | 51 | 0 | 51 | 100.0 |
| Leptospermum myrsinoides | 55 | 9 | 64 | 85.9 |
| Leucophyta brownii | 59 | 9 | 68 | 86.8 |
| Leucopogon parviflorus | 19 | 65 | 84 | 22.6 |
| Lomandra caespitosa | 18 | 11 | 29 | 62.1 |
| Lomandra effusa | 33 | 12 | 45 | 73.3 |
| Lomandra leucocephala ssp. robusta | 20 | 0 | 20 | 100.0 |
| Maireana brevifolia | 266 | 7 | 273 | 97.4 |
| Maireana oppositifolia | 228 | 6 | 234 | 97.4 |
| Melaleuca acuminata ssp. acuminata | 85 | 41 | 126 | 67.5 |
| Melaleuca brevifolia | 218 | 11 | 229 | 95.2 |
| Melaleuca decussata | 10 | 2 | 12 | 83.3 |
| Melaleuca halmaturorum | 2517 | 282 | 2799 | 89.9 |
| Melaleuca lanceolata | 746 | 114 | 860 | 86.7 |
| Melaleuca uncinata | 49 | 0 | 49 | 100.0 |
| Muehlenbeckia florulenta | 417 | 68 | 485 | 86.0 |
| Muehlenbeckia gunnii | 7 | 2 | 9 | 77.8 |
| Muehlenbeckia horrida ssp. horrida | 4 | 0 | 4 | 100.0 |
| Myoporum insulare | 633 | 29 | 662 | 95.6 |
| Myoporum montanum | 1 | 0 | 1 | 100.0 |
| Myoporum parvifolium | 12 | 0 | 12 | 100.0 |
| Nitraria billardierei | 53 | 3 | 56 | 94.6 |
| Olearia axillaris | 193 | 2 | 195 | 99.0 |
| Olearia ramulosa | 8 | 0 | 8 | 100.0 |
| Pelargonium australe | 377 | 18 | 395 | 95.4 |
| Pittosporum angustifolium | 1 | 0 | 1 | 100.0 |
| Platylobium obtusangulum | 2 | 0 | 2 | 100.0 |
| Poa labillardieri var. labillardieri | 1724 | 166 | 1890 | 91.2 |
| Poa poiformis var. poiformis | 291 | 53 | 344 | 84.6 |
| Puccinellia stricta | 79 | 6 | 85 | 92.9 |
| Rhagodia candolleana ssp. candolleana | 1035 | 15 | 1050 | 98.6 |
| Rhagodia crassifolia | 15 | 0 | 15 | 100.0 |

| Species | Plants | Alive | Dead | Survival (%) |
|---|---|---|---|---|
| Senecio pinnatifolius (NC) | 14 | 0 | 14 | 100.0 |
| Tetragonia implexicoma | 67 | 4 | 71 | 94.4 |
| Themeda triandra | 54 | 10 | 64 | 84.4 |
| Thomasia petalocalyx | 8 | 7 | 15 | 53.3 |
| Threlkeldia diffusa | 371 | 1 | 372 | 99.7 |
| Velleia arguta | 10 | 0 | 10 | 100.0 |
| Vittadinia australasica var. | 21 | 6 | 27 | 77.8 |
| Vittadinia cuneata var. | 289 | 60 | 349 | 82.8 |
| Vittadinia sp. | 18 | 1 | 19 | 94.7 |
| Wahlenbergia sp. | 6 | 0 | 6 | 100.0 |
| Xanthorrhoea caespitosa | 5 | 2 | 7 | 71.4 |
| Xanthorrhoea semiplana ssp. | 105 | 19 | 124 | 84.7 |
| Dead (unknown species) | 9969 | 0 | 9969 | 0.0 |
| **Total 128 species** | **50800** | **34472** | **16328** | **67.9** |

## 3.3. Overall survivorship in each zone

The revegetation survivorship results according to planting zone present an interesting overview of the field sampling – see Table 9. The most commonly planted zones monitored were Saline Edge (3), Rising Ground (4), Sandhill (8) and Other inland (9), making up almost 90% of all plants recorded.

In terms of survival rates, the only stand-out zone was Cliff top (7) with an excellent survivorship rate of 87.1%, but it should be noted that the sample size for this zone (420 plants) was very small. All other zones fell in the good 60-80% survivorship category.

***Table 9 - Autumn survivorship by planting zone***

| Zone | Zone description | Plants | Alive | Dead | Proportion of total plants per zone (%) | Survival (%) |
|---|---|---|---|---|---|---|
| 1 | Lake/lagoon edge | 976 | 697 | 279 | 1.9 | 71.4 |
| 2 | Saline swamp | 1655 | 1136 | 519 | 3.3 | 68.6 |
| 3 | Saline edge | 16250 | 10709 | 5541 | 32.0 | 65.9 |
| 4 | Rising ground | 10042 | 7552 | 2490 | 19.8 | 75.2 |
| 5 | Slope/embankment | 178 | 132 | 46 | 0.4 | 74.2 |
| 6 | Cliff | 101 | 71 | 30 | 0.2 | 70.3 |
| 7 | Cliff top | 420 | 366 | 54 | 0.8 | 87.1 |
| 8 | Sandhill | 7558 | 5006 | 2552 | 14.9 | 66.2 |
| 9 | Other inland | 11658 | 7550 | 4108 | 21.9 | 64.8 |
| 10 | Coastal | 1962 | 1253 | 709 | 3.6 | 63.9 |
| **Total** | | **50800** | **34472** | **16328** | **100** | **67.9** |

# 4. DISCUSSION

## 4.1.1 Overall survivorship

At the time of monitoring in Autumn 2014, overall survivorship of the 2013 plantings was good. Survivorship levels had dropped moderately from 86.5% to 67.9% between the spring 2013 and autumn 2014 monitoring periods, with over ¾ of all sites recording survivorship rates of over 60%. The first summer after establishment provides challenges for seedlings due to the higher temperatures and limited moisture. As presented in the results, the majority of sites did not suffer high rates of plant mortality. The three sites that did suffer the highest mortality rates (a change of 60-80%) over the summer were Biddle N & G Waltowa, Williams site 2 Waltowa and Jockwar Samphire 2013.

Given the circumstances, these overall survivorship rates and site specific trends are consistent with previous survivorship monitoring results published by the Goolwa to Wellington LAP in relation to 2010 and 2011 plantings in the CLLMM region (Durbridge, 2012)

## 4.1.2 Survivorship at species level

It was noted that *Juncus kraussii* had the lowest recorded survivorship among commonly-planted species, see Figure 4. However, this is highly likely to be more reflective of the fact that this species remains more readily identifiable after death, and hence needs to be considered in the context that the majority (61%) of dead plants were unable to be positively identified. As such, the survivorship data for the majority of individual species are likely to be considerable over-estimates and this particular element of analysis is therefore unfortunately limited in value in this instance.

***Figure 4 – the Biddle Waltowa site, where Juncus kraussii had 0% recorded survivorship of 36 identified individuals, but a further 210 dead plants were unable to be identified, skewing the survivorship figures for several other species at this site, where a total of 579 plants (dead or alive) were observed.***

## 4.1.3 Notable sites

**Sites with high survivorship rates**

The Camac Rowett, Camac Tamara and Narrung Lifestyle Block sites were notable for high seedling success rates and vigorous plant growth. Site preparation and maintenance appeared to be similar, and the large Camac Rowett site appeared to have been planted after topsoil scalping to reduce the soil-stored seedbank of weeds. The site was then planted out in rip lines, which makes maintenance slashing and spraying easier, but may impact upon habitat structure. These sites demonstrated the improved results that can be obtained when larger investments are made in site preparation and follow-up maintenance.

Once plants are established at these sites, future plantings could look at establishing a more natural structure through in-fill plantings and possibly thinning of mid or overstorey species that are at abnormally high densities in some areas.

***Figure 4 - The three highest percentage survivorship sites in autumn 2014***

***TOP – Camac Rowett site: 91% survivorship. Strong plant growth and evidence of weed control between planting rows***

***MID – Hartnett Extension site: 97% survivorship.***

***BELOW – Shadows Lagoon West: 96% survivorship.***

**Sites with low survivorship rates**

Other sites with notably poor survivorship such as Biddle Waltowa (Figure 4 and 6), McClure Waltowa, Biddle and Jockwar Samphire (Figure 6) appeared to have been subject to inundation. At these sites, plants were counted when stakes were seen. Inundation during the planting period could have either killed the plants early, or may have prevented them ever being planted next to stakes.

| | | |
|---|---|---|
| ***16%** survivorship* | ***14%** survivorship* | ***25%** survivorship* |
| *Biddle Waltowa* | *Williams Waltowa* | *Jockwar Samphire* |

***Figure 5 - Three sites with the lowest survivorship levels in autumn 2014***

A comparison of the detailed survival count data for the three sites with the lowest survivorship statistics (see Table 3) is provided in Table 10, to enable closer inspection of the factors that may have led to such high mortality rates over the 2013/14 summer.

Firstly, it is worth noting that these sites were all considered to consist entirely of "saline edge" (zone 3) planting areas. These areas are not only prone to inundation as previously mentioned, but they also usually consist of heavy soils with higher salinity – conditions likely to challenge many plants during the heat of their first summer. Given the landscape of the Lower Lakes, is not surprising to note that this zone was one of the most commonly encountered during the study (32% of all plants counted were in zone 3). However, of more interest is the fact that zone 3 actually produced an overall survivorship rate of 66% - so the high levels of mortality noted in the three poorest performing sites were not uniform across the region.

***Table 10 – Comparison of species counted at the three sites with the poorest revegetation survivorship rates (Note: in addition to previous colour-coding, red = 0%)***

| | Biddle Waltowa | | Williams Waltowa | | Jockwar Samphire | |
|---|---|---|---|---|---|---|
| | total plants counted | survivorship % | total plants counted | survivorship % | total plants counted | survivorship % |
| **Zone 3 total plantings** | **579** | **16** | **672** | **14** | **954** | **25** |
| *Atriplex paludosa ssp.* | 27 | 96 | 28 | 93 | 32 | 100 |
| *Atriplex semibaccata* | 10 | 100 | 1 | 100 | 45 | 98 |
| *Atriplex suberecta* | - | - | 3 | 100 | 61 | 100 |
| *Carpobrotus rossii* | - | - | - | - | 5 | 100 |
| *Dead (unknown species)* | 210 | 0 | 277 | 0 | 573 | 0 |
| *Disphyma crassifolium* | 14 | 86 | 21 | 90 | 8 | 100 |
| *Enchylaena tomentosa var.* | 2 | 100 | | - | 35 | 100 |
| *Ficinia nodosa* | 237 | 8 | 180 | 2 | 10 | 0 |
| *Juncus kraussii* | 36 | 0 | 108 | 0 | 121 | 7 |
| *Leptospermum lanigerum* | - | - | - | - | 3 | 100 |
| *Maireana brevifolia* | - | - | - | - | 7 | 86 |
| *Melaleuca acuminata* | - | - | - | - | 6 | 50 |
| *Melaleuca brevifolia* | - | - | - | - | 3 | 100 |
| *Melaleuca halmaturorum* | 35 | 54 | 17 | 29 | 41 | 63 |
| *Duma florulenta* | 4 | 25 | 7 | 57 | 2 | 100 |
| *Myoporum insulare* | 1 | 100 | 1 | 100 | 6 | 100 |
| *Rhagodia candolleana ssp.* | 3 | 100 | 29 | 100 | 1 | 100 |

Closer inspection of Table 10 reveals that a similar number of total plants and species diversity was counted at each of the poorest performing sites. According to the results, most species revealed small numbers and generally high survivorship levels, but this may be distorted by the sheer number of unidentified dead plants (or possibly stakes without plants) counted, and hence creates a risk of misinterpretation. Most revealing therefore, are those species that remained physically identifiable when dead. Of these, *Finicia nodosa* and *Juncus kraussii* are evident as species with the highest planting abundance at these 3 sites, but very poor survivorship of 0-8%. This is substantially lower than their overall survivorship rates of 57-77% (see Table 8) for the wider study, during which they were two of the most commonly encountered plants.

It appears therefore that local factors at these three sites, including soil characteristics and inundation regime, are most likely to have influenced revegetation survivorship success.

### 4.1.4 Site inundation

Planting success – particularly at wetland edges – may have been affected by high rainfall over the planting period in 2013. Rainfall measured at nearby locations (refer to Table 11) shows significantly above-average rainfall, and while this generally benefits dryland revegetation sites, plantings at wetland edges would have been subject to very wet or inundated site conditions during and after the planting season. This may have been a significant factor in survivorship and the available growth zone adjacent to wetland edges.

***Table 11 - Monthly total rainfall (mm) across CLLMM planting region***

| | | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Jan | Feb | Mar |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Meningie | 2013-14 | 46.6 | 76.9 | 86.4 | 104.2 | 76.4 | 58.6 | 28.6 | 10.2 | 21.4 | 25.4 | 33.8 | 28.4 |
| | Mean 1961-90 | 37.6 | 54.7 | 62.2 | 61.6 | 57.0 | 48.2 | 39.0 | 27.4 | 23.7 | 25.4 | 33.8 | 28.4 |
| Narrung | 2013-14 | 44.7 | 75.2 | 103.6 | 107.1 | 64.0 | 56.8 | 20.4 | 10.0 | 18.0 | 22.4 | 31.8 | 9.0 |
| | Mean 1961-90 | 32.7 | 50.4 | 55.0 | 57.7 | 52.0 | 41.3 | 37.5 | 24.9 | 21.1 | 18.5 | 18.5 | 17.1 |
| Finniss | 2013-14 | 34.4 | 37.4 | 148.4 | 116.8 | 96.0 | 62.4 | 29.2 | 33.6 | 23.2 | 13.6 | 41 | 9.4 |
| | Mean 1961-90 | 38.3 | 53.4 | 63.8 | 65.2 | 61.3 | 53.5 | 42.8 | 29.3 | 23.1 | 19.2 | 21.8 | 21.5 |

Higher than mean
Lower than mean

Figure 7 shows the autumn view of the Williams Waltowa site, a location where inundation effects are likely to have influenced revegetation survivorship.

***Figure 7 – A saline site impacted by inundation, with poor survivorship: Williams Site 2 Waltowa***

## 4.1.5 Tree guards

**Observations**

Unguarded plants (see Figure 8) were generally observed to have lower survivorship rates and plant health, particularly at sites where thick pasture grasses are present. These grasses often smother planted seedlings, significantly reducing their chances of survival.

***Figure 8 – Treloar: A site where plants have been staked but not guarded – in this instance however, not to the detriment of survival rates***

Most sites use paper guards which are working effectively in most instances but were often knocked over or missing at sites with high wind exposure, see Figure 9. There was also evidence of snails such as *Theba pisana* eating guards and plants at the Long Point site during spring monitoring.

***Figure 9 – The Hartnett Extension cliff top site, where many guards were dislodged or missing, albeit without detrimental effects in this instance (the highest survivorship site)***

On Hindmarsh Island, most plants were guarded with plastic film guards, which were susceptible to being blown away by wind in exposed sites. In most cases, intact guards were working well to provide some weed, weather and browsing protection, see Figure 6.

***Figure 6 - Hindmarsh Island (Farrow) site, a very high survivorship site where plastic film guards are working well***

**Guard removal**

Some sites may benefit from guard removal for some species, as guards were observed to be restricting the growth of groundcover and low shrubby species such as *Kunzea pomifera*, *Enchylaena tomentosa* and *Atriplex* sp – see Figure 11. At the Gunner Lot 2 site (Figure 12) there is heavy growth out of the top of the guards, resulting in mis-shapen plants as they grow under the guards or are shaped severely by wind exposure.

***Figure 11 – Vasarelli: a site where plants are growing out of the guards***

## 4.1.6 Weed management

Many sites contain high loads of weedy grasses such as *Lorium sp., Bromus sp* and *Avena sp.* which are providing significant competition to plantings. Other common and problematic weedy species across sites include *Brassica sp.*, *Oenothera stricta*, *Lycium ferocissimum*, *Solanum nigrum*, *Citrullus lanatus* (see Figure 12) and *Euphorbia terracina*.

***Figure 12 – Gunner: a site where plants are also growing out of the guards (although not in the area shown here), and where Camel Melons can be seen among the spray lines.***

At some properties, it may not have been possible to carry out comprehensive ground preparation before planting, and exotic species persist across sites.

Most treated sites are strongly benefitting from general follow-up weed maintenance. Continued herbicide treatment and/or slashing may be needed to manage weed loads and aid plant establishment. Maintenance will be more difficult in sites where tree guards have not been used, both from herbicide drift and difficulty in locating plants.

### 4.1.7 Issues locating sites and waypoints

**Site access**

All sites were easily accessible using the maps provided, and instructions were clear for accessing locked gates or considerations such as appropriate visiting times and clean-down procedures. Any remaining questions were well answered by landholders or by DEWNR staff.

Most landholders were contactable immediately prior to visiting sites, and had already been contacted by DEWNR staff prior to the surveys. Some sites took multiple days to gain access, but the only site where it proved problematic to arrange access over a longer period was the Jacob property on the Narrung Peninsula. Fortunately this was resolved and the site was visited before the end of the surveys.

Landholders (and in particular contacts from the Hindmarsh Island Landcare Group) were supportive of the monitoring and invaluable in providing information about the 2013

plantings. Occasionally the plantings were in different locations to the plans, and on-the-ground knowledge allowed the shifting of some transects which were initially located in older plantings or in unplanted areas. This made for a more accurate representation of the 2013 plantings. The new locations of moved transects were noted in the database, and if they could not be relocated due to the density of other transects around them, this was also recorded.

**Transect and site names on maps**

The maps and directions supplied by DEWNR were prepared well and were critical to locating sites and transects efficiently. At some sites, some transect names were not visible on the maps as they were obscured by other transects. This was remedied by a combination of checking a handheld GPS device for nearby transects that were not on the map, and checking the list of transects at each site after the survey to see if any had been missed.

### 4.1.8 Other survey limitations

**Difficulty finding dead plants**

At some sites it was difficult to find dead plants, which would have the effect of artificially increasing the impression of survivorship levels. Stakes were not a reliable indicator of a planted seedling, as some were planted without stakes, some stakes had been knocked over or otherwise removed, and often a plant group contained fewer stakes than plants. In some sites with thick grasses, the presence of unstaked plants – dead or alive – may not have been noted.

**Sites with few transects**

For smaller sites with fewer transects, the survivorship rates of the few transects completed may not accurately reflect the overall condition of the plantings. A “bad transect” with low survival may markedly decrease the survivorship score for a site, while the rest of the site may have higher condition. This is a minor (but unavoidable) drawback of the process of randomly assigning transect locations.

**Mixed-age and infill plantings**

Some plantings contained significant numbers of mature plants. In this case, obviously mature age (est. > 3y) were not counted, but where the age was not easily able to be determined, they were counted as instructed by DEWNR project staff.

In addition, many of the Hindmarsh Island sites were subject to infill plantings since the 2013 CLLMM project plantings. This is helping to replace dead plants and provide much-needed density and diversity across sites, but made it very difficult to determine the age of plants. In such cases where doubt existed, all plants were counted.

# 5. RECOMMENDATIONS

## 5.1. General management recommendations

Based on the results of the survivorship monitoring, key recommendations proposed for consideration include:

1. Ensure that follow up weed control is maintained across sites, such as slashing and spot spraying of problematic weeds. Effective implementation of this would involve regular checks on sites and reporting any emergent weed outbreaks for management, along with continuing control measures for existing weeds.

2. Control measures should be implemented immediately on spreading weeds such as *Emex australis* and *Echium plantagineum*. Refer to Section 5.2 for a list of significant management issues.

3. Consider using guards around plants wherever possible in future plantings to reduce grazing and competition from weedy grasses. Although it was not explicitly recorded, field observations indicated that one of the strongest determinants of plant survival was the presence or absence of a guard.

4. Continue to work with nearby landholders to report and manage the impacts of pest animals such as hares and rabbits to minimise impacts on plantings. These species have significant impacts on site condition through diggings, and affect plant survivorship through grazing pressure.

5. For sites with markedly low survivorship rates, factors such as site preparation, planting method and inundation levels should be reviewed and recorded. This may result in some insight into the factors that may have contributed to plant death and help prevent similar problems occurring in future plantings.

6. Some sites with high survival rates were anecdotally noted to have markedly different site preparation and planting methods. These should be reviewed and analysed in order to determine any correlation between survivorship and combinations of site history, soil type, topography, hydrology, site preparation, species selection, planting method, and post-planting maintenance. Sites prepared using soil scraping and planted in rows appeared to have the strongest plant health and high survivorship, but without access to information about site preparation and planting method this remains subjective.

7. Implement an abbreviated version of the survivorship survey at 3 years after planting. This would help to indicate the longer-term success of the plantings and aid in planning adjacent and infill plantings to help continue the transition of sites to a species composition reflecting remnant native vegetation.

## 5.2. Site specific management recommendations

Autumn site specific management recommendations are included in Table 12. Recommendations resulting from the spring surveys were not revisited during autumn monitoring due to time constraints, but are also included for reference in Table 13, as some actions may still be relevant.

***Table 12 - Autumn monitoring - management recommendations***

| Site name | Location (E/N) | Issue/recommendation |
|---|---|---|
| **Camac Tamara** | 0340962/6060374 | Mature fruiting *Lycium ferocissimum*. |
| **Davis, Robbie A** | 0340508/6054714 | Mature fruiting *Gomphocarpus fruticosus*. |
| **Davis, Robbie A** | Across site | Continue measures for *Emex australis*. |
| **Feibig Waltowa** | Along roadside | Scattered *Asparagus asparagoides*. |
| **Grey and Mundoo** | Across site | *Citrullus lanatus*. |
| **Grey and Mundoo** | Across site | High loads of *Euphorbia terracina.* |
| **Gunner Gemlake Fife 5** | 0347858/ 6041672 | Rabbit burrows (apparently abandoned) |
| **Gunner Gemlake Fife 5** | 0347858/ 6041672 | Scattered *Chondrilla juncea*. |
| **Gunner Lot 2** | 351150/6046723 | Scattered *Chondrilla juncea*. |
| **Gunner Lot 2** | 350390/6046391 | *Citrullus lanatus* individual. |
| **Hartwell** | Across site | Scattered *Solanum nigrum.* |
| **Hartwell** | Near rainwater tank | *Citrullus lanatus*. |
| **Hayter** | Cropped area adjacent to plantings | *Citrullus lanatus* - try to prevent incursion into plantings. |
| **Hindmarsh (Gilbert)** | 306117/6066830 | Discarded rubbish noted. |
| **Hindmarsh (Farrow)** | Across site | Scattered *Marrubium vulgare*. |
| **Hindmarsh (Farrow)** | Wet areas | *Cenchrus clandestinus* requires control measures. |
| **Hindmarsh (Johnson)** | Across site | Scattered *Cynara cardunculus*. |
| **Hindmarsh (Lane)** | Across site. | Juvenile *Lycium ferocissimum* individuals – not yet fruiting. |
| **Hindmarsh (Swan Point)** | South-eastern corner of site | Mature *Lycium ferocissimum* individual. |
| **Hindmarsh (Wyndgate Homestead)** | Across site | Thick *Cenchrus clandestinus*. Guards should be maintained as long as possible, and grass controlled. |
| **Hoopman JE** | 0355563/6030768 | *Echium plantagineum* next to vehicle track. Control required to prevent vehicles from spreading it across the site. |
| **Jacob** | Across site | Chronic infestation of *Emex australis*. Continue to support landholder to treat the site using measures such as reducing vehicle and foot traffic, manual removal of seed and application of herbicide. |
| **Jacob** | Across site | Scattered mature *Citrullus lanatus* individuals. |
| **Long Point** | Fenceline | Large mature *Lycium ferocissimum* individual on fenceline requiring removal (exact location not recorded). |

| | | |
|---|---|---|
| **Long Point** | Fenceline | *Emex australis* noted just outside the fence line. Control measures would help to prevent this becoming established on the site. |
| **McClure Highway** | Across site | Scattered juvenile *Asparagus asparagoides* individuals. |
| **McClure Highway** | Across site | Scattered *Chondrilla juncea* individuals. |
| **Meningie Pine Removal** | 0349542/6048500 | *Asparagus asparagoides*. |
| **Modistach** | Across site | Scattered juvenile *Solanum*. |
| **Narrung Lifestyle Blocks** | North-west part of the site | *Citrullus lanatus* appeared to be treated, but may need to be followed up. |
| **Orange-bellied Feedlot** | 0358145/6025861 | *Asparagus asparagoides* infestation. |
| **Orange-bellied Feedlot** | 0358145/6025861 | Mature fruiting *Gomphocarpus cancellatus* individual. |
| **Orange-bellied Feedlot** | 0358021/6025807 | Scattered *Echium plantagineum*. |
| **Orange-bellied Feedlot** | 0357976/6025781 | Rabbit warrens. |
| **Rice** | Across site | Monitor sprayed *Xanthium spinosum* for recruitment. |
| **Shadows Lagoon** | 0311026/6066940 | Thick *Cenchrus clandestinus* climbing tree guards and older plantings. |
| **Shadows Lagoon** | 0310774/6066787 | *Onopordum acanthium* and juvenile (non-fruiting) *Lycium ferocissimum* individuals. |
| **Shadows Lagoon West** | 031010/303916 | Deer grazing has damaged older plantings. |
| **Shadows Lagoon West** | 0309230/6067029 | Small infestation of Tall Wheat Grass. |
| **Shadows Lagoon West** | 0309067/6067001 | Small infestation of Tall Wheat Grass. |
| **Shaw** | 0301049/6073597 | Unused stakes and guards left, and more along fenceline. Remove if being used in future plantings. |
| **Shaw** | Northern site | *Citrullus lanatus* scattered through northern site. |
| **Shaw** | North east end of northern site | Juvenile *Rubus fructosus* individual. |
| **Shaw** | 0300291/6073751 | Weedy area needing control measures. Scattered *Citrullus lanatus*, *Solanum nigrum* and *Echium plantagineum*, along with other broadleaf weeds and tall grasses. |
| **Stornoway** | Across site | Scattered *Chondrilla juncea*. |
| **Stratland** | Southern part of the site (by unsealed road) | High load of exotic grasses. Manage with careful slashing and herbicide application. |
| **The Pulgi** | Across site | Mature fruiting *Lycium ferocissimum* individual. |
| **Treloar ZW** | 0334404/6053001 | Mature *Lycium ferocissimum* individual. |
| **Vasarelli 2013** | Southern boundary of site | *Citrullus lanatus* and *Echium plantagineum* individuals. |
| **Vasarelli 2013** | Across site | Scattered *Solanum sp.* |
| **Wellington Dairies** | 0347399/6089547 | Mature fruiting *Lycium ferocissimum* individual. |
| **Wellington Dairies** | 0349609/6089552 | Juvenile *Lycium ferocissimum* individual – not yet fruiting. |
| **Wellington Lodge Lake Edge** | 0349701/6077762 | Fox activity noted. |
| **Yalkuri** | 0329086/6058881 | Scattered *Solanum nigrum* and *Citrullus lanatus*. |

***Table 13 - Spring monitoring - management recommendations***

| Site name | Location (E/N) | Issue/recommendation |
|---|---|---|
| **Camac Rowett** | Various patches across site | Patches of *Xanthium spinosum* not yet flowering. |
| **Hoopman** | 0355724/6030954 | Five mature and fruiting *Solanum linnaeatum* plants. |
| **Hoopman** | 0355543/6031006 | Two mature and fruiting *Solanum linnaeatum* plants at start of transect. |
| **Hoopman** | 0355409/6030976 | Large *Solanum linnaeanum* plants on exposed sandhill near transect. |
| **Hoopman** | 0355817/6030874 | Mature Lycium ferocissimum individuals under stand of Allocasuarina verticillata. |
| **McClure Highway** | Across site | *Vicia sp.* across site, with large infestation near the highway. |
| **McClure Waltowa** | 200m west of 0355626/6058829 | Large amount of seedling trays left in a pile after planting – need to be picked up. |
| **Meningie Pine Removal** | Across site | Scattered *Pinus halepensis* seedlings emerging. |
| **Treloar** | 0334759/6052766 | Juvenile *Lycium ferocissimum* individual. |
| **Treloar** | 0335037/6052888 | Juvenile *Lycium ferocissimum* individual. |
| **Wellington Lodge Lake Edge** | Across site | Rabbit burrows and signs of digging around tree guards and browsing. May require active control to prevent further site degradation. |

# 6. REFERENCES

DEH (2010) *Securing the Future: Long Term Plan for the Coorong, Lower Lakes and Murray Mouth*. Department for Environment and Heritage: Adelaide, South Australia.

