

Dirk Hartog Island National Park Weed Management and Action Plan (2013 - 2018)

November 2012

Prepared for
Department of Environment and Conservation



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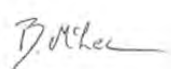
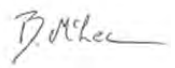
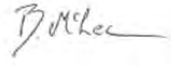
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Abbreviations

Abbreviation	Definition
AMSA	Australian Maritime Safety Authority
ARPP Act	<i>Agriculture and Related Resources Protection Act 1976</i>
AWS	Australian Weeds Strategy
BAM Act	<i>Biosecurity and Agriculture Management Act 2007</i>
BoM	Bureau of Meteorology
BRS	Bureau of Rural Sciences
CALM Act	<i>Conservation and Land Management Act 1984</i>
DAFWA	Department of Agriculture and Food Western Australia
DEC	Department of Environment and Conservation
DoH	Department of Health
EP Act	<i>Environmental Protection Act 1986</i>
EPA	Environmental Protection Authority
EWSWA	Environmental Weeds Strategy for Western Australia
GIS	Geographic Information System
GNP	Good Neighbour Policy
GPS	Global Positioning System
ha	Hectares
IPPP	Invasive Plant Prioritisation Process
IUCN	International Union for the Conservation of Nature
IWM	Integrated Weed Management
km	kilometres
KPI	Key Performance Indicator
m	metres
mm	millimetres
NHT	National Heritage Trust
PDCA	Plan-Do-Check-Act
SOP	Standard Operating Procedure
WA	Western Australia
WC Act	<i>Wildlife Conservation Act 1950</i>
Shark Bay WHP	Shark Bay World Heritage Property
WHP	World Heritage Property
WMA	Weed Management Area
WMS	Weed Monitoring Site
WoNS	Weeds Of National Significance
WRP	Weed Record Point
WSA	Weed Surveillance Area

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1 Introduction

This document was prepared for the Department of Environment and Conservation (DEC) to guide the management of existing and potential weeds on Dirk Hartog Island. The purpose of the Weed Management and Action Plan is to outline a program for weed management, surveillance and monitoring within DEC tenure areas.

1.1 Background Information

Extending over an area of 62,000 hectares (ha) Dirk Hartog Island (the island) is the largest island off the Western Australian coast. It is located approximately 800 kilometres (km) north of Perth, and 35 km from the town of Denham within the Shark Bay World Heritage Property (Shark Bay WHP) (Figure 1). The Shark Bay WHP is at the transition of the South West and Eremaean botanical provinces, resulting in a diversity of habitats, high species richness and the presence of many flora species at their limits of geographical distribution.

With the exception of a number of small freehold properties, the majority of the island has been managed as a National Park since 29 October 2009. The island and surrounding region is recognised as having significant historical and conservation values, which include a high diversity of flora and fauna, endemic and threatened species, and as a location for nesting by Loggerhead Turtles.