Durbridge, R. (2012) *Vegetation Survivorship Monitoring of the Community Revegetation Project Summary Final Report – June 30th 2012.* Goolwa to Wellington Local Action Planning Association.

# 7. APPENDIX A. SITE DATASHEET

**Vegetation Survivorship Monitoring Site Summary**

Plan ID: _____ Plan Name: _____

TransectID completed:

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Photo points taken:

| Camera Ref# | Easting | Northing | Bearing | Height |
|---|---|---|---|---|
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Anecdotal Observation:

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|---|
| *e.g. evidence of pest animals, general health/vigour of plants and pest plant impacts.* |

# 8. APPENDIX B. TRANSECT DATASHEET

**Vegetation Survivorship Monitoring Transect Datasheet**

TransectID: _____ Transect Direction (bearing in degrees): _____

Main Observer: _____ Field Assistant: _____

Date: _____ Time: _____

Survey:

| DataEntry RecordID | LineID (A or B) | Species | Alive | Dead | Observation (e.g. pull from ground, grazed) |
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| DataEntry RecordID | LineID (A or B) | Species | Alive | Dead | Observation (e.g. pull from ground, grazed) |
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# 9. APPENDIX C. INDIVIDUAL SITE SUMMARIES

## *9.1. Notes for referring to this section*

**Site maps**

Where a site map includes multiple sites, a listing of waypoints is included with the site notes for reference.

**Detailed site survivorship data**

Plant counts by site are available in the tables in Section 3. In some cases, a site justifies further details to be included in this report due to poor survivorship or large changes between the spring and autumn counts; this is included with the site notes. This way, the most relevant data is highlighted.

Full survivorship count data for each site, including dead and alive by polygon, zone, transect, and species, is available in the database **survival_rel.accdb**.

## 9.1.1 Biddle N & G Waltowa - PlanID 9

### 9.1.1.1 Site map


Site contained transects 1989, 1991, 1992, 1993, 1994, 1997, 1998, 1999, 2000, 2001, 2002

#### 9.1.1.2 Site photo

#### 9.1.1.3 Survivorship results

Site surveyed in spring 2013 and autumn 2014.

| Biddle N & G Waltowa | Spring | | Autumn | |
|---|---|---|---|---|
| | **Alive** | **Dead** | **Alive** | **Dead** |
| | 478 | 68 | 93 | 486 |
| **Survival** | **87.5%** | | **16.1%** | |

Autumn survivorship was very poor at 16.1%, with most plants species experiencing significant die-off over the dry summer months. Survivorship dropped markedly from the 87.5% recorded in the spring survey, with survival of sedges and grasses particularly low. *Atriplex* species were observed to be surviving well – defying the overall trend for the site – and significant numbers of *Melaleuca halmaturorum* survived. It is notable that the site was made up of only Zone 3 (Saline edge) plantings, and with the observation of nearby inundation during the spring monitoring,

Many plants were unguarded across the site. No significant pest plant or animal impacts were noted.

## 9.1.2 Camac Rowett – PlanID 306

### 9.1.2.1 Site map

#### 9.1.2.2 Site photo

#### 9.1.2.3 Survivorship results

Site surveyed in spring 2013 and autumn 2014.

| Camac Rowett's Block | Spring | | Autumn | |
|---|---|---|---|---|
| | **Alive** | **Dead** | **Alive** | **Dead** |
| | 941 | 128 | 2412 | 239 |
| **Survival** | **88.0%** | | **91.0%** | |

At 91%, the autumn survivorship was the highest for large sites containing mixed species. Survivorship percentage held steady from the spring surveys, and the slight increase could be attributed to different transect locations taking in different areas of the site.

Plants across the site were exceptionally large and healthy and displayed the most advanced growth across all sites surveyed. Some plant deaths due to inundation were noted along the north-eastern end of the site.

Follow up weed control appears to be excellent although it has resulted in mostly bare ground between rows. Selective spraying has allowed some patches of *Atriplex prostrata* and *Distichlis distichophylla* to establish. Some persisting *Cynodon dactylon* and *Cenchrus clandestinus* was noted along the lake edge.

## 9.1.3 Camac Tamara – PlanID 305

### 9.1.3.1 Site map

#### 9.1.3.2 Site photo

#### 9.1.3.3 Survivorship results

Site surveyed in spring 2013 and autumn 2014.

| Camac Tamara | Spring | | Autumn | |
|---|---|---|---|---|
| | Alive | Dead | Alive | Dead |
| | 497 | 72 | 863 | 137 |
| **Survival** | **87.3%** | | **86.3%** | |

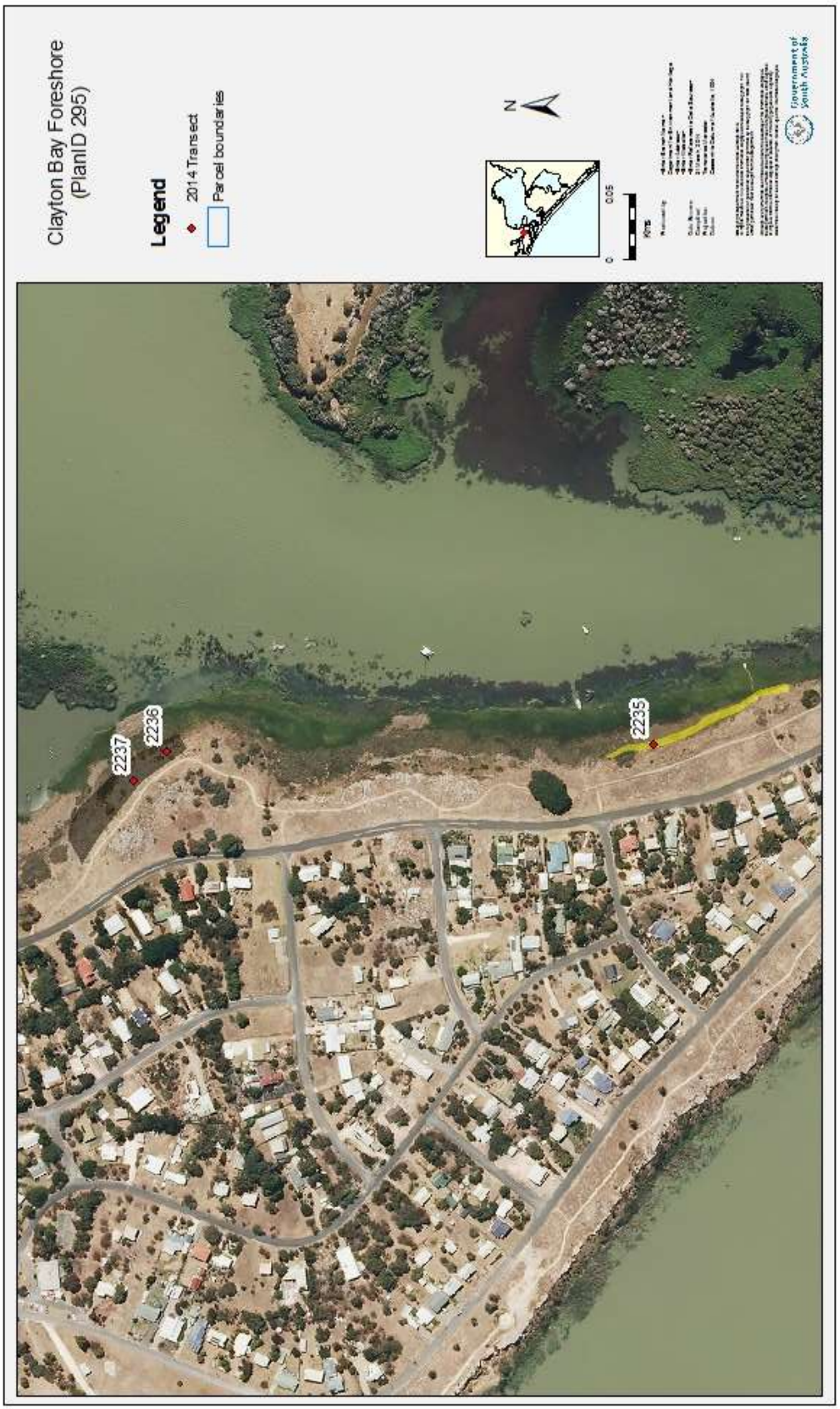
Autumn survivorship was excellent at 86.3% - a small drop from the spring survey at 87.3%. No species experienced significant die off, however it was difficult to determine the species of some dead plants. Plant health is excellent with strong growth across all species.

Weed loads were higher than at the Camac Rowett site. Weeds are more prevalent along the lake edge where they are hard to manage, with *Cynodon dactylon* and thick *Cenchrus clandestinus* dominant, and *Atriplex prostrata* also common.

A good spread of other established natives were noted around the site. Sedges were seen close to the lake edge, and mature stands of *Duma florulenta* on drier ground. Some recruitment of *Distichlis distichophylla* was noted.

## 9.1.4 Clayton Bay Foreshore – PlanID 295

### 9.1.4.1 Site map



#### 9.1.4.2 Site photo

#### 9.1.4.3 Survivorship results

Site surveyed in autumn 2014.

| Clayton Bay Foreshore | Autumn | |
|---|---|---|
| | Alive | Dead |
| | 315 | 171 |
| **Survival** | **64.8%** | |

Survivorship across the site was good at 64.8%. Most plants observed were either sedges or grasses, and survivorship was high for *Ficinia nodosa* and *Poa*. Contrastingly, survivorship of *Juncus kraussii* was found to be much lower, with no visible indication as to the cause.

Zone 3 (saline edge) survivorship was low at 32.4% of 207 plants counted, while zone 4 (rising ground) was much higher at 88.9% of 279 plants counted.

Exotic grasses such as *Cenchrus clandestinus* persist across the site. Most guards were still intact and providing adequate protection from exotic grass competition. Some areas appear to have been sprayed with herbicide, with patches of bare ground and dead grass.

## 9.1.5 Council Triangle – PlanID 292

### 9.1.5.1 Site map

#### 9.1.5.2 Site photo

#### 9.1.5.3 Survivorship results

Site surveyed in autumn 2014.

| Council Triangle | Autumn | |
|---|---|---|
| | Alive | Dead |
| | 468 | 236 |
| **Survival** | **66.5%** | |

Survivorship across the site was good at 66.5%. Most species were surviving well, but it was difficult to determine the species of most of the dead plants and this resulted in distorted high survivorship scores at a species level.

Many guards at the site were missing, or blown or pushed over. Significant grazing pressure on the unguarded plants may have contributed to the lower survivorship at the site and also made it difficult to identify dead plants to species level.

Some *Euphorbia terracina* was noted across the site but it was mostly growing outside of guards.

## 9.1.6 Davis, Robbie A – PlanID 12

### 9.1.6.1 Site map

#### 9.1.6.2 Site photo

#### 9.1.6.3 Survivorship results

Site surveyed in spring 2013 and autumn 2014.

| Davis, Robbie A | Spring | | Autumn | |
|---|---|---|---|---|
| | **Alive** | **Dead** | **Alive** | **Dead** |
| | 434 | 19 | 287 | 346 |
| **Survival** | **95.8%** | | **45.3%** | |

Autumn survivorship was fair at 45.3%, with *Acacias* and *Eucalypts* struggling. *Ficinia nodosa* was mostly dead with 37% survival of 220 plants counted. Grasses were also struggling across the site – perhaps due to drainage from the rise on the upper part of the site and subsequent lack of soil moisture.

Survivorship dropped off markedly from the spring surveys (95.8%), which could be a result of the dry summer and the fact that most autumn transects were located on the high ground where moisture stress is likely to be higher, while the spring surveys included at least one transect on lower ground.

Some stock disturbance was noted, with droppings and signs of grazing on some plants. Weedy grasses also persist across the site but most guards remain intact. High loads of Caltrop (*Emex australis*) were found. Plants were found both inside and outside guards across

the site and the problem are being actively managed by the landholder. As a result, no vehicles entered the site and boots were cleaned before leaving the property.

## 9.1.7 Fiebig Waltowa – PlanID 10

### 9.1.7.1 Site map

Site contained transects 1928, 1929, 1930, 1931, 1933, 1934, 1935, 1937, 1938, 1939, 1940, 1941, 1943, 1946, 1947, 1948, 1949, 1951, 1952, 1954, 1955

#### 9.1.7.2 Site photo

#### 9.1.7.3 Survivorship results

Site surveyed in spring 2013 and autumn 2014.

| Feibig Waltowa | Spring | | Autumn | |
|---|---|---|---|---|
| | Alive | Dead | Alive | Dead |
| | 818 | 181 | 1060 | 581 |
| **Survival** | **81.9%** | | **64.8%** | |

Survivorship was good at 64.8%. *Atriplex* species survival was excellent. *Ficinia nodosa* also survived well while *Juncus kraussii* was much lower (48.8%). Survivorship decreased moderately from spring monitoring (81.9%).

Plant health was high across the site, with good growth noted for most species. Some unplanted *Melaleuca* sp seedlings were found scattered on the ground. *Asparagus asparagoides* was noted along the roadside and one rabbit was observed during the survey.

## 9.1.8 Grey and Mundoo – PlanID 283

### 9.1.8.1 Site map


Site contained transects 2303, 2304, 2305, 2306, 2307, 2308, 2309, 2311, 2312, 2313, 2314, 2315, 2330, 2476, 2477, 2478, 2479, 2480, 2482, 2484, 2485, 2487, 2489, 2491, 2492, 2493, 2495, 2496, 2497, 2498, 2847, 2849, 2850

#### 9.1.8.2 Site photo

#### 9.1.8.3 Survivorship results

Site surveyed in autumn 2014.

| Grey and Mundoo | Autumn | |
|---|---|---|
| | Alive | Dead |
| | 425 | 130 |
| **Survival** | **76.2%** | |

Survivorship was high at 76.2%. A diverse range of species were planted at the site, and unlike many other sites, *Atriplex* species was not commonly found. *Eucalyptus* species survived very well. Plant health and growth was good across both sites, although a small number of *Eucalyptus* and *Acacia* plants appeared to be carrying an unidentified disease. Older plantings were scattered through the site.

*Citrullus lanatus* was scattered throughout site, and high loads of *Euphorbia terracina* were present in patches.

## 9.1.9 Griffin 2013 – PlanID 294

### 9.1.9.1 Site map

#### 9.1.9.2 Site photo

#### 9.1.9.3 Survivorship results

Site surveyed in spring 2013 and autumn 2014.

| Griffin 2013 | Spring | | Autumn | |
|---|---|---|---|---|
| | Alive | Dead | Alive | Dead |
| | 254 | 32 | 140 | 28 |
| **Survival** | 88.8% | | 83.3% | |

Autumn survivorship was excellent at 83.3% - a small drop from the spring survey at 88.8%. All planted species appeared to be growing well, with no significant die-off of any particular species. *Allocasuarina verticillata* were observed to be growing particularly well. Some transects at the site were unplanted and weren't moved due to the density of other transects nearby.

Some *Cenchrus clandestinus* was observed in patches across the site. *Emex australis* was seen in the paddock next to the plantings. *Scabiosa atropurpurea*, *Euphorbia terracina* and *Lagurus ovatus* were also noted across the site. Evidence of woody weed control was seen, with dead *Lycium ferocissimum* across the site. Rabbit burrows were observed in sandier parts of the site.

## 9.1.10 Gunner Gemlake Fife 5 – PlanID 3

### 9.1.10.1 Site map

### 9.1.10.2 Site photo

### 9.1.10.3 Survivorship results

Site surveyed in spring 2013 and autumn 2014.

| Gunner Gemlake Fife 5 | Spring | | Autumn | |
|---|---|---|---|---|
| | **Alive** | **Dead** | **Alive** | **Dead** |
| | 1031 | 208 | 590 | 570 |
| **Survival** | **83.2%** | | **50.9%** | |

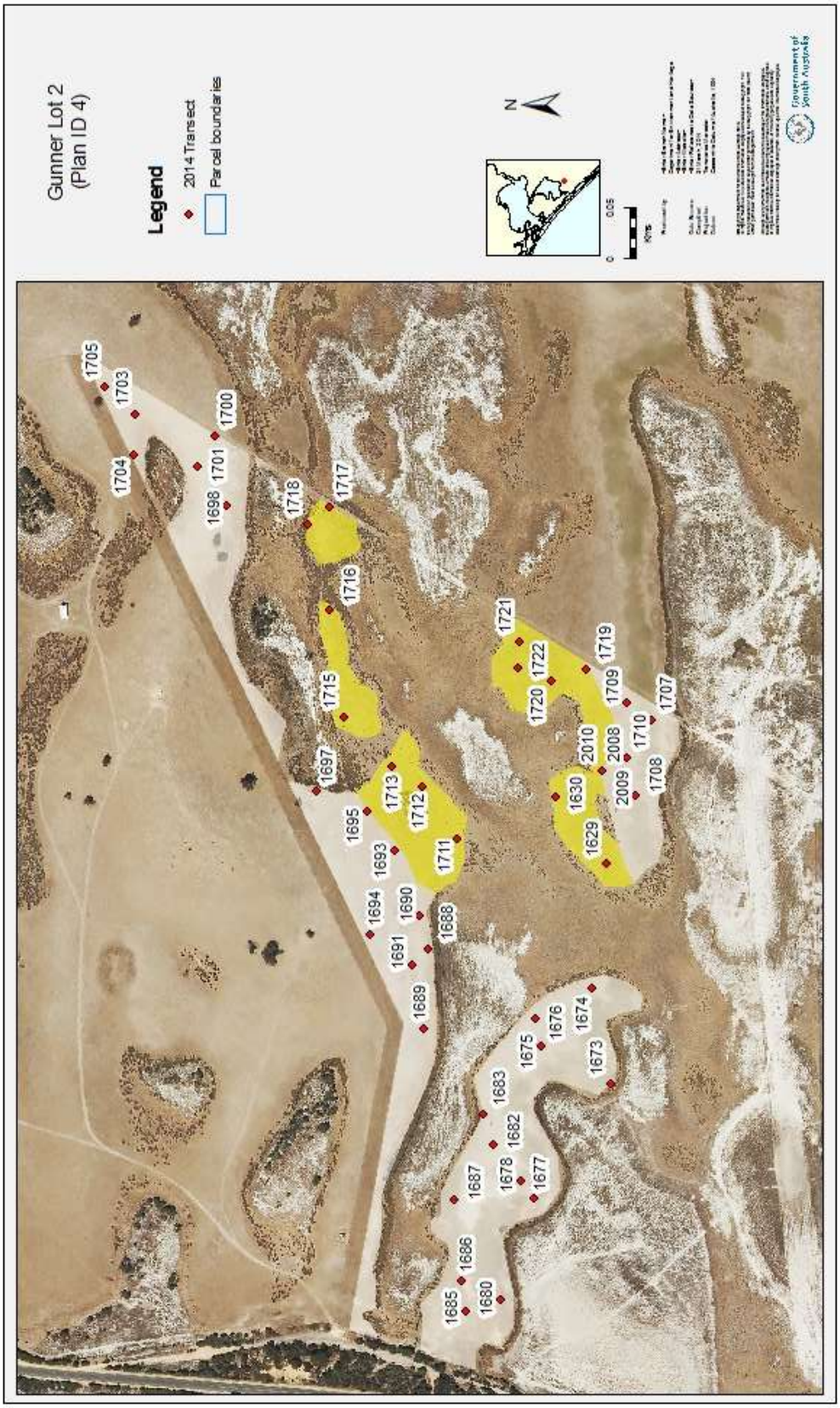
Autumn survivorship was fair at 50.9% - a significant drop from the spring survivorship of 83.2%. Most overstorey species appeared to be surviving well, along with *Ficinia nodosa* and grasses such as *Austrostipa sp.* and *Austrodanthonia sp.* Species that appeared to be struggling included *Bursaria spinosa* and *Banksia ornata*.

The site is mostly sand dune covered by exotic grasses and is subject to high elevation gradients. Some plants are healthy – particularly toward the bottom of the dunes. *Pelargonium australe* had excellent growth across the site, and most *Vittadinea cuneata* were flowering or had flowered. Survivorship appeared to decrease with increased elevation and could be a function of reduced soil moisture at the top of the sandhills.

Weedy grasses and *Oenothera stricta* are prevalent across the site but not thick enough to provide competition for space. No woody weeds were seen across the site. *Theba pisana* were grazing on some plants, but impacts appeared to be low.

## 9.1.11 Gunner Lot 2 – PlanID 4

### 9.1.11.1 Site map



### 9.1.11.2 Site photo

### 9.1.11.3 Survivorship results

Site surveyed in spring 2013 and autumn 2014.

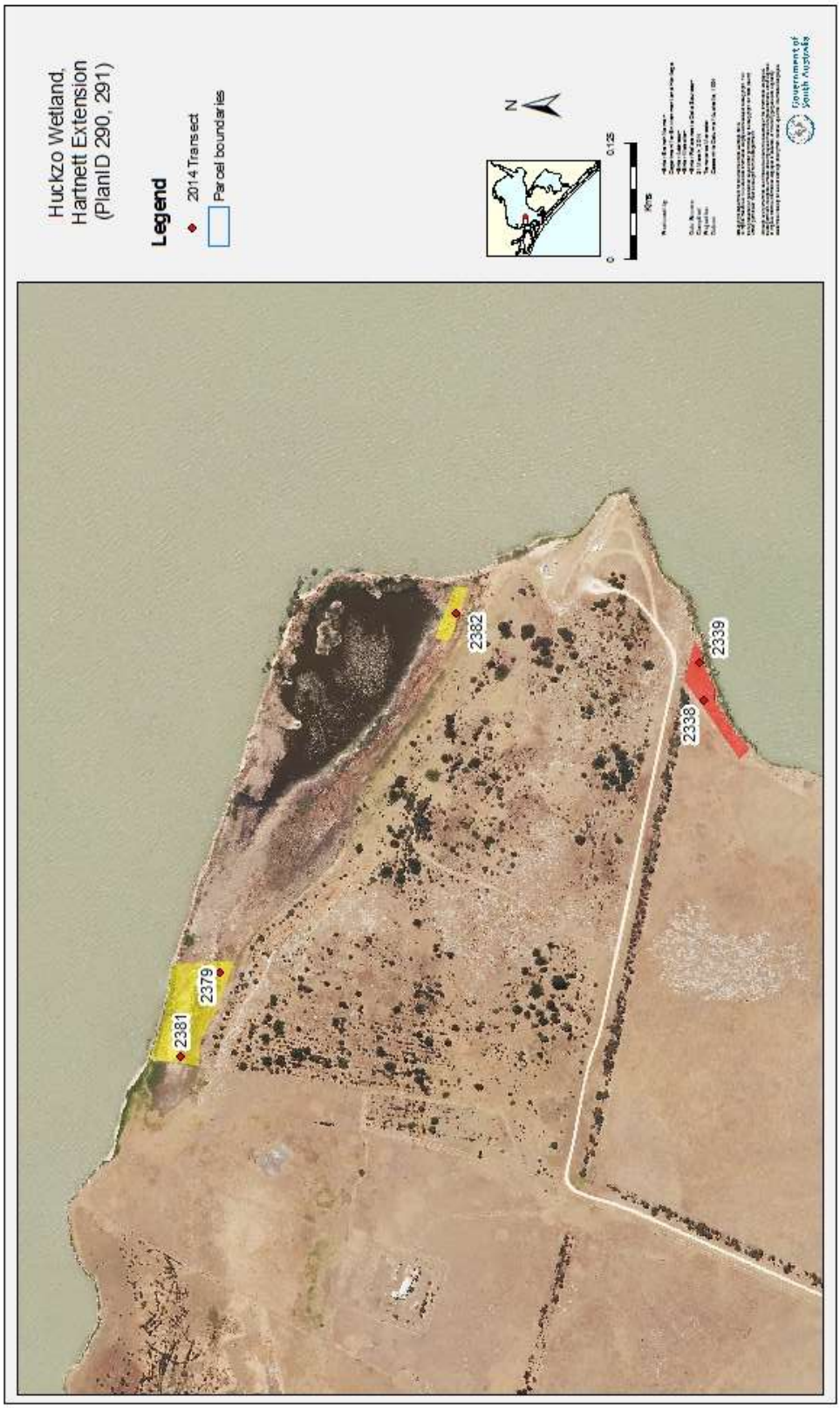
| Gunner Lot 2 | Spring | | Autumn | |
|---|---|---|---|---|
| | **Alive** | **Dead** | **Alive** | **Dead** |
| | 1100 | 218 | 1600 | 1278 |
| **Survival** | **83.5%** | | **55.6%** | |

Autumn survivorship was fair at 55.6% - a significant drop from the spring monitoring at 83.5%. *Atriplex* species and *Allocasuarina verticillata* had high survivorship rates, while some species observed to be struggling included wetland-edge species such as *Juncus kraussii* (22.6% survival of 195 plants counted) and *Melaleuca halmaturorum.*

Most plants exhibited good growth. Guards are working fairly well with most still intact and – in some cases, restricting the growth of plants. Many plants are already shaped by strong winds across the site due to the open, cleared nature of the surrounding landscape. *Oenothera stricta* and weedy grasses persist across a mostly sandy soil. *Chondrilla juncea* was noted around transect 1703, and *Citrullus lanatus* around transect 1684.

## 9.1.12 Hartnett Extension – PlanID 291

### 9.1.12.1 Site map




Site contained transects 2338, 2339

### 9.1.12.2 Site photo

### 9.1.12.3 Survivorship results

Site surveyed in autumn 2014.

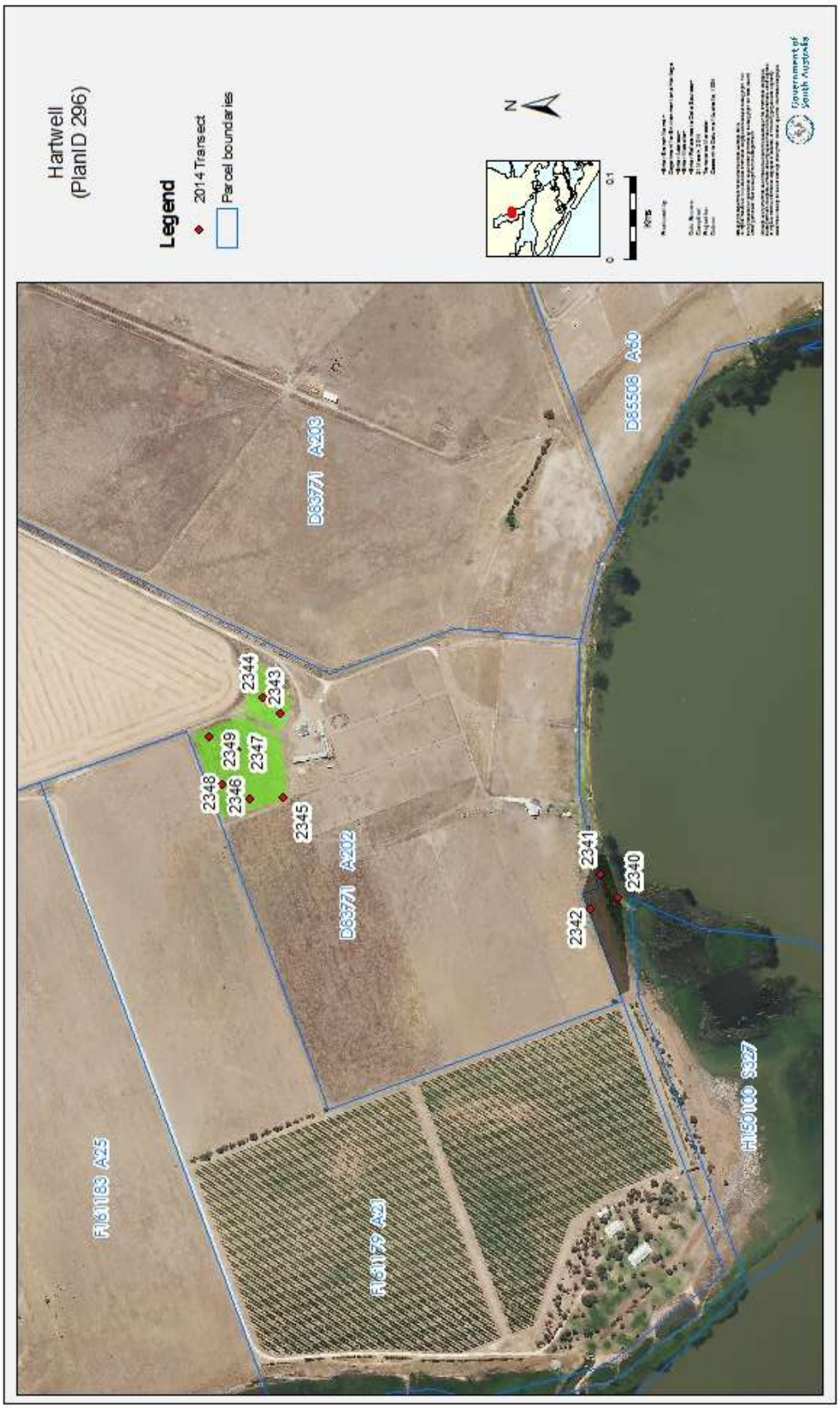
| Hartnett Extension | Autumn | |
|---|---|---|
| | Alive | Dead |
| | 114 | 3 |
| **Survival** | **97.4%** | |

Survivorship was the highest recorded for any site at 97.4%, but was subject to a small sample size of 2 transects. All species showed high survivorship and good growth, and *Pelargonium australe* was notable for its vigour. Many guards had been flattened or were lost.

Some *Thinopyrum elongatum* and *Lagurus ovatus* was observed.

## 9.1.13 Hartwell – PlanID 296

### 9.1.13.1 Site map



### 9.1.13.2 Site photo

### 9.1.13.3 Survivorship results

Site surveyed in autumn 2014.

| Hartwell | Autumn | |
|---|---|---|
| | Alive | Dead |
| | 229 | 55 |
| **Survival** | **80.6%** | |

Survivorship was excellent at 80.6%. Overstorey plants such as *Eucalyptus*, *Leptospermum* and *Melaleuca* all appeared to be surviving well and adding good growth. *Acacia pycnantha* showed excellent growth. Ground across the site appeared dry with cracking soils. Many tree guards were flattened around E 307570 N 6074205.

## 9.1.14 Hayter – PlanID 297

### 9.1.14.1 Site map

### 9.1.14.2 Site photo

### 9.1.14.3 Survivorship results

Site surveyed in autumn 2014.

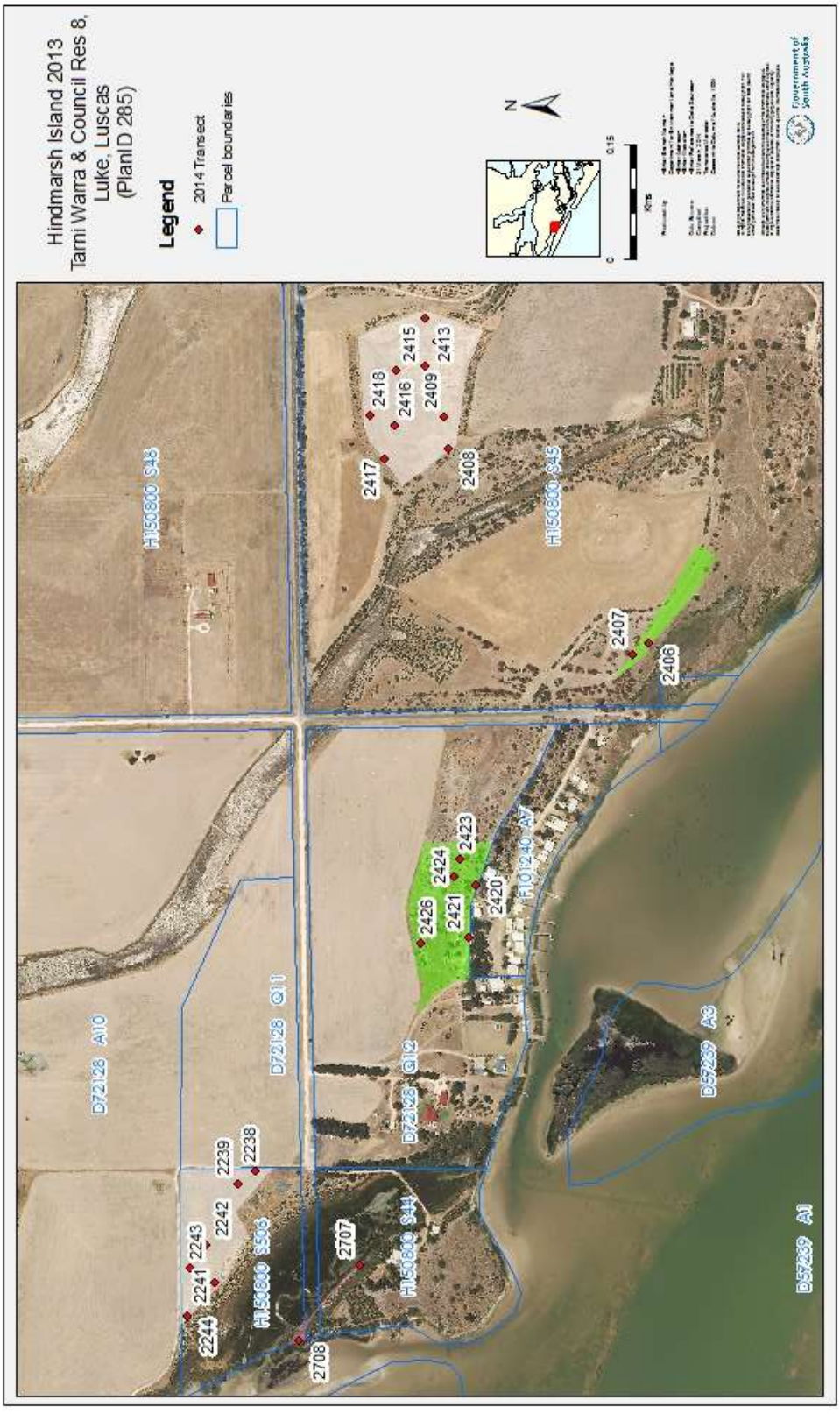
| Hayter | Autumn | |
|---|---|---|
| | Alive | Dead |
| | 435 | 109 |
| **Survival** | **80.0%** | |

Survivorship was excellent at 80%. All species that were planted in higher numbers across the site showed high survivorship and good growth. Older plantings were scattered throughout and were not included in the survey where possible. The area around transect 2359 (E 306995 N 6075423) was mostly inundated and pools of surface water were common in that area, although only a small number of plants were affected.

Some *Citrullus lanatus* plants were present in the cropped area adjacent to plantings, but none were noted within the planted areas. No other significant pest plant or animal impacts were recorded.

## 9.1.15 Hindmarsh Island (Council Reserve) – PlanID 285

### 9.1.15.1 Site map




Site contained transects 2420, 2421, 2423, 2424, 2426

### 9.1.15.2 Site photo

### 9.1.15.3 Survivorship results

Site surveyed in autumn 2014.

| Council Reserve | Autumn | |
|---|---|---|
| | **Alive** | **Dead** |
| | 43 | 11 |
| **Survival** | **77.8%** | |

Survivorship was good at 77.8%. Plants surveyed were mostly healthy with good growth, and some more mature plantings are beginning to give some structure to the site.

Weedy grasses persist across the site, and *Euphorbia terracina* and *Conyza* plants were scattered throughout.

## 9.1.16 Hindmarsh Island (Dredge) – PlanID 285

### 9.1.16.1 Site map


Site contained transects 2266, 2267, 2268

### 9.1.16.2 Site photo

### 9.1.16.3 Survivorship results

Site surveyed in autumn 2014.

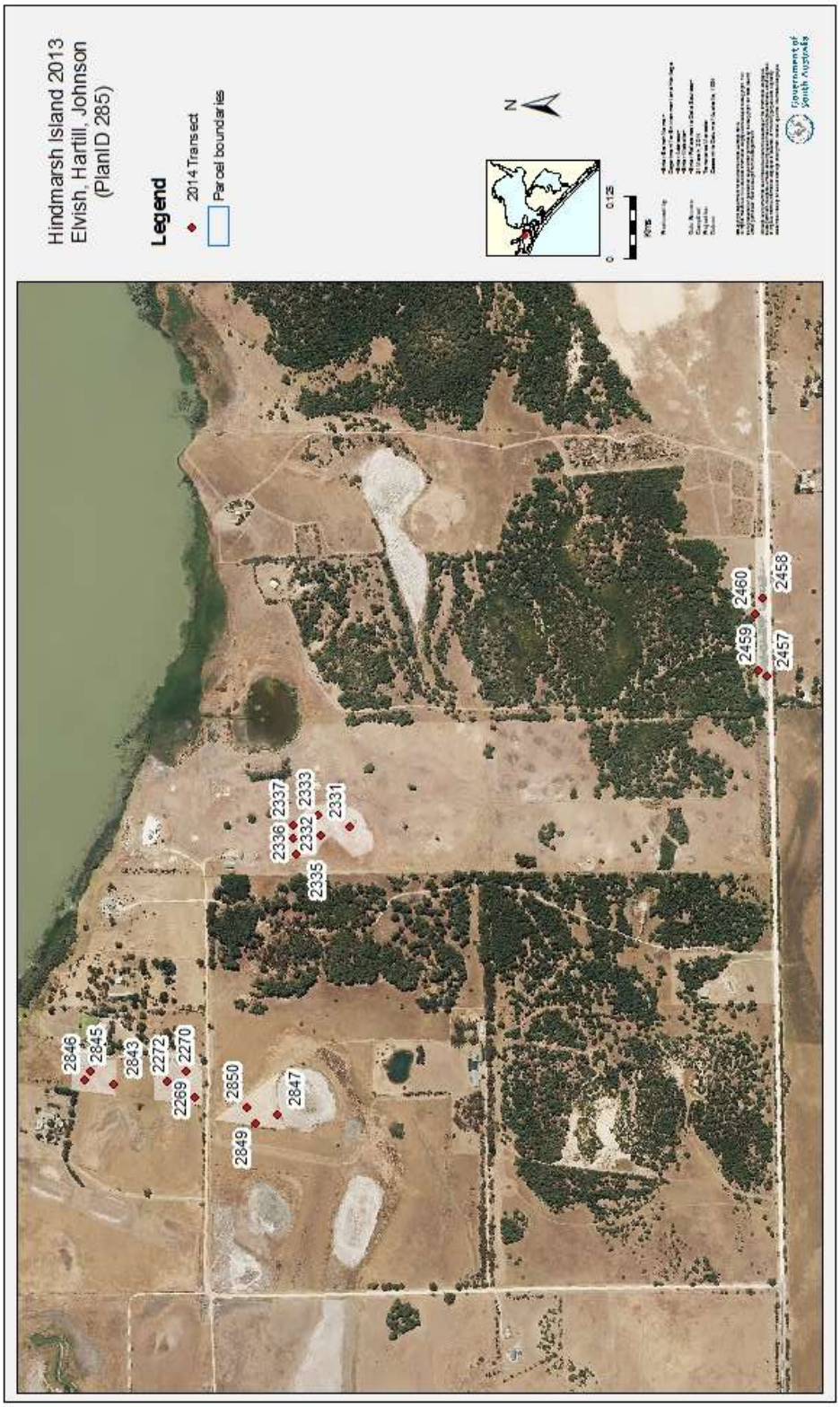
| Dredge | Autumn | |
|---|---|---|
| | Alive | Dead |
| | 56 | 57 |
| **Survival** | **49.6%** | |

Survivorship was fair at 49.6%. The site also held older plantings, and surviving plants were healthy with good growth. Some guards were missing, as was common across Hindmarsh Island sites where the use of plastic film guards was widespread and susceptible to blowing away at certain sites.

The site was located on a roadside, making it susceptible to weed incursion. *Euphorbia terracina* and *Cenchrus clandestinus* were scattered through the site.

## 9.1.17 Hindmarsh Island (Elvish) – PlanID 285

### 9.1.17.1 Site map




Site contained transects 2269, 2270, 2272, 2843, 2845, 2846

### 9.1.17.2 Site photo

### 9.1.17.3 Survivorship results

Site surveyed in autumn 2014.

| Elvish | Autumn | |
|---|---|---|
| | Alive | Dead |
| | 62 | 57 |
| **Survival** | **52.1%** | |

Survivorship was fair across the site at 52.1%. Where plants have survived, they are healthy, especially toward the bottom of the rise with *Melaleuca halmaturorum* doing particularly well. Some older plants are scattered through the patches.

Some slashing has been done around patches of plantings, but thick grass cover remains within patches, including *Cenchrus clandestinus* . *Distichlis distichophylla* is present, but little other native grass cover was noted.

## 9.1.18 Hindmarsh Island (Farrow) – PlanID 285

### 9.1.18.1 Site map


Site contained transects 2273, 2274

### 9.1.18.2 Site photo

### 9.1.18.3 Survivorship results

Site surveyed in autumn 2014.

| Farrow | Autumn | |
|---|---|---|
| | Alive | Dead |
| | 72 | 10 |
| **Survival** | **87.8%** | |

Survivorship was very high across the site at 87.8%. Plants were very healthy with strong growth. Some slightly older plantings were noted through the patches. The areas by the water showed a more native species composition, with *Halosarcia sp.* and *Distichlis distichophylla* dominant.

Thick exotic grass cover persists throughout the site. *Marrubium vulgare* was also noted, along with *Euphorbia terracina*.

## 9.1.19 Hindmarsh Island (Ferrymans Reserve) – PlanID 285

### 9.1.19.1 Site map

### 9.1.19.2 Site photo

### 9.1.19.3 Survivorship results

Site surveyed in autumn 2014.

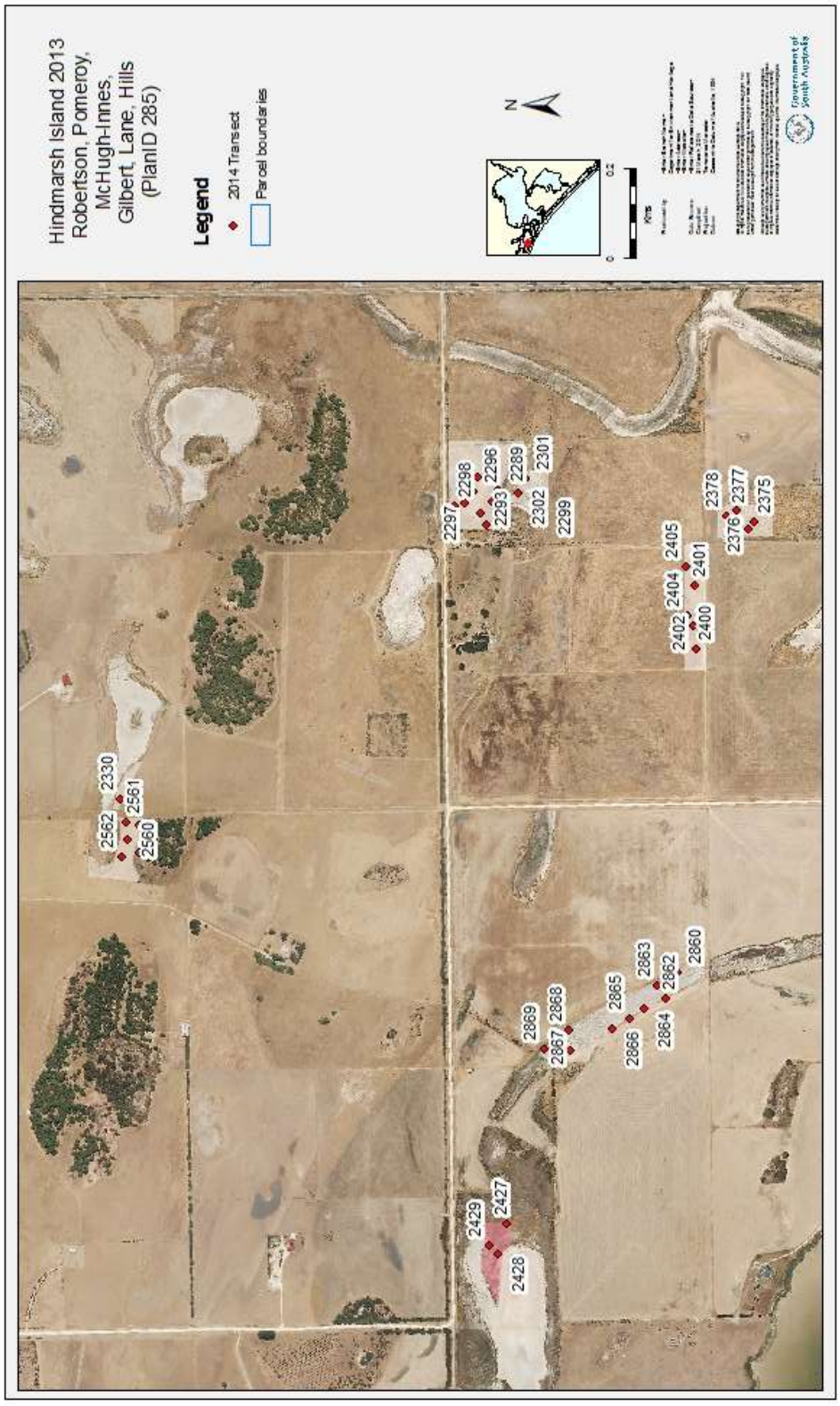
| Ferrymans Reserve | Autumn | |
|---|---|---|
| | Alive | Dead |
| | 160 | 71 |
| **Survival** | **69.3%** | |

Survivorship was good across the site at 69.3%. Significant die-back was noted on *Hakea mitchellii*, but most surviving plants were healthy and showing strong growth. Some older plantings were mixed through the site.

Sparse exotic grass cover persists across most of the site, although this had largely died off over summer. *Lagurus ovatus* was widespread.

## 9.1.20 Hindmarsh Island (Gilbert) - PlanID 285

### 9.1.20.1 Site map




Site contained transects 2287, 2289, 2290, 2292, 2293, 2294, 2296, 2297, 2298, 2299, 2301, 2302

### 9.1.20.2 Site photo

### 9.1.20.3 Survivorship results

Site surveyed in autumn 2014.