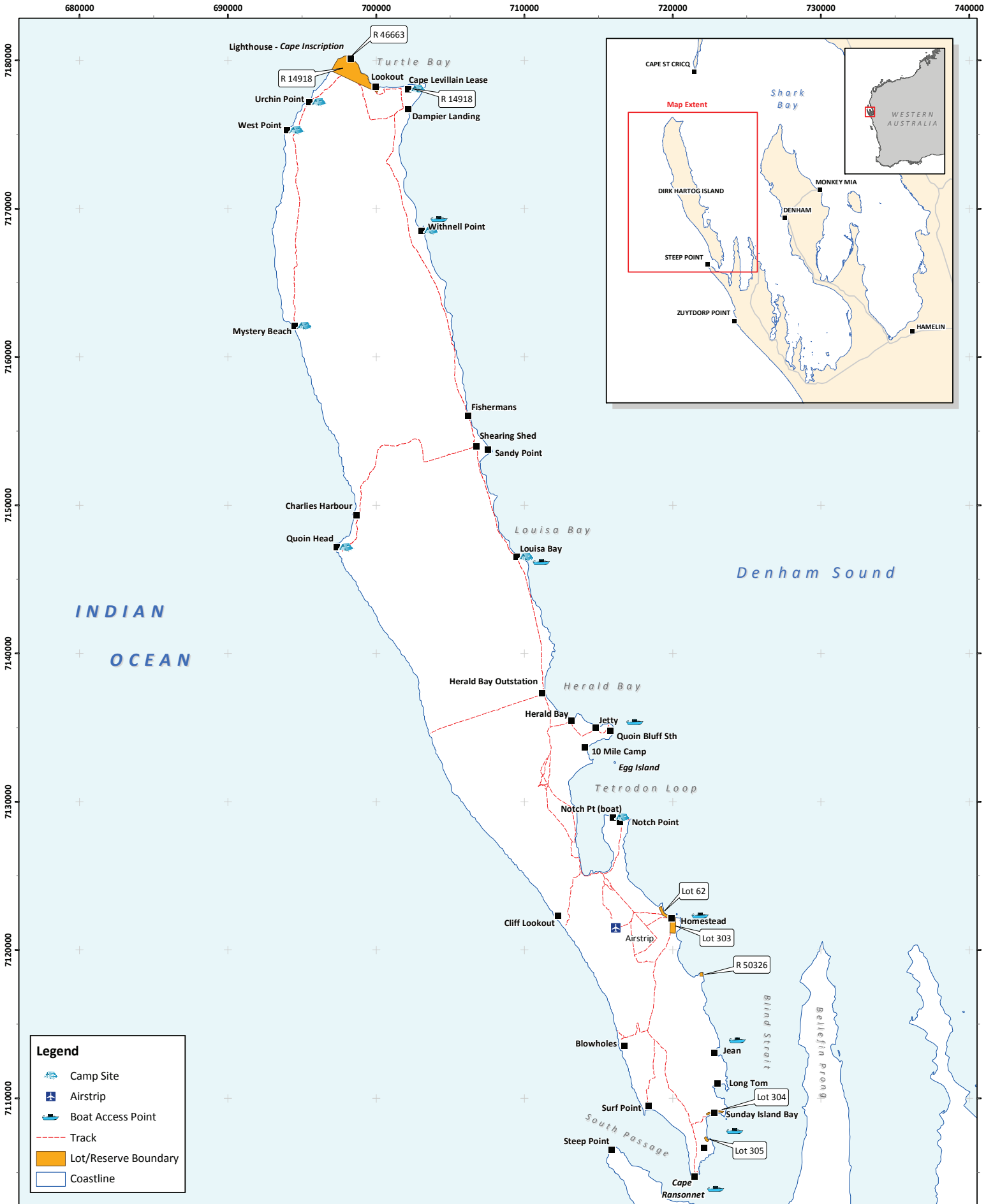
1.2 Scope and Purpose

The management of weed species has previously been identified as a priority for the island in the draft Dirk Hartog Island National Park Ecological Restoration Strategic Plan (Gillen et al. 2011) and the Shark Bay Terrestrial Reserves and Proposed Reserve Addition Management Plan (DEC 2012a). This includes management of high risk species and preventing the further introduction of weed species to the island. The purpose of the Dirk Hartog Island Weed Management and Action Plan is to provide DEC with an integrated suite of methods to effectively manage existing and potential weed threats to the Dirk Hartog Island National Park.

Astron Environmental Services (Astron) undertook a Baseline Weed Survey of Dirk Hartog Island to record the distribution, abundance and cover of existing weed species (Astron 2012b). A total of 49 weed species were identified. In the Baseline Survey Report, recorded weed species were ranked according to the Invasive Plant Prioritisation Process (IPPP) variables (DEC 2008a) using risk matrices provided by DEC (DEC 2012b). The species rankings were then used to identify 15 weed species as a priority for management (refer Table 3, section 4.1).