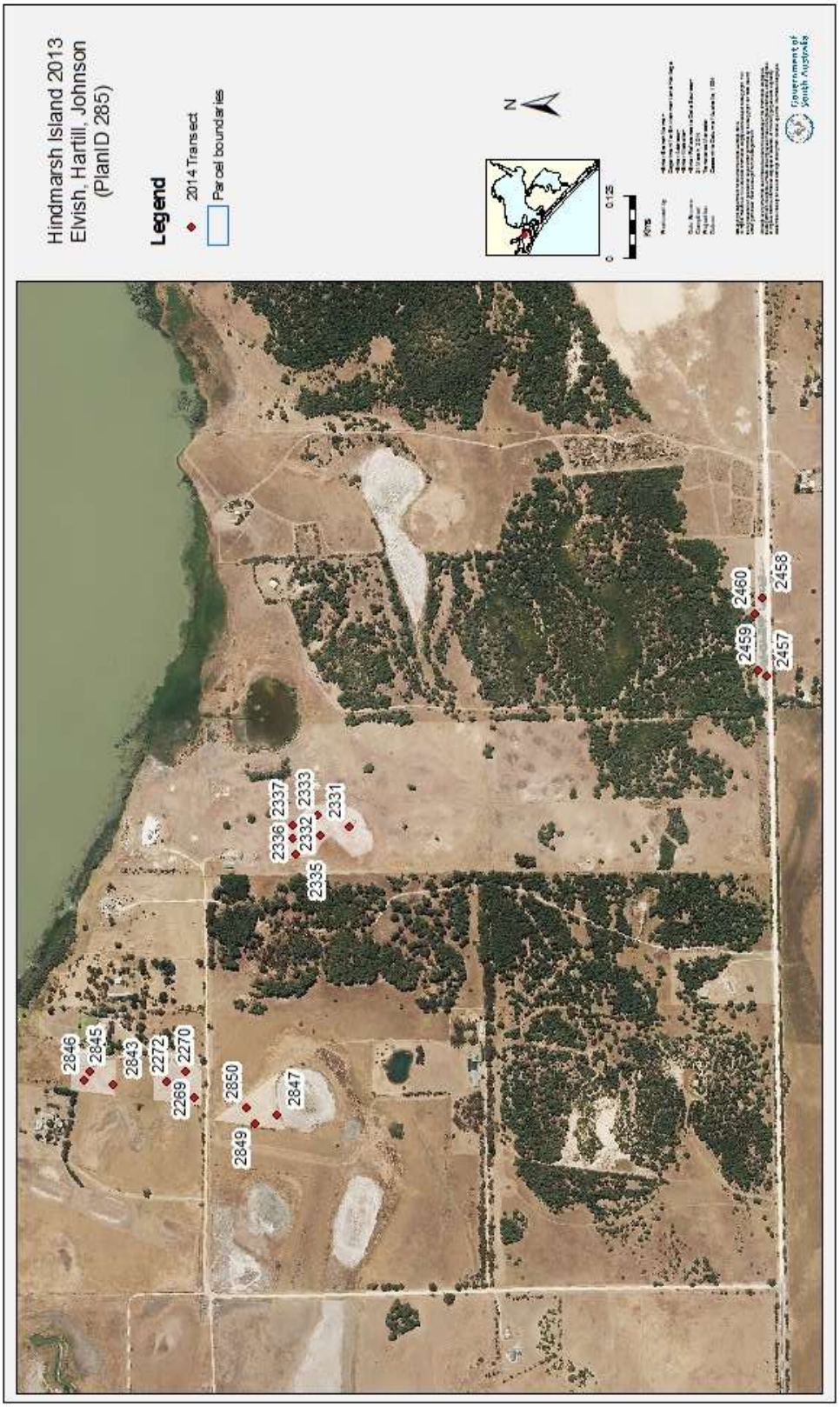
| Gilbert | Autumn | |
|---|---|---|
| | Alive | Dead |
| | 150 | 61 |
| **Survival** | **71.1%** | |

Survivorship was high across the site at 71.1%. Some transects only contained plants which were estimated to be 3 or more years. This was discussed with DEWNR staff and these plants were counted. Significant *Atriplex sp.* and *Distichlis distichophylla* cover was also noted.

Weedy grasses persist across the site and are thick through some patches, along with a scattering of small *Marrubium vulgare.*

## 9.1.21 Hindmarsh Island (Hartill) – PlanID 285

### 9.1.21.1 Site map




Site contained transects 2331, 2332, 2333, 2335, 2336, 2337

### 9.1.21.2 Site photo

### 9.1.21.3 Survivorship results

Site surveyed in autumn 2014.

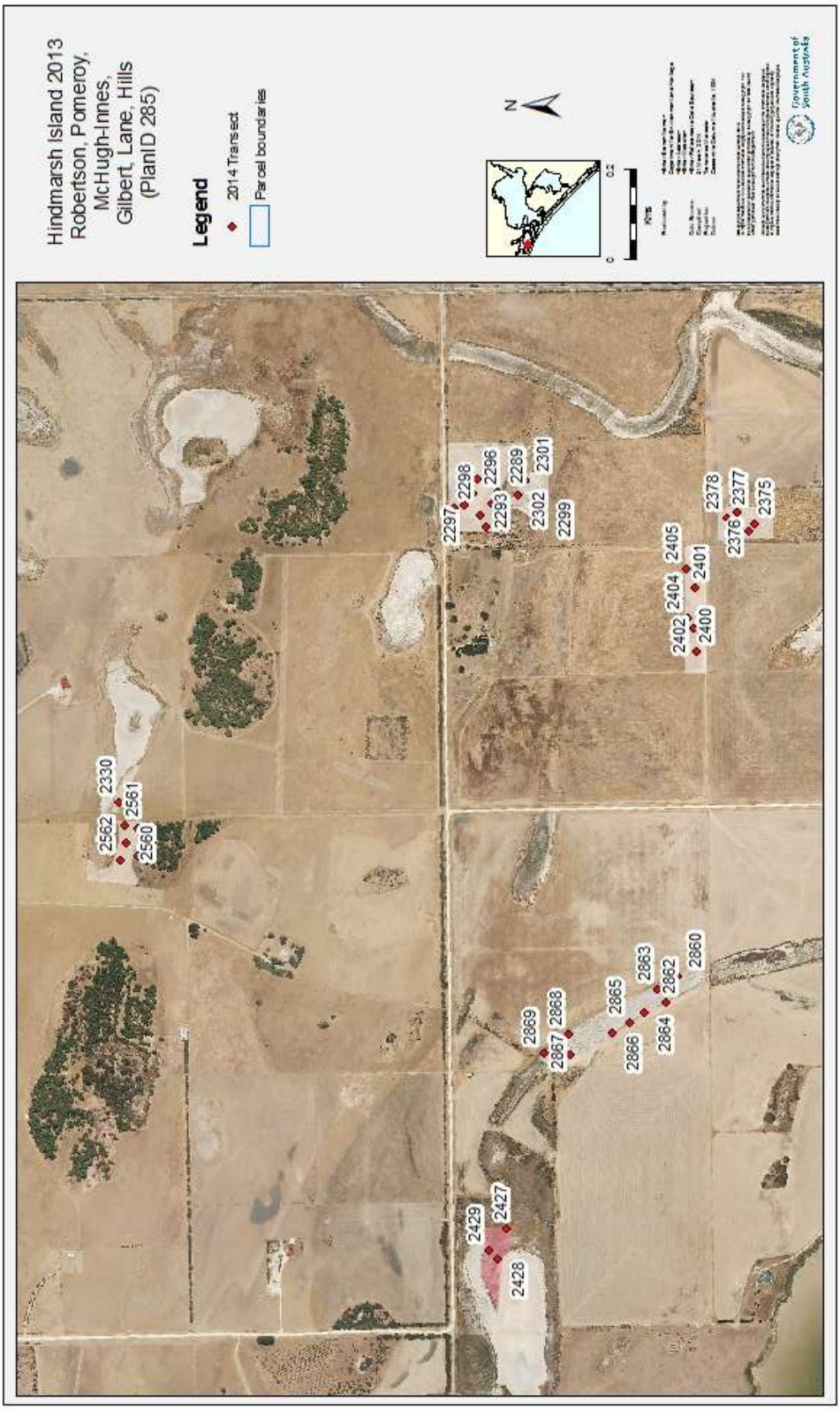
| Hartill | Autumn | |
|---|---|---|
| | Alive | Dead |
| | 86 | 43 |
| **Survival** | **66.7%** | |

Survivorship was good at 66.7%. The site appeared to be a pine removal site and pre-planting preparation may have been lower than most other sites.

The site hosted very high weed loads and species richness including some problematic weeds that require control. There were large numbers of *Solanum nigrum*, *Conyza sp.* and *Citrullus lanatus*. *Lycium ferocissimum*, *Solanum linnaeanum* and *Onopordum acanthium* were also noted across the site, with all weedy species having mature individuals. There was no notable evidence of weed control.

## 9.1.22 Hindmarsh Island (Hills) – PlanID 285

### 9.1.22.1 Site map




Site contained transects 2375, 2376, 2377, 2378

### 9.1.22.2 Site photo

### 9.1.22.3 Survivorship results

Site surveyed in autumn 2014.

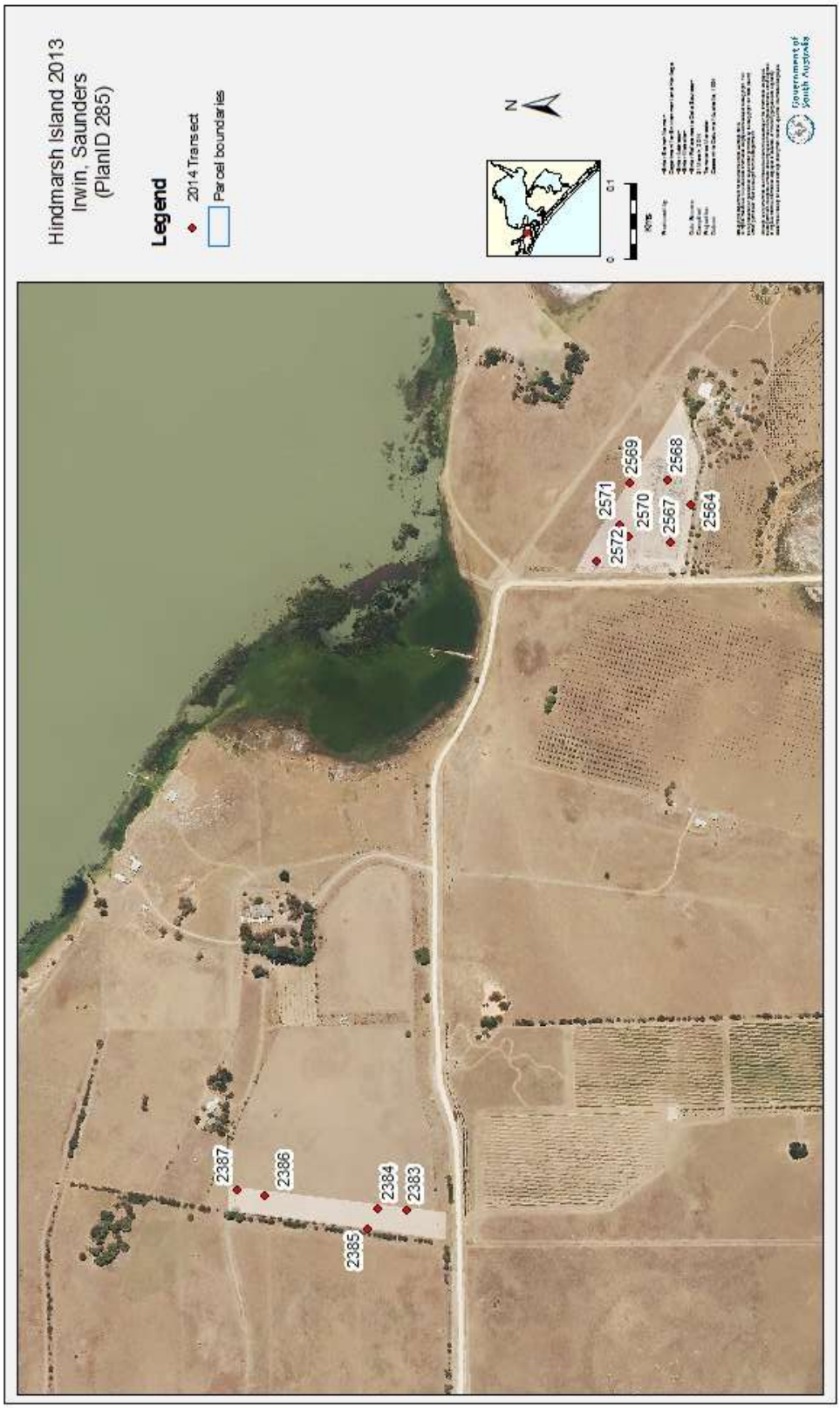
| Hills | Autumn | |
|---|---|---|
| | Alive | Dead |
| | 32 | 29 |
| **Survival** | **52.5%** | |

Survivorship was fair across the site at 52.5%. Plants are healthy with good growth and weeds are mostly restricted to exotic grasses. Some *Enchylaena tomentosa* are unguarded.

*Atriplex nummularia* (Old Man Saltbush) has been removed from the planting area but still borders the plantings on one side. No evidence of pest animals was noted.

## 9.1.23 Hindmarsh Island (Irwin) – PlanID 285

### 9.1.23.1 Site map




Site contained transects 2383, 2384, 2385, 2386, 2387

### 9.1.23.2 Site photo

### 9.1.23.3 Survivorship results

Site surveyed in autumn 2014.

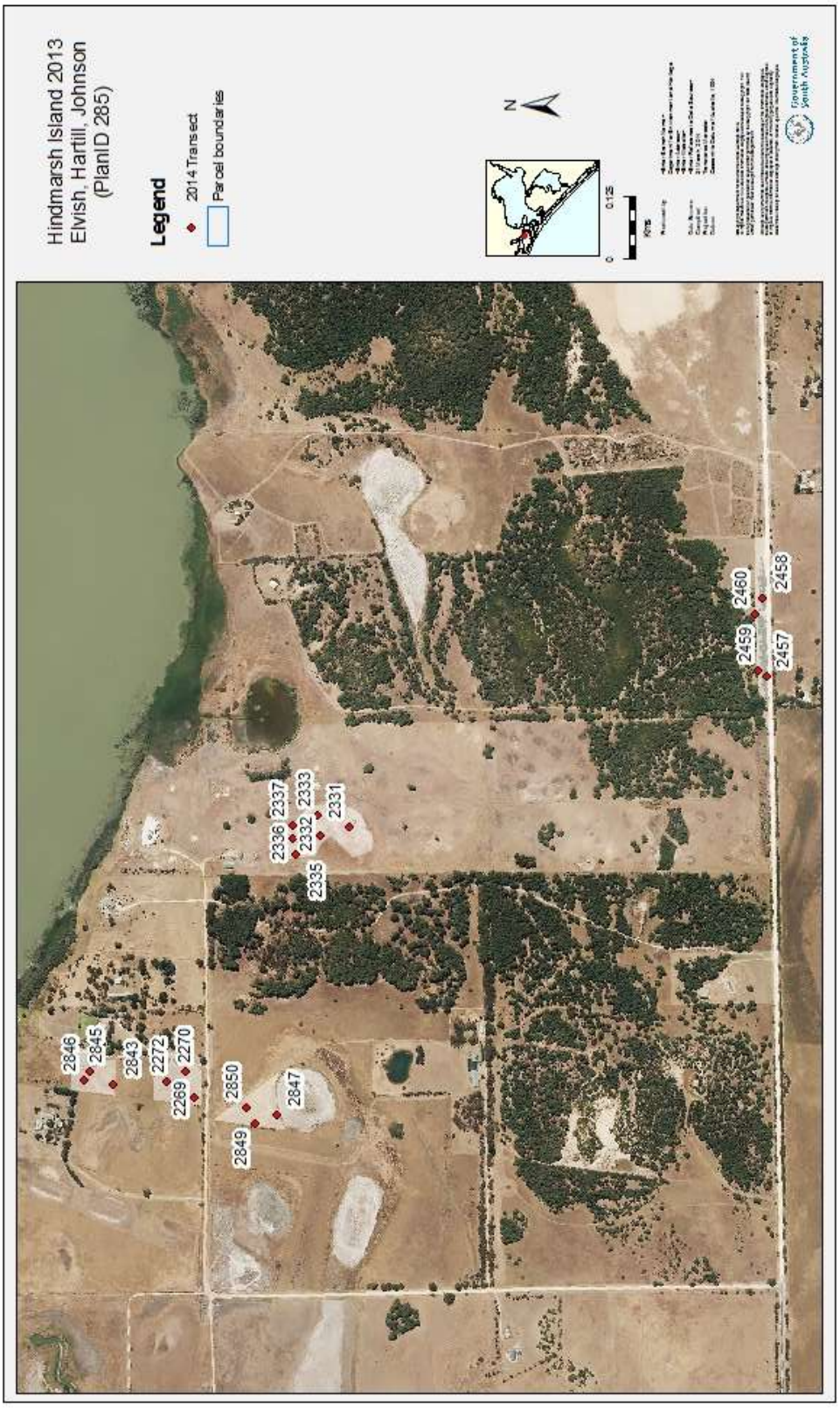
| Irwin | Autumn | |
|---|---|---|
| | Alive | Dead |
| | 90 | 52 |
| **Survival** | **63.4%** | |

Survivorship was good at 63.4%. Most surviving plants are reasonably healthy; however they appear to be dry with low moisture retention in the sandy soil.

Tall grasses persist across the site, with *Lagurus ovatus* and *Oenothera stricta* also widespread. *Theba pisana* were present in guards, but not in large numbers and didn't appear to be grazing on plants.

## 9.1.24 Hindmarsh Island (Johnson) – PlanID 285

### 9.1.24.1 Site map




Site contained transects 2847, 2849, 2850

### 9.1.24.2 Site photo

### 9.1.24.3 Survivorship results

Site surveyed in autumn 2014.

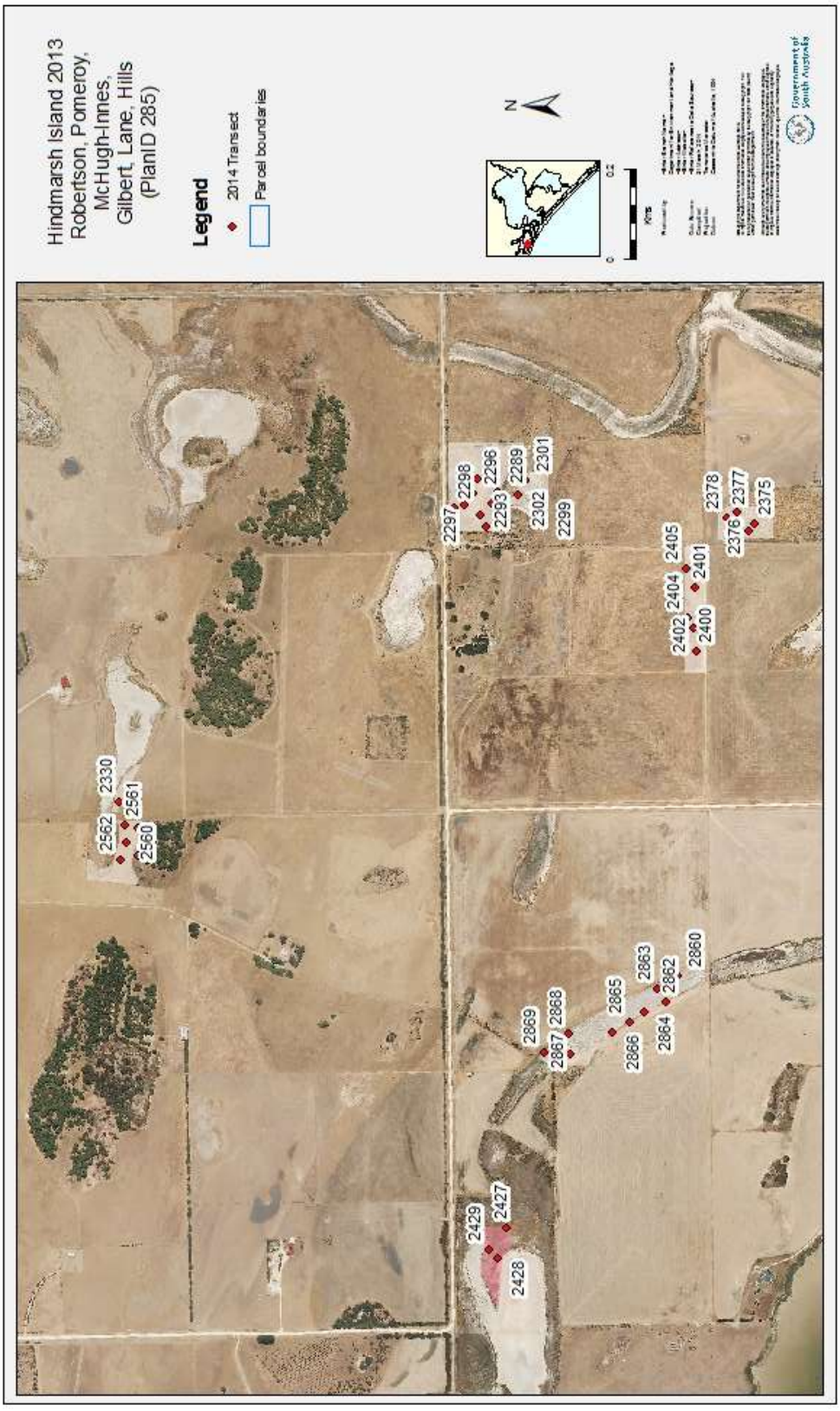
| Johnson | Autumn | |
|---|---|---|
| | Alive | Dead |
| | 29 | 43 |
| **Survival** | **40.3%** | |

Survivorship was fair at 40.3%. Plant health was generally good, with some older plantings scattered throughout. *Distichlis distichophylla* was abundant across the site, and *Halosarcia sp.* was prevalent around the seasonal wetland. There were also *Maireana brevifolia, Enchylaena tomentosa* and *Atriplex semibaccata* individuals outside of guards.

Some *Cynara cardunculus* and broadleaf weeds were noted. Heavy loads of dead grass may be suppressing most other weeds.

## 9.1.25 Hindmarsh Island (Lane) – PlanID 285

### 9.1.25.1 Site map




Site contained transects 2399, 2400, 2401, 2402, 2404, 2405

### 9.1.25.2 Site photo

### 9.1.25.3 Survivorship results

Site surveyed in autumn 2014.

| Lane | Autumn | |
|---|---|---|
| | **Alive** | **Dead** |
| | 119 | 39 |
| **Survival** | **75.3%** | |

Survivorship was good at 75.3% and surviving plants were healthy. Unguarded *Enchylaena tomentosa* were scattered throughout – probably from older plantings.

Some juvenile *Lycium ferocissimum* seedlings were noted across the site, but no mature plants were seen.

## 9.1.26 Hindmarsh Island (Lucas) – PlanID 285

### 9.1.26.1 Site map


Site contained transects 2408, 2409, 2410, 2412, 2413, 2414, 2415, 2416, 2417, 2418

### 9.1.26.2 Site photo

### 9.1.26.3 Survivorship results

Site surveyed in autumn 2014.

| Lucas | Autumn | |
|---|---|---|
| | **Alive** | **Dead** |
| | 134 | 39 |
| **Survival** | **75.1%** | |

Survivorship was good at 75.1%, with excellent success of *Allocasuarina verticillata* and other overstorey species. Plants are generally in good health despite competition from weed cover.

Thick grasses persist across the site and planted areas contain a mix of exotic species including *Lagurus ovatus, Cenchrus clandestinus* and *Euphorbia terracina*.

## 9.1.27 Hindmarsh Island (Luke) – PlanID 285

### 9.1.27.1 Site map


Site contained transects 2406, 2407

### 9.1.27.2 Site photo

### 9.1.27.3 Survivorship results

Site surveyed in autumn 2014.

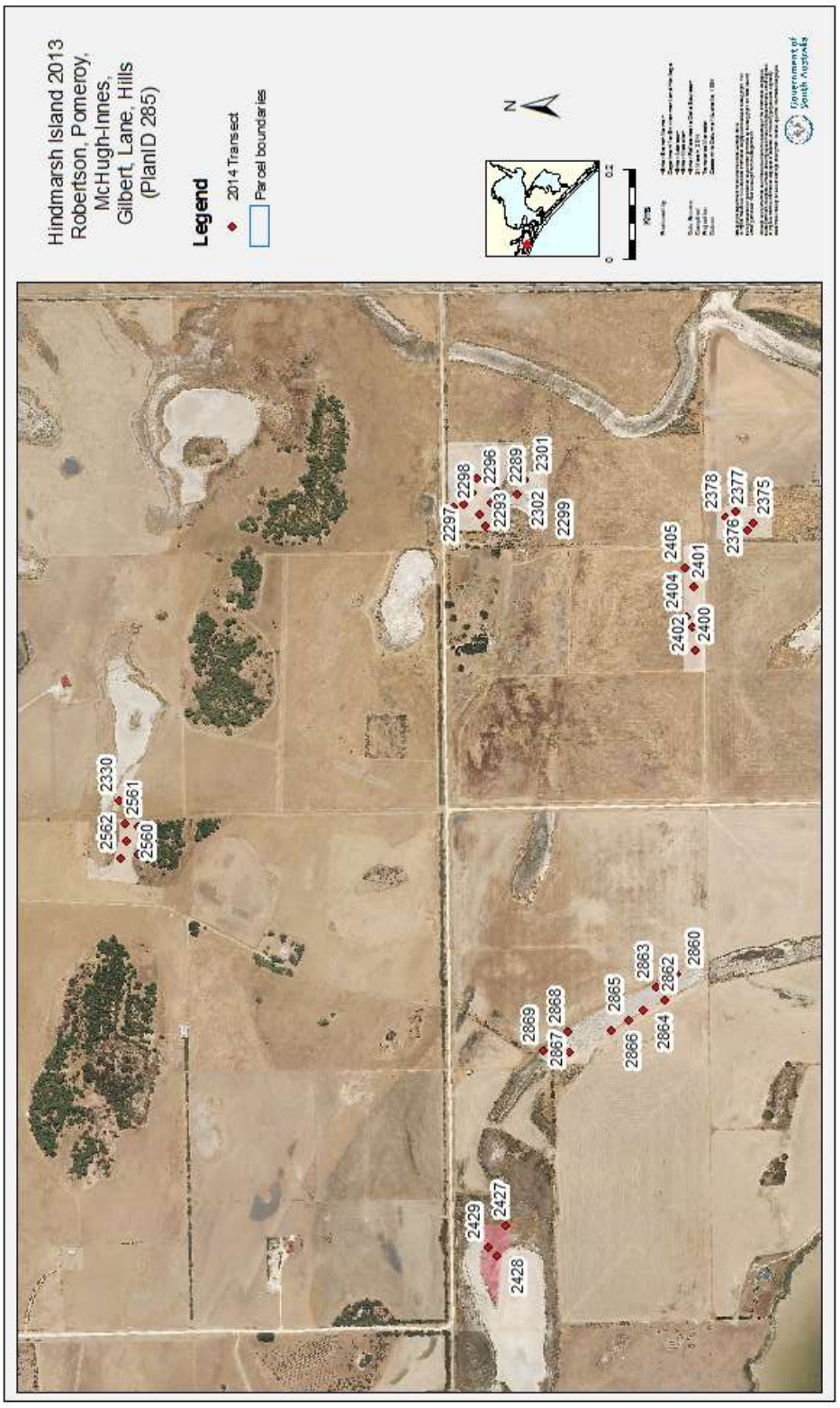
| Luke | Autumn | |
|---|---|---|
| | **Alive** | **Dead** |
| | 31 | 8 |
| **Survival** | **79.5%** | |

Survivorship was good at 79.5%. Plants are generally in good health despite competition from weed cover, with *Allocasuarina verticillata* growing particularly well.

Thick grasses cover the site and a mix of exotic species including *Lagurus ovatus*, *Cenchrus clandestinus* , *Euphorbia terracina* and *Arctotheca calendula* persisting through the planted patches. Areas around the plantings had recently been slashed.

## 9.1.28 Hindmarsh Island (McHugh-Innes) – PlanID 285

### 9.1.28.1 Site map




Site contained transects 2427, 2428, 2429, 2860, 2861, 2862, 2863, 2864, 2865, 2866, 2867, 2868, 2869

### 9.1.28.2 Site photo

### 9.1.28.3 Survivorship results

Site surveyed in autumn 2014.

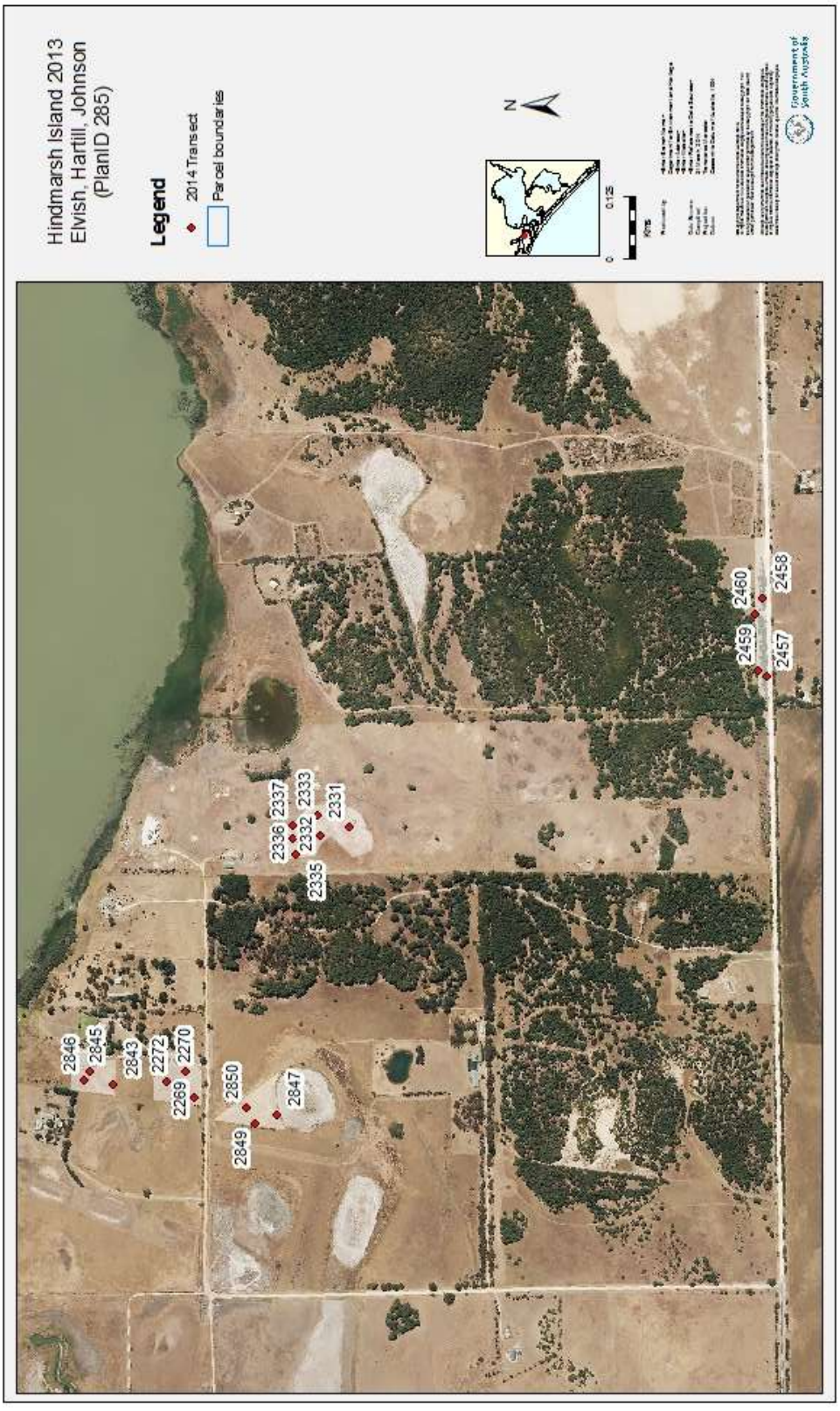
| McHugh-Innes | Autumn | |
|---|---|---|
| | Alive | Dead |
| | 11 | 30 |
| **Survival** | **26.8%** | |

Survivorship was poor across the site at 26.8%. Many transects were unplanted, with no stakes or other signs of planting. Of the surviving plants, *Myoporum insulare* in particular were growing well.

No significant pest plant or animal impacts were noted, apart from the high load of exotic grasses.

## 9.1.29 Hindmarsh Island 2013 (Minnis) – PlanID 285

### 9.1.29.1 Site map




Site contained transects 2457, 2458, 2459, 2460

### 9.1.29.2 Site photo

### 9.1.29.3 Survivorship results

Site surveyed in autumn 2014.

| Minnis | Autumn | |
|---|---|---|
| | Alive | Dead |
| | 128 | 30 |
| **Survival** | **81.0%** | |

Survivorship was excellent at 81%. Plant health is good, particularly *Acacia longifolia* and *Myoporum insulare*. Some older plants were scattered through the plantings. The west side of the site was not planted, so two transects were moved.

The site is located on a roadside verge, and *Thinopyrum elongatum* and broadleaf weeds including *Oenothera stricta* were noted. There were significant loads of *Theba pisana* and *Cochlicella sp.* Taller grasses were present throughout the site but mostly fairly sparse, along with some *Lagurus ovatus*.

## 9.1.30 Hindmarsh Island (Mulungushi) – PlanID 285

### 9.1.30.1 Site map


Site contained transects 2464, 2465, 2466, 2467, 2468, 2469, 2470, 2471, 2472, 2474

### 9.1.30.2 Site photo

### 9.1.30.3 Survivorship results

Site surveyed in autumn 2014.

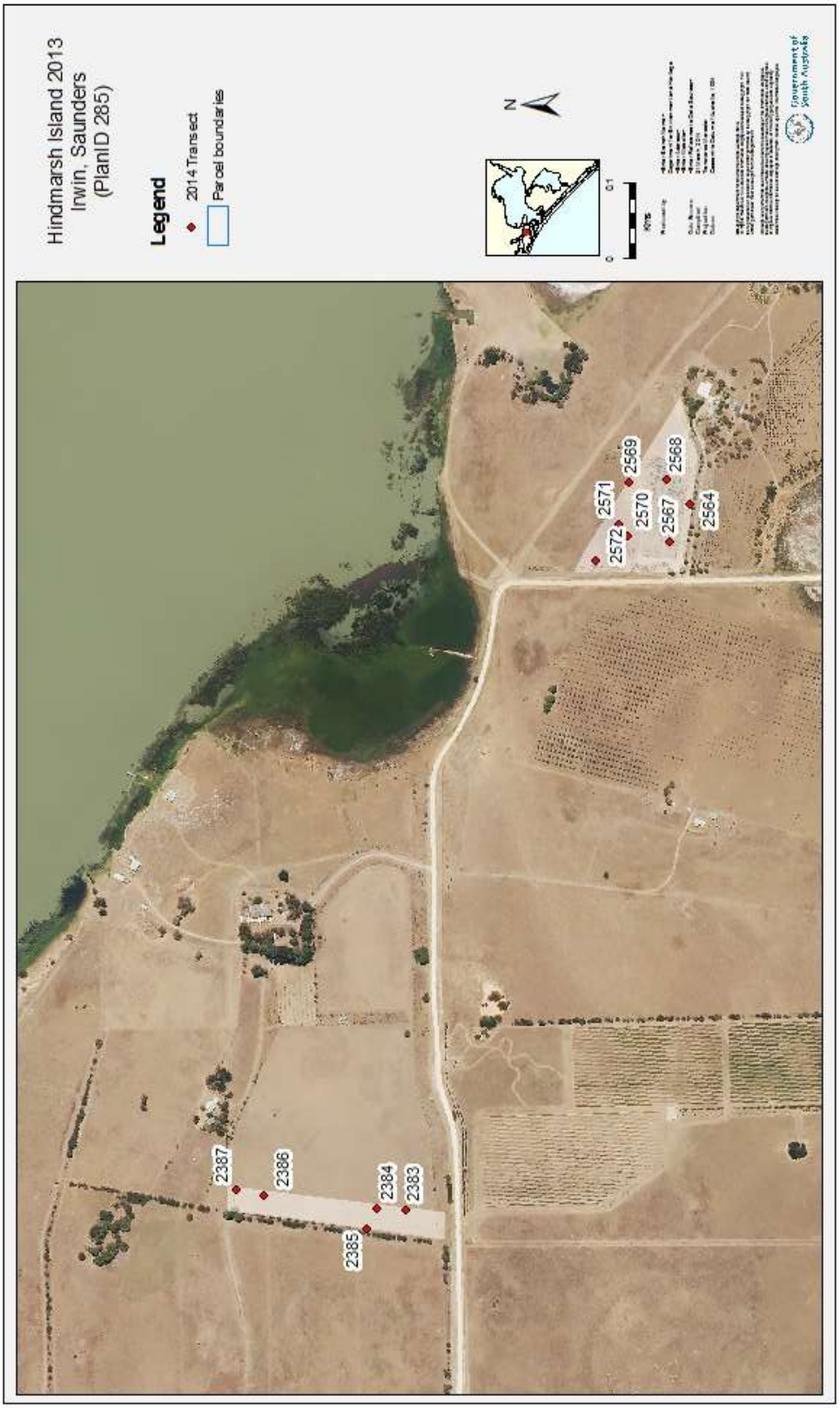
| Mulungushi | Autumn | |
|---|---|---|
| | Alive | Dead |
| | 123 | 39 |
| **Survival** | **75.9%** | |

Survivorship was good at 75.9%. Plants were noted to be healthy, with good growth across most species.

There was significant cover of weeds through the planted patches, with weedy grasses and *Euphorbia terracina* prominent. Continued application of selective herbicide and/or slashing may be needed.

## 9.1.31 Hindmarsh Island (Saunders) – PlanID 285

### 9.1.31.1 Site map




Site contained transects 2564, 2567, 2568, 2569, 2570, 2571, 2572

### 9.1.31.2 Site photo

### 9.1.31.3 Survivorship results

Site surveyed in autumn 2014.

| Saunders | Autumn | |
|---|---|---|
| | Alive | Dead |
| | 37 | 90 |
| **Survival** | **29.1%** | |

Survivorship was poor at 29.1%, on what are mostly sand dune planting areas. Some surviving plants have good growth. The site appeared to have some older plants within patches, estimated at around 3 years old.

Some mosses and *Distichlis distichophylla* is growing beneath the taller exotic grasses – particularly on the south-eastern slope, and may benefit from more regular slashing of weeds. Heavy grass cover persists across the site – including in guards – and is competing with planted seedlings. Plastic guards are intact on most plants. *Oenothera stricta* and *Lagurus ovatus* were also common. Two hares were seen on the site.

## 9.1.32 Hindmarsh Island (Sturt Farm) – PlanID 285

### 9.1.32.1 Site map


Site contained transects 2692, 2693, 2694, 2854, 2855, 2856, 2857, 2859

### 9.1.32.2 Site photo

### 9.1.32.3 Survivorship results

Site surveyed in autumn 2014.

| Stuart Farm | Autumn | |
|---|---|---|
| | Alive | Dead |
| | 113 | 48 |
| **Survival** | **70.2%** | |

Survivorship was good at 70.2%. In many cases it was difficult to determine what had been planted recently, with older and newer plantings mixed through transects. Plant health was generally good and *Melaleuca lanceolata* and *Allocasuarina verticillata* were growing well.

No significant pest plant or animal impacts were noted, except the presence of thick exotic grasses across the site.

## 9.1.33 Hindmarsh Island (Swan Point) – PlanID 285

### 9.1.33.1 Site map

### 9.1.33.2 Site photo

### 9.1.33.3 Survivorship results

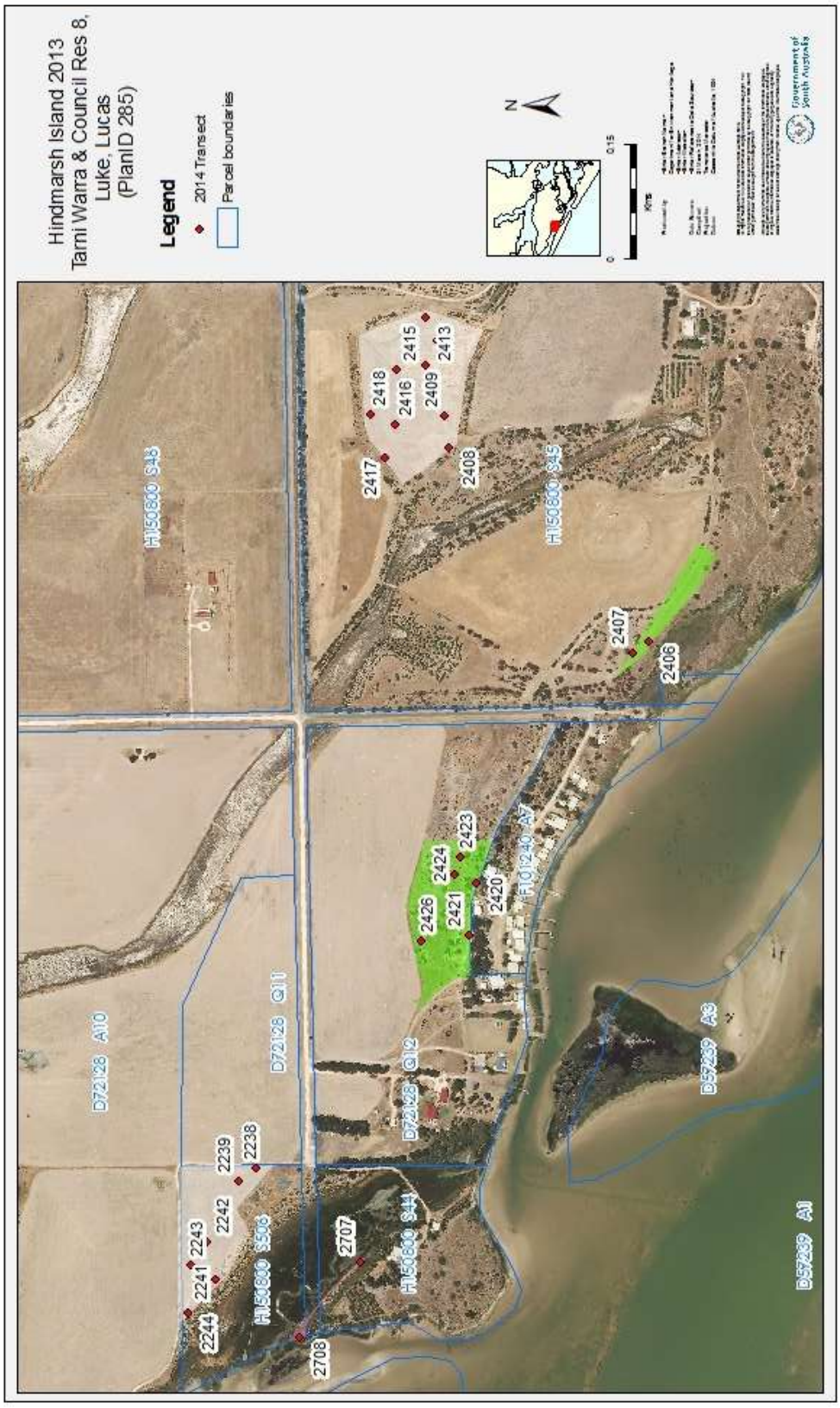
Site surveyed in autumn 2014.

| Swan Point | Autumn | |
|---|---|---|
| | **Alive** | **Dead** |
| | 51 | 11 |
| **Survival** | **82.3%** | |

Survivorship was excellent at 82.3%. Many transects were unplanted (8 of 15), but surviving plants had excellent health and sturdy growth. *Lagurus ovatus* was widespread.

## 9.1.34 Hindmarsh Island (Tarni Warra) – PlanID 285

### 9.1.34.1 Site map




Site contained transects 2238, 2239, 2240, 2241, 2242, 2243, 2244, 2707, 2708

### 9.1.34.2 Site photo

### 9.1.34.3 Survivorship results

Site surveyed in autumn 2014.

| Tarni Warra | Autumn | |
|---|---|---|
| | Alive | Dead |
| | 79 | 23 |
| **Survival** | **77.5%** | |

Survivorship was good at 77.5%. Excellent older revegetation and regeneration was noticed across the site, despite fairly heavy grass cover and the presence of *Euphorbia terracina*, *Lagurus ovatus* and dandelion.

The lake-edge areas appeared to be on a trajectory to restoration of high quality native habitat. The site was very well maintained, with no noticeable weed species or pest animal impacts. Weed matting was in place along the driveway entrance, and the local landcare group was infill planting at the site at the time of the survey.

## 9.1.35 Hindmarsh Island (Wyndgate Homestead) – PlanID 285

### 9.1.35.1 Site map

### 9.1.35.2 Site photo

### 9.1.35.3 Survivorship results

Site surveyed in autumn 2014.

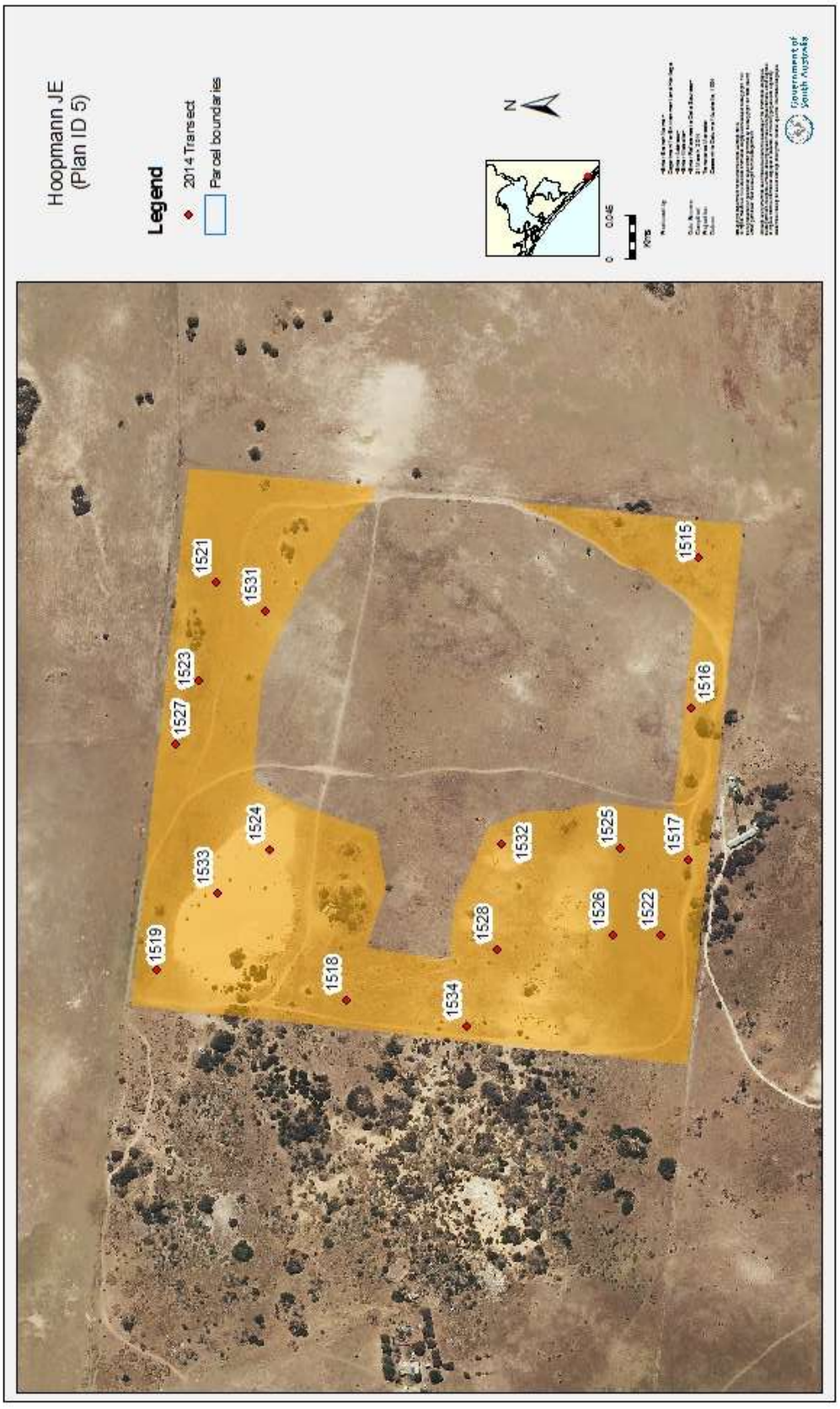
| Wyndgate Homestead | Autumn | |
|---|---|---|
| | Alive | Dead |
| | 49 | 12 |
| **Survival** | **80.3%** | |

Survivorship was excellent at 80.3%. The site was small and relatively sheltered and all surviving plants were healthy. *Melaleuca halmaturorum* are growing particularly well.

Thick *Cenchrus clandestinus* was present across the site and may have a significant impact when guards are removed or lost to the wind.

## 9.1.36 Hoopmann JE – SiteID 5

### 9.1.36.1 Site map



### 9.1.36.2 Site photo

### 9.1.36.3 Survivorship results

Site surveyed in spring 2013 and autumn 2014.

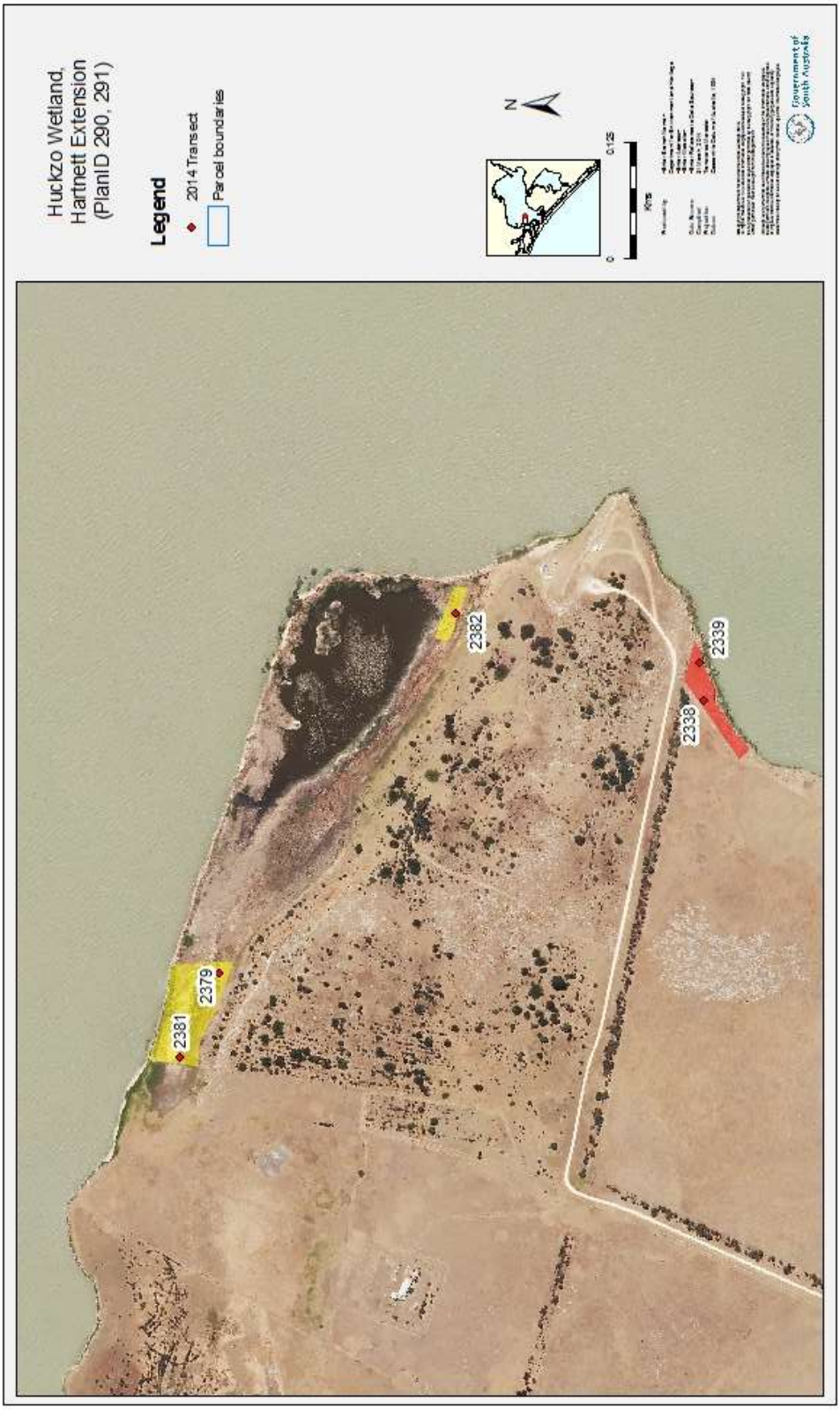
| Hoopmann | Spring | | Autumn | |
|---|---|---|---|---|
| | **Alive** | **Dead** | **Alive** | **Dead** |
| | 913 | 244 | 545 | 291 |
| **Survival** | **78.9%** | | **65.2%** | |

Autumn survivorship was good at 65.2%. *Cyperus gymnocaulos* had a low survival rate with around half surviving. In contrast and consistent with other sites, *Ficinia nodosa* survived well with 93.8% surviving.

The site was sandy, with fairly heavy grazing of plants noted. As with many other sandy sites on inland dunes, *Oenothera stricta* was scattered throughout. *Euphorbia terracina* was also common, along with exotic grasses which were sparser than at some other sites and this could be attributed to lower soil moisture. Scattered *Citrullus lanatus* was also noted. *Theba pisana* were present in guards on some transects.

## 9.1.37 Huczko Wetland – PlanID 290

### 9.1.37.1 Site map




Site contained transects 2379, 2381, 2382

### 9.1.37.2 Site photo

### 9.1.37.3 Survivorship results

Site surveyed in autumn 2014.

| Huczko Wetland | Autumn | |
|---|---|---|
| | Alive | Dead |
| | 148 | 55 |
| **Survival** | **72.9%** | |

Survivorship was good at 72.9%. Almost all species had a high survival rate, with the exception of *Enchylaena tomentosa*, which may have been subject to inundation. A significant number of dead plants (around 25%) were unable to be identified. More mature plants (est. 3y) were scattered through the site.

Groundcover species were observed to be growing into the guards, including both Samphire and *Atriplex prostrata*. No significant pest plant or animal impacts were noted.

## 9.1.38 Jacob – PlanID 310

### 9.1.38.1 Site map

### 9.1.38.2 Site photo

### 9.1.38.3 Survivorship results

Site surveyed in autumn 2014.

| Jacob | Autumn | |
|---|---|---|
| | Alive | Dead |
| | 322 | 211 |
| **Survival** | **60.4%** | |

Survey was planned for spring but access to the site was not possible due to an *Emex australis* infestation.

Autumn survivorship was good at 60.4%. Most species that could be identified had high rates of survival. *Enchylaena* and *Melaleuca* plants had high survival rates and showed strong growth. Plant health across the site is high, with vigorous growth of most species. Older plantings were scattered through the site and excluded from counting where possible.

The site has a heavy infestation of *Emex australis* which is being treated by the owner using measures such as reducing vehicle and foot traffic, manual removal of seed and herbicide. *Citrullus lanatus* was also present across the site. Other weed cover was sparse, except for *Oxalis sp.* which was common but not dominant due to the weed control between patches.

## 9.1.39 Jockwar Samphire 2013 – PlanID 369

### 9.1.39.1 Site map

### 9.1.39.2 Site photo

### 9.1.39.3 Survivorship results

Site surveyed in spring 2013 and autumn 2014.

| Jockwar Samphire | Spring | | Autumn | |
|---|---|---|---|---|
| | **Alive** | **Dead** | **Alive** | **Dead** |
| | 325 | 45 | 238 | 716 |
| **Survival** | **87.8%** | | **24.9%** | |

Autumn survivorship was poor at 24.9%, a large drop from the spring survivorship of 87.8%. Most species counted had high survivorship rates with the exception of *Juncus kraussii* (6.6% of 121 plants counted). However, the species of most dead plants could not be identified, so individual species survivorship percentages are potentially biased.

By the autumn monitoring, it was difficult to tell whether a plant had been planted by looking at each stake. This resulted in plants being counted for each stake standing and may also distort the dead plant count.

Exotic grasses were scattered throughout, but the seasonal inundation means that these are not dominant. The south-eastern wetland had evidence of sheep incursion, with manure and tracks in mud as well as evidence of grazing. A relatively new fence surrounds the wetland,

and it is difficult to ascertain whether this was fenced prior to or after the revegetation plantings.

## 9.1.40 Long Point – PlanID 250

### 9.1.40.1 Site map

### 9.1.40.2 Site photo

### 9.1.40.3 Survivorship results

Site surveyed in spring 2013 and autumn 2014.

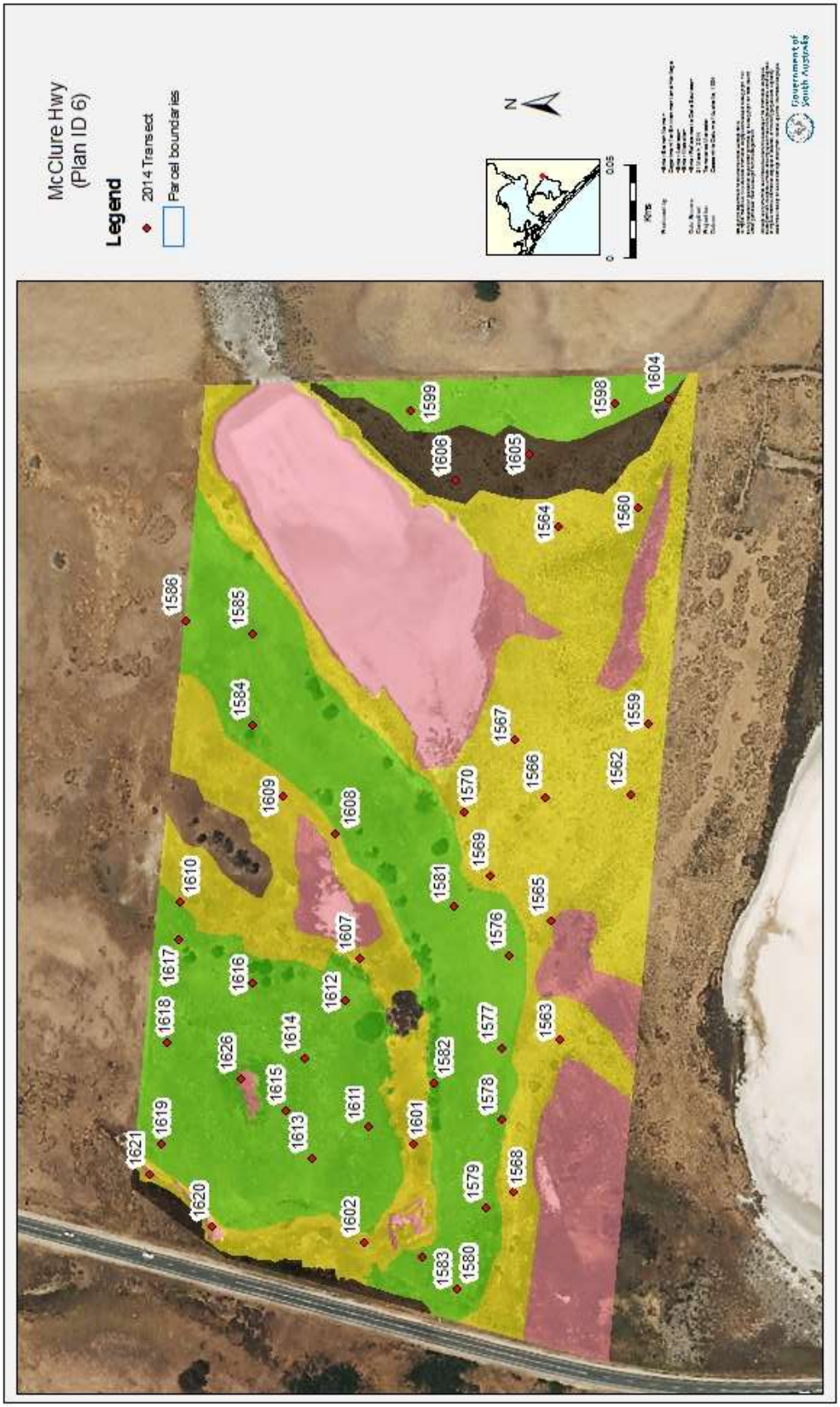
| Long Point | Spring | | Autumn | |
|---|---|---|---|---|
| | **Alive** | **Dead** | **Alive** | **Dead** |
| | 520 | 270 | 279 | 356 |
| **Survival** | **65.8%** | | **43.9%** | |

Survivorship was fair at 43.9% - a moderate drop from the spring survivorship of 65.8%. Overstorey plants had good survival rates, while sedges struggled. Many transects were unplanted. Surviving plants appeared healthy and vigorous.

Heavy grazing of plants was common across the site. A large number of guards were flattened either from wind or kangaroo activity, and many kangaroos were observed grazing at the site.

## 9.1.41 McClure Hwy – PlanID 6

### 9.1.41.1 Site map



### 9.1.41.2 Site photo

### 9.1.41.3 Survivorship results

Site surveyed in spring 2013 and autumn 2014.

| McClure Hwy | Spring | | Autumn | |
|---|---|---|---|---|
| | **Alive** | **Dead** | **Alive** | **Dead** |
| | 1579 | 376 | 2214 | 1219 |
| **Survival** | **80.8%** | | **64.5%** | |

Survivorship across the site was good at 64.5% - a moderate drop from the spring survivorship of 80.8%. Zone 8 plantings (57% of all plants counted) brought the overall site rate down with 56.4% survival.

Most surviving plants appeared healthy, with *Juncus kraussii* in particular growing well and with a high survival rate which surpassed most other sites. Other species with high survivorship and in good health included *Banksia sp*., *Allocasuarina verticillata* and *Acacia pycnantha*. No *Leucopogon parviflorus* seedlings survived, reflecting the low survivorship of this species across most sites.

## 9.1.42 McClure Waltowa – PlanID 7

### 9.1.42.1 Site map


Site contained transects 1968, 1969, 1970, 1971, 1973, 1974, 1975, 1977, 1978, 1979

### 9.1.42.2 Site photo

### 9.1.42.3 Survivorship results

Site surveyed in spring 2013 and autumn 2014.

| McClure Waltowa | Spring | | Autumn | |
|---|---|---|---|---|
| | Alive | Dead | Alive | Dead |
| | 451 | 51 | 214 | 248 |
| **Survival** | **89.8%** | | **46.3%** | |

Survivorship across the site was fair at 46.3% - a large drop from the spring survey at 89.8%. Most sedges were dead, with *Juncus kraussii* widely planted and having a very low rate of survival. *Atriplex sp.* survived well and showed good growth. As with other sites it was difficult to determine the species of dead plants. The site held water at the time of spring monitoring, making it impossible to reach some transects. This inundation has likely had a significant influence on plant survivorship.

No significant pest plant or animal impacts were noted. Very little weed cover was observed across the site, and most weed species may be suppressed by seasonal inundation. One fox was observed during the survey.

## 9.1.43 McKinlay – PlanID 304

### 9.1.43.1 Site map


Site contained transects 2431, 2432, 2433, 2434, 2435, 2436, 2438, 2440, 2441, 2442, 2443, 2444,2445

### 9.1.43.2 Site photo

### 9.1.43.3 Survivorship results

Site surveyed in autumn 2014.

| McKinlay | Autumn | |
|---|---|---|
| | Alive | Dead |
| | 288 | 89 |
| **Survival** | 76.4% | |

Survivorship was high at 76.4% and general plant health is good, however some grass species are struggling. Possible site inundation at the lake edge could be affecting survivorship there.

The north-west of the site supports some mature *Eucalyptus* which are beginning to provide some structure. No significant native groundcover was observed. Grazed weedy grasses persist across the site, but there were no significant pest plant or animal impacts noted.

## 9.1.44 Meningie Pine Removal – PlanID 17

### 9.1.44.1 Site map

### 9.1.44.2 Site photo

### 9.1.44.3 Survivorship results

Site surveyed in spring 2013 and autumn 2014.

| Meningie Pine Removal | Spring | | Autumn | |
|---|---|---|---|---|
| | Alive | Dead | Alive | Dead |
| | 325 | 36 | 283 | 331 |
| **Survival** | **90.0%** | | **46.1%** | |

Autumn survivorship was fair at 46.1%, a large drop from the spring survey at 90%. Most species had poor survival rates. An exception was *Ficinia nodosa* which was widely planted and growing well. Most plants across the site were observed to be small.

Some recruitment of *Melaleuca sp.* and *Acacia pycnantha* was observed. The site is dry, sandy, and in some parts sloping, and this may be influencing plant health at the site as moisture is not retained by the soil. With pines being recently removed from the site, residual soil acidity caused by decomposing pine leaf litter could possibly be influencing plant health.

Patchy weed cover persists across the site and is mostly made up of exotic grasses. No pest animal impacts were noted.

## 9.1.45 Milang Common – PlanID 288

### 9.1.45.1 Site map

### 9.1.45.2 Site photo

### 9.1.45.3 Survivorship results

Site surveyed in autumn 2014.

| Milang Common | Autumn | |
|---|---|---|
| | Alive | Dead |
| | 803 | 195 |
| **Survival** | **80.5%** | |

Survivorship was high at 80.5%. *Atriplex*, *Dianella* and *Poa* species were widely planted and are surviving well. There was evidence of follow up herbicide treatment within planting areas which has eliminated competition from exotic species.

Rabbit diggings were observed across the site. Some exotic grass cover was noted between patches, and should be monitored for incursion into the planted areas.

## 9.1.46 Modistach – PlanID 300

### 9.1.46.1 Site map

### 9.1.46.2 Site photo

### 9.1.46.3 Survivorship results

Site surveyed in autumn 2014.

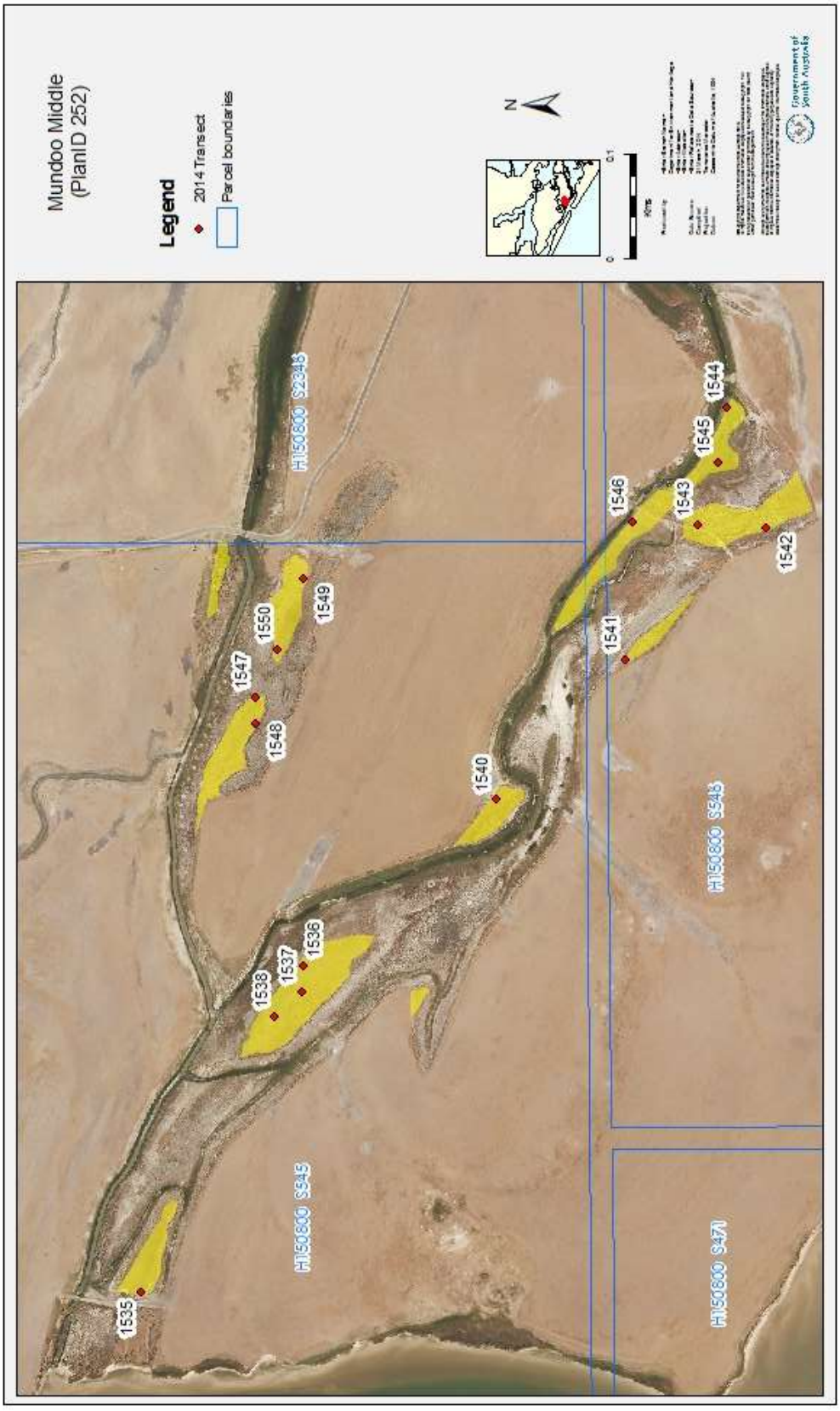
| Modistach | Autumn | |
|---|---|---|
| | Alive | Dead |
| | 64 | 39 |
| **Survival** | **62.1%** | |

Survivorship was good at 62.1%. *Austrostipa*, *Goodenia* and *Poa* species were widely planted and are surviving well.

Herbicide spraying was evident throughout the site, indicating active management of weeds. One fox was observed near transect 2712.

## 9.1.47 Mundoo Middle – PlanID 252

### 9.1.47.1 Site map



### 9.1.47.2 Site photo

### 9.1.47.3 Survivorship results

Site surveyed in spring 2013 and autumn 2014.

| Mundoo Middle | Spring | | Autumn | |
|---|---|---|---|---|
| | **Alive** | **Dead** | **Alive** | **Dead** |
| | 462 | 35 | 463 | 67 |
| **Survival** | **93.0%** | | **87.4%** | |

Autumn survivorship was excellent at 87.4%, a small decrease from the spring survivorship of 93%. All species showed high survivorship, particularly *Ficinia nodosa, Atriplex sp.* and *Melaleuca halmaturorum*. Plant health was general high, with most species showing good growth.

Some native ground cover was noted closer to the water's edge, including *Halosarcia sp.*, *Atriplex sp.* and *Enchylaena tomentosa*. Low exotic grasses persist across the site, but are not competing strongly with the plants.

## 9.1.48 Mundoo North – PlanID 254

### 9.1.48.1 Site map

### 9.1.48.2 Site photo

### 9.1.48.3 Survivorship results

Site surveyed in spring 2013 and autumn 2014.

| Mundoo North | Spring | | Autumn | |
|---|---|---|---|---|
| | Alive | Dead | Alive | Dead |
| | 844 | 26 | 668 | 260 |
| **Survival** | **97%** | | **72.0%** | |

Autumn survivorship was good at 72%, a moderate drop from 97% in the spring surveys. Most species are surviving well, with *Juncus kraussii* the only widely planted species with a significant percentage of dead individuals. Plants are showing good growth across the rest of the site, particularly *Duma florulenta, Rhagodia candolleana,* and *Atriplex sp.*

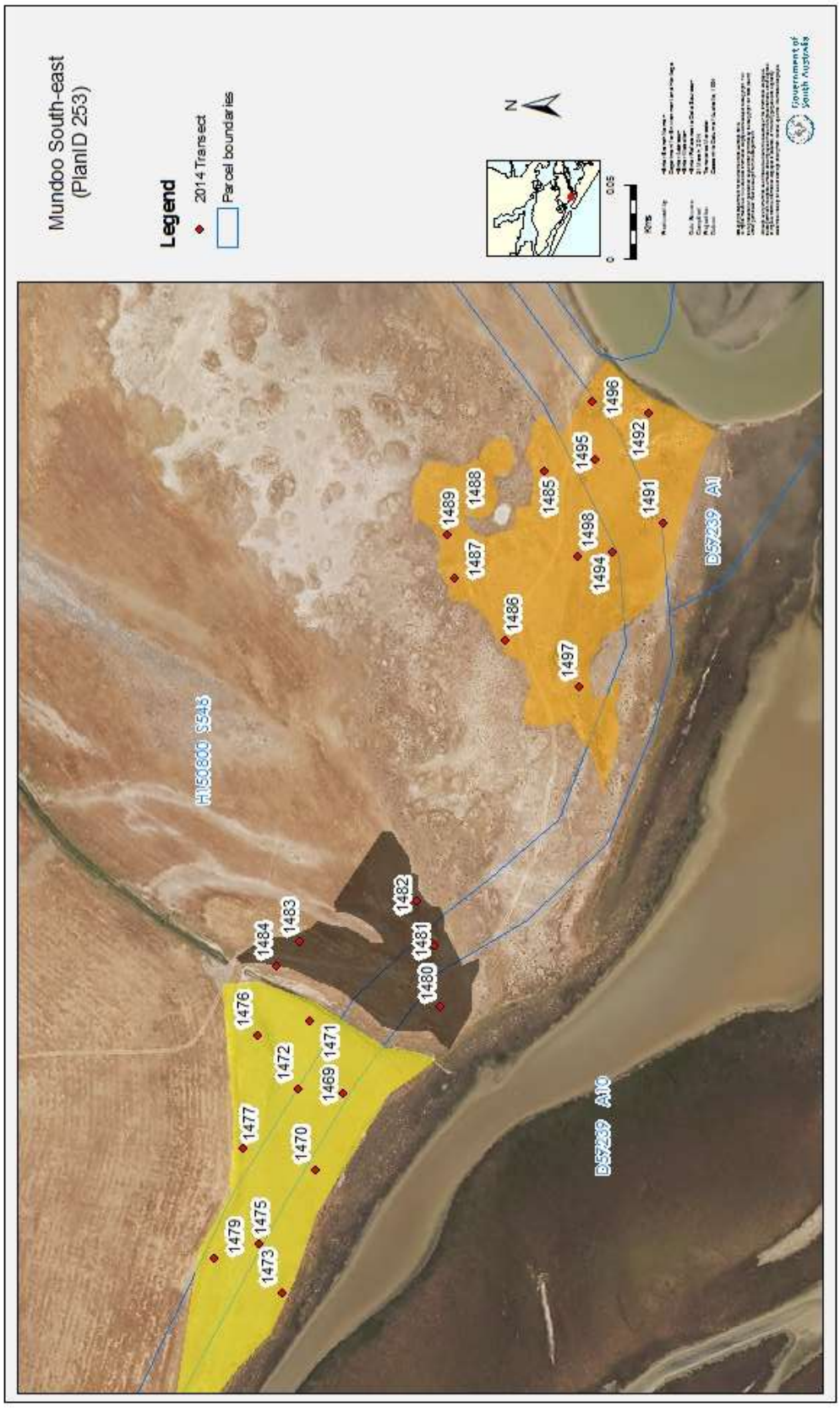
Very few plants have been planted at the west end of the site. Scattered stakes and signs of inundation indicate that planting in that area was either unsuccessful or not attempted.

Some small stands of *Juncus kraussii* are established, with *Cyperus gymnocaulos*, *Ficinia nodosa*, *Distichlis distichophylla* and *Sarcocornia sp.* also present.

Occasional stock breaches have occurred, with tracks visible in the wetland, but no grazing or other significant impacts on the plants were noted. *Cynodon dactylon*, *Cenchrus clandestinus* and other weedy grasses are present across the site, along with some broadleaf weeds including *Cynara cardunculus*.

## 9.1.49 Mundoo South-east – PlanID 253

### 9.1.49.1 Site map



### 9.1.49.2 Site photo

### 9.1.49.3 Survivorship results

Site surveyed in spring 2013 and autumn 2014.

| Mundoo South-east | Spring | | Autumn | |
|---|---|---|---|---|
| | **Alive** | **Dead** | **Alive** | **Dead** |
| | 777 | 22 | 1221 | 582 |
| **Survival** | **97.2%** | | **67.7%** | |

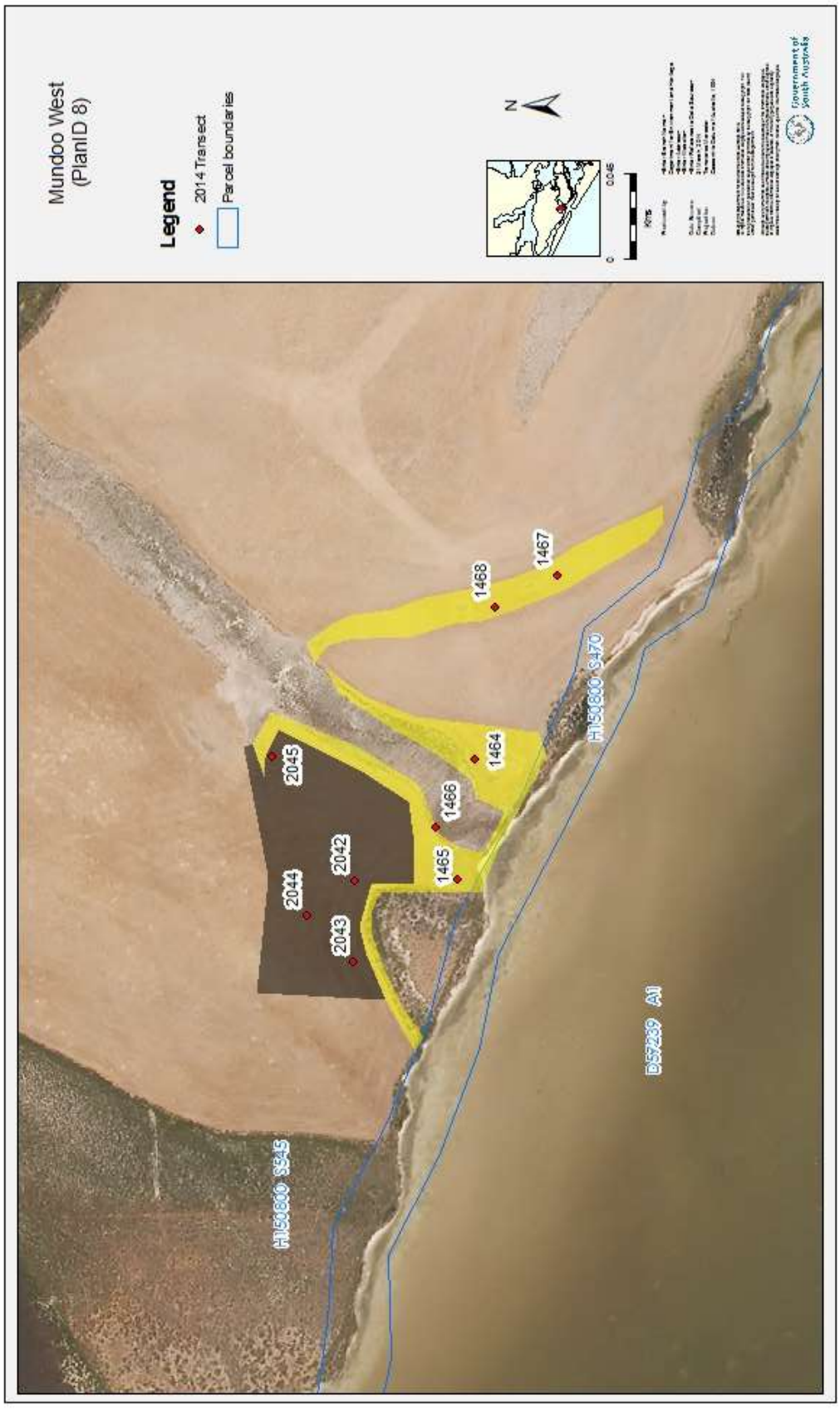
Autumn survivorship was good at 67.7%, a significant drop from the spring survey at 97.2%. All widely-planted species had high rates of survival, with most species showing strong growth. *Pelargonium australe* plants were notable for their vigorous growth. Indundation of the site may have affected seedling survival, with dead *Juncus kraussii* and *Enchylaena tomentosa*.

Regenerating *Atriplex*, *Halosarcia* and *Maireana* plants were noted in patches.

There were many burnt stakes around E 311336 N 6062897, which the landholder indicated started from a campfire. Most plants appear to have survived but it is difficult to determine what was lost in the fire, with the area covered by emergency vehicles tracks and burnt stakes. *Theba pisana* were found on most guards and one hare was seen on site.

## 9.1.50 Mundoo West – PlanID 8

### 9.1.50.1 Site map



### 9.1.50.2 Site photo

### 9.1.50.3 Survivorship results

Site surveyed in spring 2013 and autumn 2014.

| Mundoo West | Spring | | Autumn | |
|---|---|---|---|---|
| | Alive | Dead | Alive | Dead |
| | 470 | 20 | 486 | 82 |
| **Survival** | **95.9%** | | **85.6%** | |

Autumn survivorship was excellent at 85.6%, a moderate drop from the spring survey at 95.9%. All species appeared to be surviving well, and plants appeared to be healthy with vigorous growth on most species.

Some recruitment of *Atriplex sp.* from nearby mature plants appeared to be occurring and low remnant saltmarsh is established around the water's edge. Patchy *Distichlis distichophylla* is regenerating across the site.

Low exotic grass cover across site. No significant pest plant or animal impacts were recorded.

## 9.1.51 Narrung Lifestyle Blocks – PlanID 308

### 9.1.51.1 Site map

### 9.1.51.2 Site photo

### 9.1.51.3 Survivorship results

Site surveyed in spring 2013 and autumn 2014.

| Narrung Lifestyle Blocks | Spring | | Autumn | |
|---|---|---|---|---|
| | Alive | Dead | Alive | Dead |
| | 206 | 8 | 1348 | 151 |
| **Survival** | **96.3%** | | **89.9%** | |

Autumn survivorship was excellent at 89.9%, a small decrease from the spring surveys at 96.3%. All species had high survival rates and were observed to be healthy with robust growth. Some older plantings were scattered through the site. Occasional grazing of planted grasses was noted.

Preparation, layout and maintenance of the site appeared to be similar to the Camac Rowett and Camac Tamara sites, and the results are similarly effective. The site generally avoids the long rows of plants seen in the Camac sites, and has established a more natural revegetation pattern. Planting density was high in the north-west corner of the site with a large stand of *Maireana sp*.

## 9.1.52 Narrung Wetland – PlanID 307

### 9.1.52.1 Site map

### 9.1.52.2 Site photo

### 9.1.52.3 Survivorship results

Site surveyed in autumn 2014.

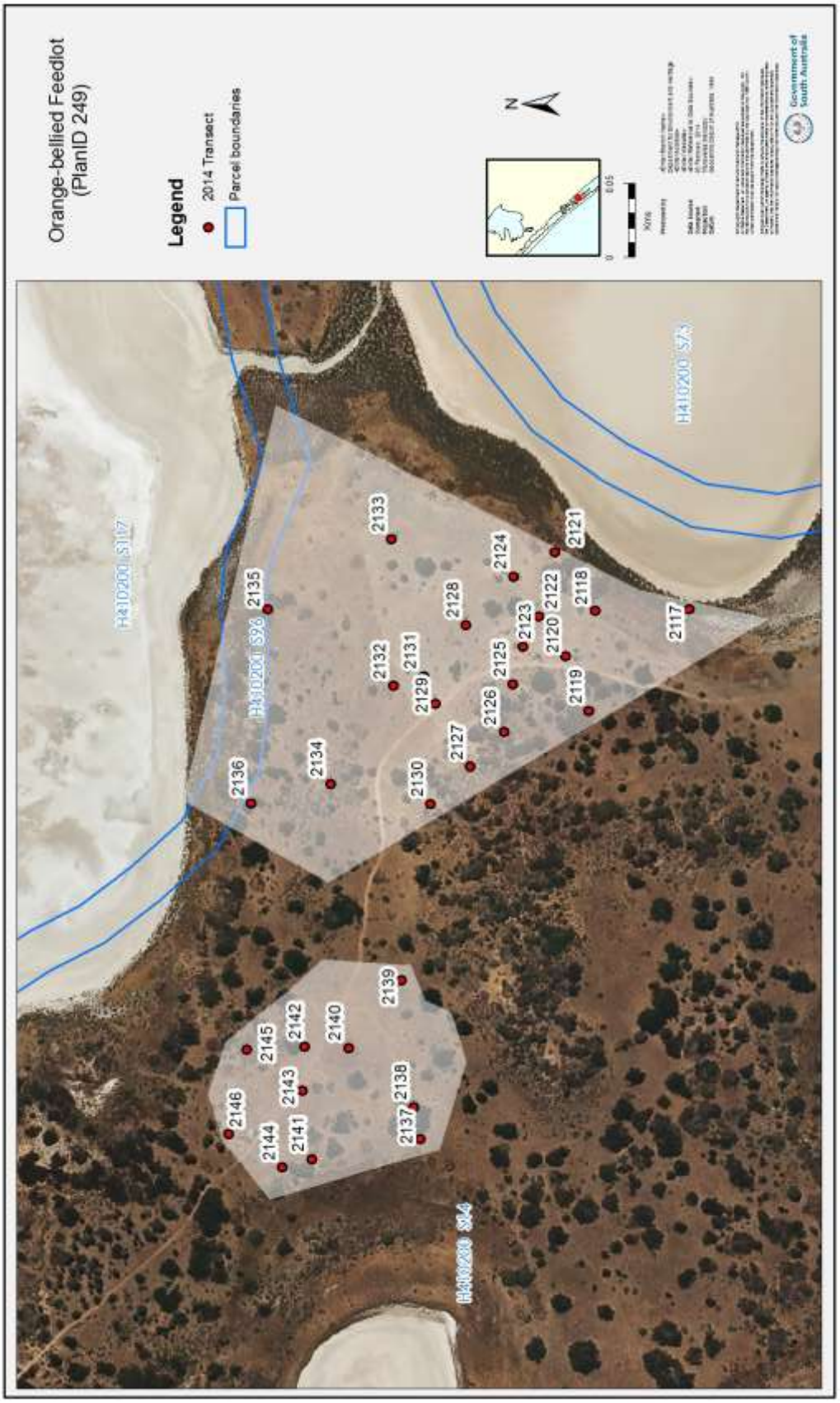
| Narrung Wetland | Autumn | |
|---|---|---|
| | Alive | Dead |
| | 629 | 167 |
| **Survival** | **79.0%** | |

Survivorship was high at 79%. All species had good survival rates, with *Austrostipa sp.* slightly lower. Some guards have been flattened by wind due to the exposed site.

Large numbers of *Conyza sp.* were observed along with *Solanum sp.* and *Geranium sp*. Indications of active weed control were seen throughout the site with evidence of recent spraying. This will need to continue in order to reduce the high weed loads and allow recent plantings to establish.

## 9.1.53 Orange-bellied Feedlot – PlanID 249

### 9.1.53.1 Site map



### 9.1.53.2 Site photo

### 9.1.53.3 Survivorship results

Site surveyed in autumn 2014.

| Orange-bellied Feedlot | Autumn | |
|---|---|---|
| | **Alive** | **Dead** |
| | 580 | 126 |
| **Survival** | **82.2%** | |

Survivorship was excellent at 82.2%. Most species had good survivorship, with some die-off of *Melaleuca halmaturorum* and *Melaleuca lanceolata* noted.

Many transects were not planted out, while others contained plants with no stakes, or a mix of older and more recent plantings. In this case, the obviously mature plants (> 3y) were not counted. At least one transect (2135) contained mature, unstaked *Acaena novae-zelandiae* rather than the expected staked seedlings.

The plants that were counted were mostly of good health, with moderate growth across most species.

## 9.1.54 Point Malcolm Lighthouse – PlanID 309

### 9.1.54.1 Site map

### 9.1.54.2 Site photo

### 9.1.54.3 Survivorship results

Site surveyed in autumn 2014.

| Point Malcolm Lighthouse | Autumn | |
|---|---|---|
| | **Alive** | **Dead** |
| | 213 | 38 |
| **Survival** | **84.9%** | |

Survivorship was excellent at 84.9%. All species had high survivorship rates. Plants are mostly robust, and particularly *Atriplex sp.* and *Dianella sp.* are growing strongly.

No significant pest plant or animal impacts were noted. Results appear good considering that it is a challenging, elevated site with high exposure and steep gradients. Weeds across the site appear to be under active management with slashing and herbicide.

## 9.1.55 Rice – PlanID 289

### 9.1.55.1 Site map

### 9.1.55.2 Site photo

### 9.1.55.3 Survivorship results

Site surveyed in spring 2013 and autumn 2014.

| Rice | Spring | | Autumn | |
|---|---|---|---|---|
| | **Alive** | **Dead** | **Alive** | **Dead** |
| | 320 | 15 | 393 | 40 |
| **Survival** | **95.5%** | | **90.8%** | |

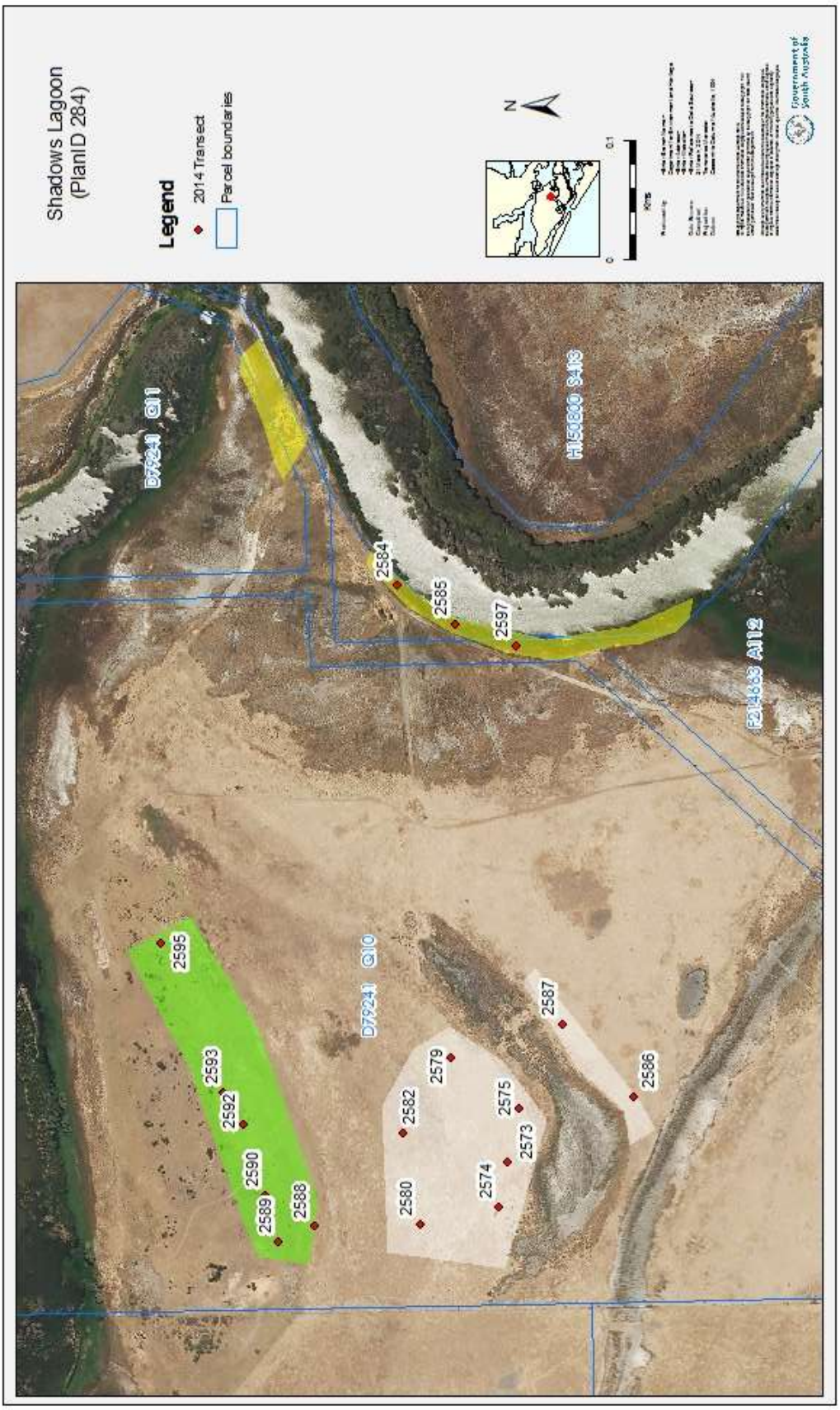
Autumn survivorship was excellent at 90.8%, a small decrease from the spring result of 95.5%.

Plants were very healthy with strong growth. In particular, *Atriplex sp.* and *Enchylaena tomentosa* were showing excellent growth and beginning to claim space from exotic weed cover. Some *Atriplex sp.* were very dry due to a lack of recent rains.

Some follow up spraying of broadleaf and woody weeds was noted across the site. Scattered *Xanthium spinosum* individuals were seen, but had been sprayed with herbicide in each instance.

## 9.1.56 Shadows Lagoon – PlanID 284

### 9.1.56.1 Site map



### 9.1.56.2 Site photo

### 9.1.56.3 Survivorship results

Site surveyed in autumn 2014.

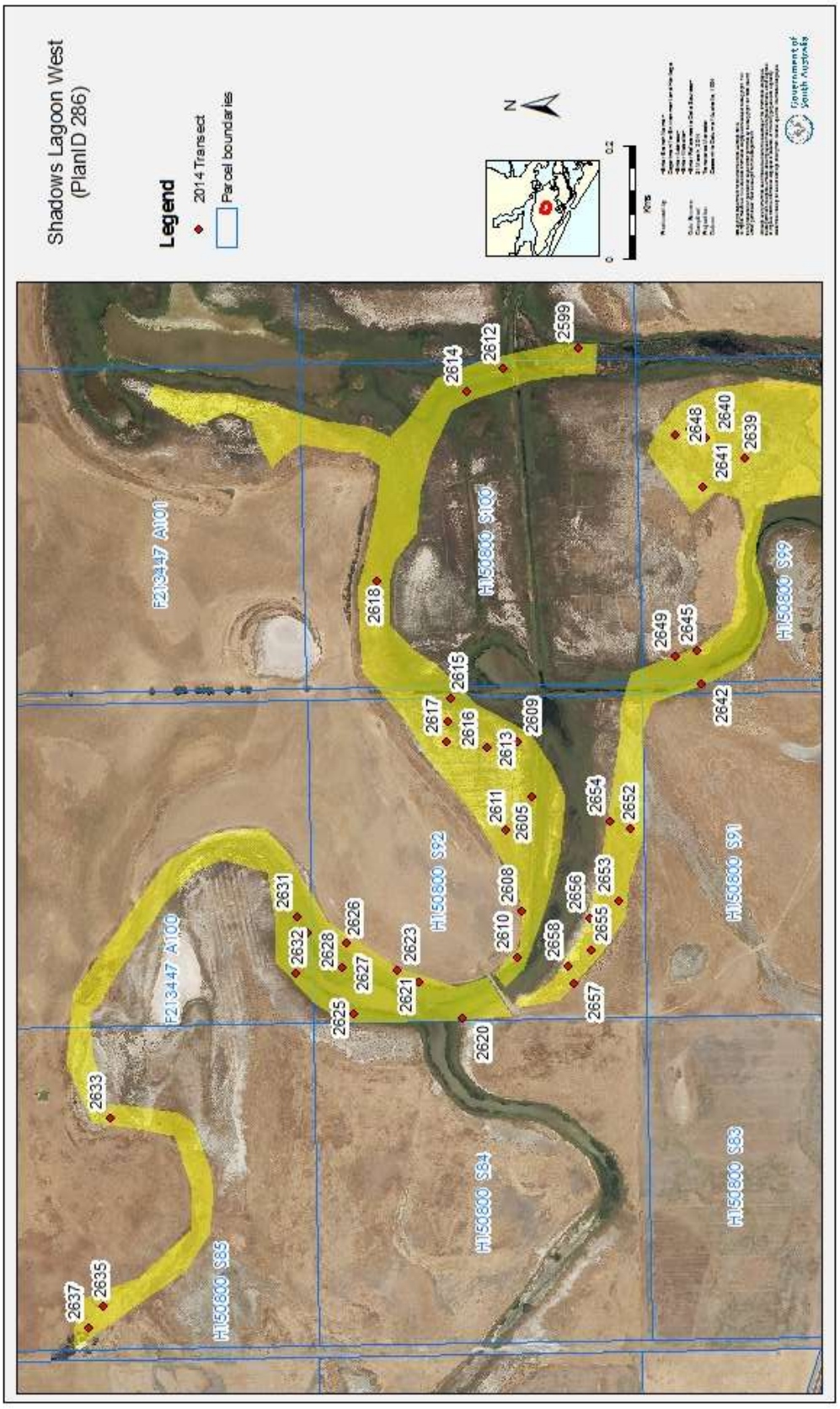
| Shadows Lagoon | Autumn | |
|---|---|---|
| | Alive | Dead |
| | 204 | 89 |
| **Survival** | **69.6%** | |

Autumn survivorship was good at 69.6%, with all species recording high survivorship rates. Many dead plants were missing entirely which resulted in very few dead plants counted at the species level. Most surviving plants are healthy with strong growth.

Deer grazing has damaged some older plantings and removed some stakes, but it was difficult to tell what damage was done to 2013 plants as often the plants were missing entirely. There was evidence of deer shooting on site including shells and a deer leg.

## 9.1.57 Shadows Lagoon West – PlanID 286

### 9.1.57.1 Site map



### 9.1.57.2 Site photo

### 9.1.57.3 Survivorship results

Site surveyed in autumn 2014.

| Shadows Lagoon West | Autumn | |
|---|---|---|
| | Alive | Dead |
| | 629 | 29 |
| **Survival** | **95.6%** | |

Autumn survivorship was excellent at 95.6%. All plants counted were *Melaleuca halmaturorum*, and plant growth and health was high.

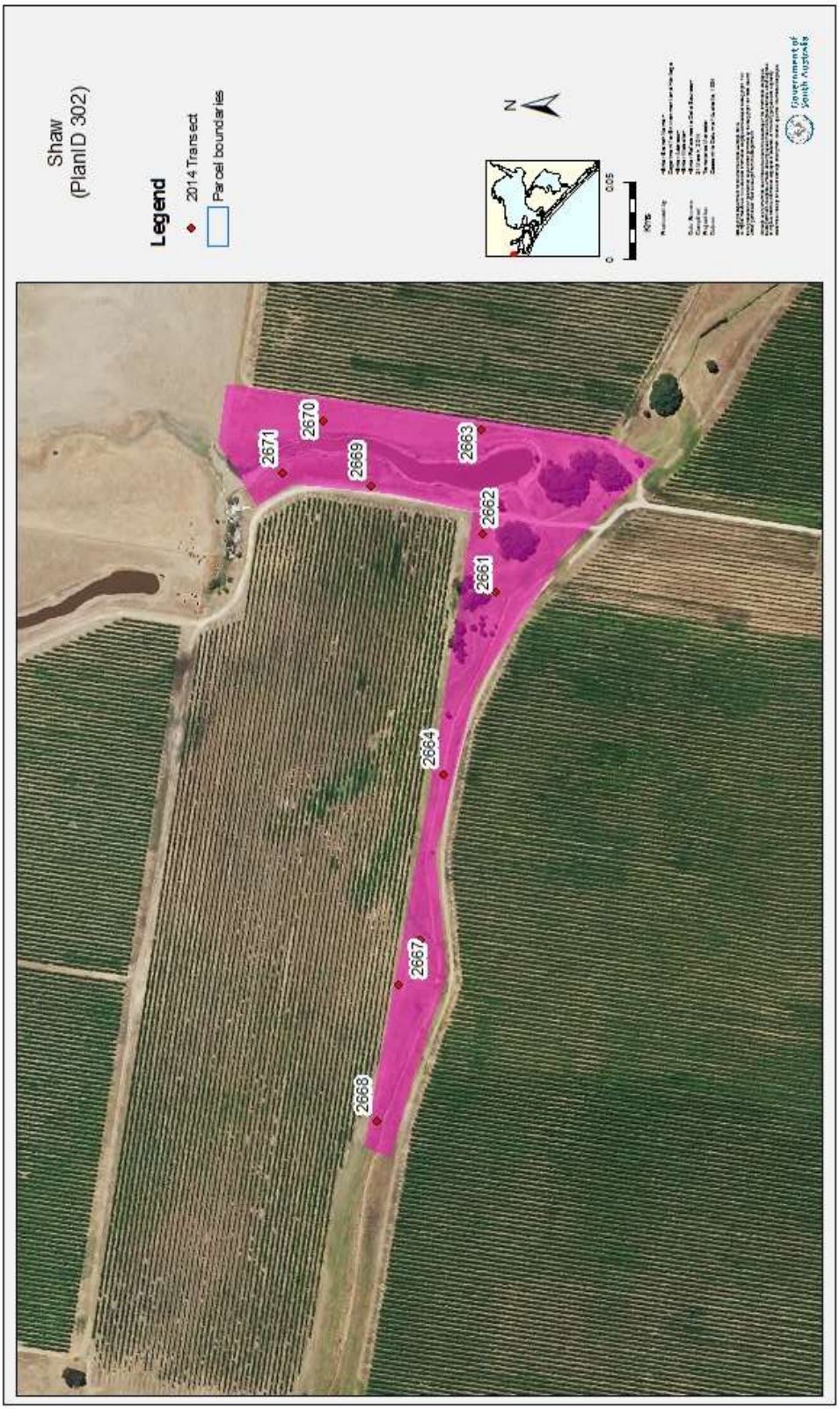
Planting locations give good access to moisture, and most plants are well guarded with plastic. Some native groundcover persists including *Sarconia sp.* and *Distichlis distichophylla*.

Scattered *Lycium ferocissimum* plants were seen across the site. There was no apparent grazing of the plantings, but grazing damage to more mature plants by deer was noted.

## 9.1.58 Shaw – PlanID 302

### 9.1.58.1 Site map

**Northern site**



**Southern site**

### 9.1.58.2 Site photo

### 9.1.58.3 Survivorship results

Site surveyed in autumn 2014.

| Shaw | Autumn | |
|---|---|---|
| | Alive | Dead |
| | 660 | 281 |
| **Survival** | **70.1%** | |

Autumn survivorship was good at 70.1%, and most species displayed good health and moderate growth. Plantings were particularly diverse in the northern site. The northeast of the northern site carried lower weed loads and displayed higher plant health than the rest of that site.

High loads of exotic grasses were noted across the whole site, but this did not appear to be significantly affecting survival of planted seedlings.

# 9.1.59 Stornoway – PlanID 248

### 9.1.59.1 Site map

### 9.1.59.2 Site photo

### 9.1.59.3 Survivorship results

Site surveyed in spring 2013 and autumn 2014.

| Stornoway | Spring | | Autumn | |
|---|---|---|---|---|
| | Alive | Dead | Alive | Dead |
| | 600 | 75 | 969 | 180 |
| **Survival** | **88.9%** | | **84.3%** | |

Autumn survivorship was excellent at 84.3%, a small drop from the spring survivorship at 88.9%. Most plants are healthy with strong growth, although inundation has killed some plants. Some older plantings are scattered through the site and were not counted.

The area immediately south of the site entrance from the main road is unplanted. Transects were moved where possible with some not moved due to high transect density nearby.

Plantings were sparse in the south-eastern corner of site, with approximately one plant every 3m in ripped rows around 6m apart.

The site has been planted in ripped rows, with sandy soils and possible weed control helping to keep the density of the mostly exotic grass cover relatively sparse. *Oenothera stricta* was common on the site, and some *Chondrilla juncea* was also observed. Some rabbit diggings

were noted around E 351206,N 6048792, but no burrows were observed on the site. *Theba pisana* were also present in some guards.

# 9.1.60 Stratland – PlanID 255

### 9.1.60.1 Site map

### 9.1.60.2 Site photo

### 9.1.60.3 Survivorship results

Site surveyed in spring 2013 and autumn 2014.

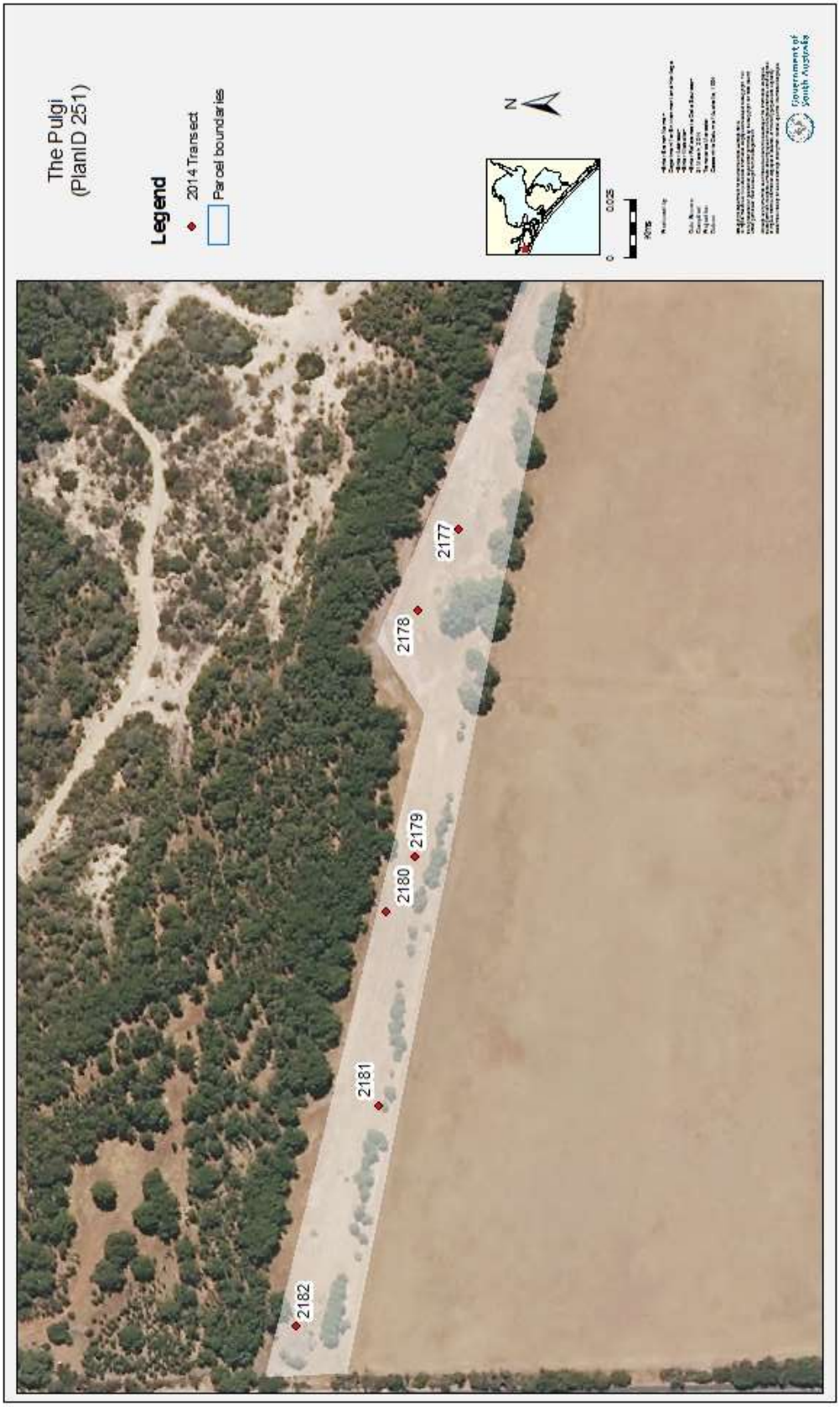
| Stratland | Spring | | Autumn | |
|---|---|---|---|---|
| | Alive | Dead | Alive | Dead |
| | 749 | 135 | 557 | 222 |
| **Survival** | **84.7%** | | **71.5%** | |

Autumn survivorship was good at 71.5%, a moderate drop from the spring monitoring at 84.7%. *Juncus kraussii* were the only species with significant die-off recorded.

Most plants were healthy; however *Atriplex* plants were very small across the northern parts of the site and may have been affected by inundation. The southern part of the site was swamped by grasses which are outcompeting and smothering native plants, particularly low-lying species such as *Disphyma crassifolium*. Despite this, *Atriplex* and *Threlkeldia diffusa* are generally growing well in this area, with spread of up to 1m across.

## 9.1.61 The Pulgi – PlanID 251

### 9.1.61.1 Site map



### 9.1.61.2 Site photo

### 9.1.61.3 Survivorship results

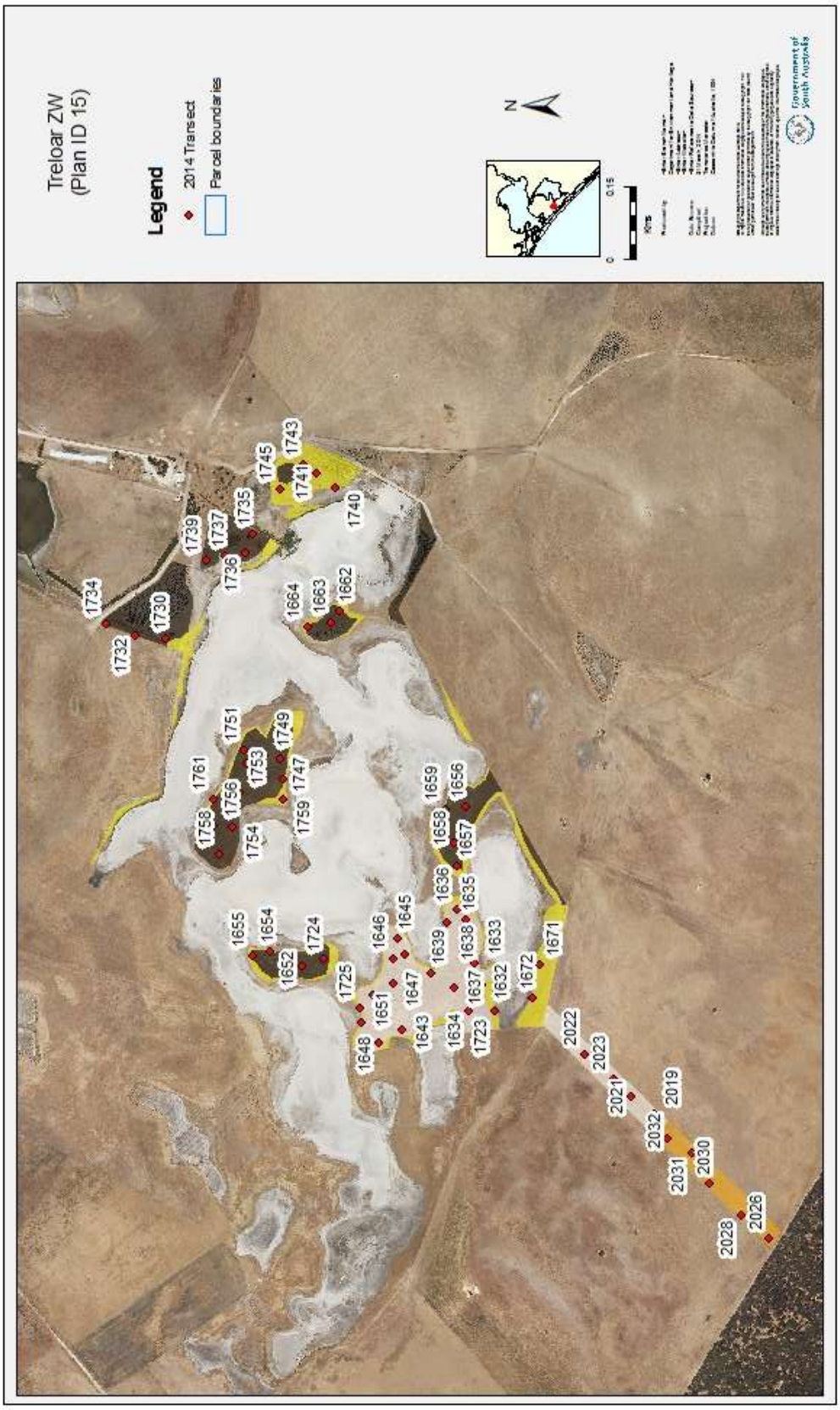
Site surveyed in autumn 2014.

| The Pulgi | Autumn | |
|---|---|---|
| | Alive | Dead |
| | 347 | 87 |
| **Survival** | **80.0%** | |

Autumn survivorship across the site was excellent at 80%. Plants are healthy, but heavy grazing was noted on most species, with the most affected being *Acacia sp., Eucalyptus sp.* and *Allocasuarina verticillata*. The site still has signs of pine removal and is fairly open, with low grass cover.

## 9.1.62 Treloar ZW – PlanID 15

### 9.1.62.1 Site map



### 9.1.62.2 Site photo

### 9.1.62.3 Survivorship results

Site surveyed in spring 2013 and autumn 2014.

| Treloar ZW | Spring | | Autumn | |
|---|---|---|---|---|
| | Alive | Dead | Alive | Dead |
| | 2431 | 290 | 3207 | 1024 |
| **Survival** | **89.3%** | | **75.8%** | |

Autumn survivorship was good at 75.8%, a moderate drop from the spring monitoring at 89.3%. Most species had high survival rates including grasses, mid-storey and overstorey species. Only a few less common plantings such as *Banksia ornata* had problems establishing. Plants are mostly healthy with good growth.

Most plants were staked but not guarded. *Oenothera stricta* was common across the site.

## 9.1.63 Vasarelli 2013 – PlanID 298

### 9.1.63.1 Site map

### 9.1.63.2 Site photo

### 9.1.63.3 Survivorship results

Site surveyed in autumn 2014.

| Vasarelli 2013 | Autumn | |
|---|---|---|
| | Alive | Dead |
| | 234 | 75 |
| **Survival** | **75.7%** | |

Autumn survivorship was good at 75.7%. Some plantings in the eroded area at the northern end of the site had been subject to inundation, with many dead plants in the area.

*Citrullus lanatus* and *Echium plantagineum* were noted on the southern boundary of site. Individual *Solanum* plants were scattered through site. Some herbicide spraying was noted in the southern part of the site.

## 9.1.64 Waghorn – PlanID 293

### 9.1.64.1 Site map

### 9.1.64.2 Site photo

### 9.1.64.3 Survivorship results

Site surveyed in autumn 2014.

| Waghorn | Autumn | |
|---|---|---|
| | Alive | Dead |
| | 299 | 67 |
| **Survival** | **81.7%** | |

Survivorship was excellent at 81.7%. Plants are healthy with vigorous growth, and grasses showed particular vigour. *Rhagodia candolleana*, *Enchylaena tomentosa* and *Threlkeldia diffusa* were growing strongly.

No significant pest plant or animal impacts were noted, although some grazing was seen on both *Allocasuarina verticillata* and *Dianella sp.* seedlings.

## 9.1.65 Watkins – PlanID 301

### 9.1.65.1 Site map

### 9.1.65.2 Site photo

### 9.1.65.3 Survivorship results

Site surveyed in autumn 2014.

| Watkins | Autumn | |
|---|---|---|
| | Alive | Dead |
| | 922 | 439 |
| **Survival** | **67.7%** | |

Survivorship was good at 67.7%. Plant health was very high with strong growth noted.

No significant pest plant or animal impacts were noted. Weedy grasses were common across most of the site, but were not out-competing the planted seedlings.

# 9.1.66 Wellington Dairies – PlanID 287

### 9.1.66.1 Site map

**Western site**

**Eastern site**

### 9.1.66.2 Site photo

### 9.1.66.3 Survivorship results

Site surveyed in spring 2013 and autumn 2014.

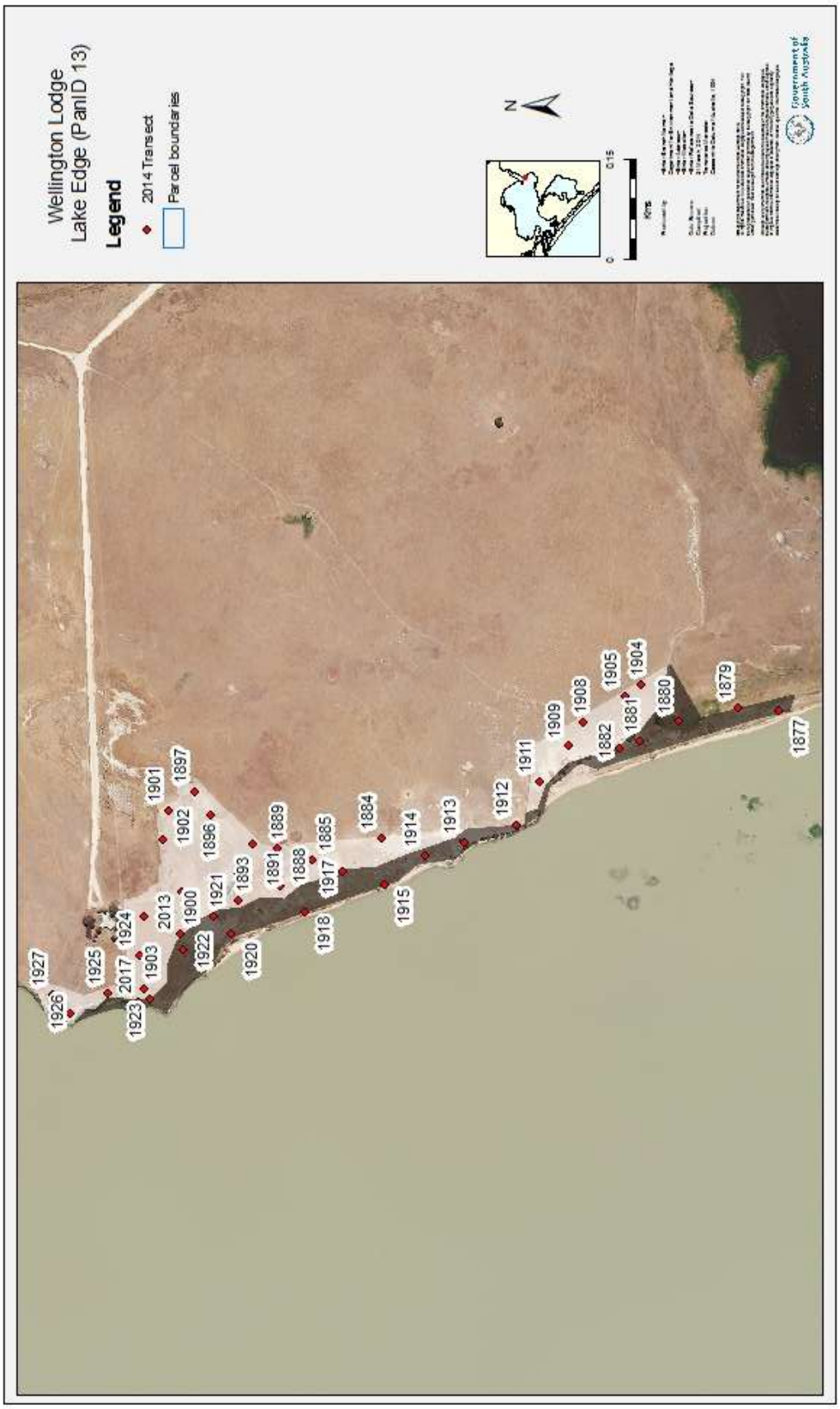
| Wellington Dairies | Spring | | Autumn | |
|---|---|---|---|---|
| | **Alive** | **Dead** | **Alive** | **Dead** |
| | 674 | 43 | 948 | 260 |
| **Survival** | **94.0%** | | **78.5%** | |

Autumn survivorship across the two locations was high at 78.5%, a moderate drop from the spring monitoring at 94%. Plants were healthy and showed strong growth, with little evidence of grazing.

*Citrullus lanatus* and *Brassica sp.* were scattered across the site and *Salsola australis* was widespread.

## 9.1.67 Wellington Lodge Lake Edge – PlanID 13

### 9.1.67.1 Site map



### 9.1.67.2 Site photo

### 9.1.67.3 Survivorship results

Site surveyed in spring 2013 and autumn 2014.

| Wellington Lodge Lake Edge | Spring | | Autumn | |
|---|---|---|---|---|
| | Alive | Dead | Alive | Dead |
| | 973 | 189 | 1193 | 1250 |
| **Survival** | **83.7%** | | **48.8%** | |

Autumn survivorship was fair at 48.8%, a large drop from the spring monitoring at 83.7%. *Juncus kraussii* was widely planted and died off markedly over the summer, with only 23.8% still alive. Most other dead plants could not be identified to the species level. *Atriplex sp.*, *Allocasuarina verticillata* and *Bursaria spinosa* survived well, and most plants showed fair growth.

*Citrullus lanatus* was noted across the site. Horse manure was seen around E 349701, N 6077762 with many guards knocked over, along with grazed plants and sedges pulled from the ground. Fox dens and tracks were also noted in this area, with one dead fox observed, possibly from baiting.

## 9.1.68 Williams Site 2 Waltowa – PlanID 2

### 9.1.68.1 Site map


Site contained transects 1981, 1982, 1983, 1984, 1985, 1986, 1987, 1988

### 9.1.68.2 Site photo

### 9.1.68.3 Survivorship results

Site surveyed in spring 2013 and autumn 2014.

| Williams site 2 Waltowa | Spring | | Autumn | |
|---|---|---|---|---|
| | Alive | Dead | Alive | Dead |
| | 527 | 127 | 91 | 581 |
| **Survival** | **80.6%** | | **13.5%** | |

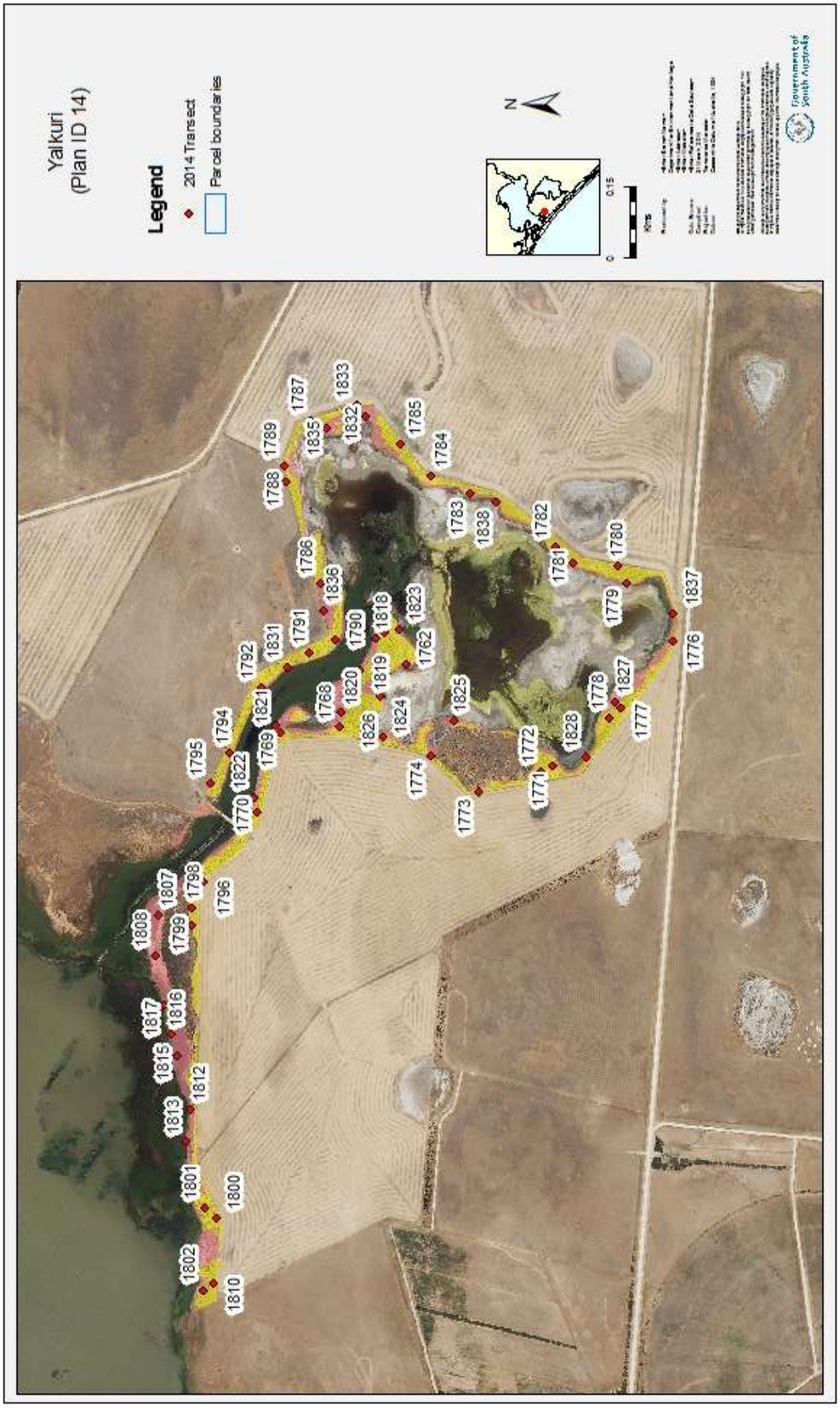
Autumn survivorship was very poor at 13.5%, a large drop from the spring monitoring at 80.6%. It is likely that plants were inundated, or were not planted next to stakes due to inundation.

During spring monitoring, some transects in the northwest of the site were not accessible because of inundation. Hence, any low survivorship or planting activity in that area would not be reflected in the site's overall survivorship percentage due to those transects being skipped.

No significant pest plant or animal impacts were recorded.

## 9.1.69 Yalkuri – PlanID 14

### 9.1.69.1 Site map



### 9.1.69.2 Site photo

### 9.1.69.3 Survivorship results

Site surveyed in spring 2013 and autumn 2014.

| Yalkuri | Spring | | Autumn | |
|---|---|---|---|---|
| | **Alive** | **Dead** | **Alive** | **Dead** |
| | 1249 | 169 | 2134 | 1302 |
| **Survival** | **88.1%** | | **62.1%** | |

Autumn survivorship was fair at 62.1%, a moderate drop from the spring monitoring at 88.1%. Most species were healthy with good growth, particularly *Atriplex sp.* Sedges were generally struggling or dead.

There was some evidence of stock incursion into the fenced area. Thick grass ran through the wetter parts of the site and consisted mostly of *Cynodon dactylon*, and *Atriplex prostrata* was also common across the site.

# 10. APPENDIX D. Survival_rel database and site photographs in digital format (see attached disk)