The scope of this Weed Management and Action Plan is to provide methodology to manage the 15 identified priority weed species and the potential for the introduction of new weed species to Dirk Hartog Island National Park.

The Weed Action Plan guides on-ground management of priority weed species on Dirk Hartog Island and is included in this document as Appendix C.



Legend

- Camp Site
- Airstrip
- Boat Access Point
- Track
- Lot/Reserve Boundary
- Coastline

Department of Environment and Conservation
 Dirk Hartog Island Weed Management and Action Plan - Weed Management And Action Plan

Figure 1: Dirk Hartog Island location and features



Author: S. Moore

Date: 20-11-2012

Drawn: Y. Hua

15206-12FMV1Rev0_121120_Figure_1

Datum: GDA 1994 - Projection: MGA Zone 49 - Scale: 1:230,000 (A3)

0 2 4 6 8 10 12 14 16 Kilometres

2 Past and Current State

2.1 History

Captain Dirk Hartog landed on Dirk Hartog Island in 1616. The subsequent history of Dirk Hartog Island included a military camp, guano mining and pearling camps in the 1800s. Dirk Hartog Island was first settled for pastoral purposes in 1860, and in 1960 contained 20,000 sheep and goats (DEC 2012a). The Dirk Hartog Island Pastoral Lease was purchased in 1968 and has operated primarily as a tourist destination since 1993.

Today, privately owned portions of Dirk Hartog Island total 75.7 ha (Lot 303, Lot 62 and Lot 304). The homestead at Lot 303 is currently managed as a private tourist venture and Reserve 50325 is leased for the purposes of ecotourism. An additional freehold lot at Sunday Island Bay (Lot 305) is privately owned. There are three other reserves on the island: two at Cape Inscription vested with the Shire of Shark Bay and the Australian Maritime Safety Authority (AMSA), and an Aboriginal reserve vested with the Malgana claimant group. The remainder of Dirk Hartog Island was purchased by the Western Australian state government in 2009 to create the Dirk Hartog Island National Park (Figure 1).

2.2 Future Land Use and Development

There are several facilities proposed on Dirk Hartog Island. DEC proposes to have a full time ranger presence on the island based at Herald Bay. The base will have substantial accommodation with facilities including a water desalination plant and power supply, and potentially a barge landing. Proposed transport includes four wheel drive vehicles and quad bikes. Additional temporary accommodation is also proposed for a previously disturbed site at Sandy Point. Existing structures at some camps will also be replaced. DEC also proposes to create an additional vehicle track to close the loop south of Mystery Beach. Creation of new tracks and reinstatement of old existing tracks is also proposed for quad bike access during the cat eradication and monitoring program.

The agreement between the Western Australia Government and the pastoral leaseholders in 2005 provided for the exchange of some areas of freehold held by the leaseholders, for other areas of freehold which have greater potential for development. Areas at Sunday Island Bay, adjacent to the existing homestead and a 2 ha site at Cape Levillain for ecotourism development were also identified. There are proposals to construct a range of accommodation and tourism facilities at these locations. Development of ecotourism accommodation on the freehold lots at the homestead and Sunday Island Bay has implications for visitor management, the ecological restoration project and the natural environment of the rest of the island (DEC 2012a). Development of accommodation at these sites will be in accordance with statutory planning processes and comply with the relevant Shark Bay Town Planning Scheme.

The Shire of Shark Bay is undertaking renovations of the lighthouse keeper's cottage and proposes improvements to access and parking in the historical precinct within Reserve 14918. Further improvement and access options are being explored to facilitate the 400 year anniversary celebrations relating to the first recorded landing of a European on the Australian continent by Dirk Hartog in 1616.

The Malgana claimant group does not have any building or development plans for the indigenous reserve, however have proposed to visit on a day use basis for fishing and as a meeting place.

The vision for Dirk Hartog Island is to provide four-wheel drive destinations that offer a range of nature based recreation, tourism opportunities and experiences in a remote and natural environment that is managed for ecological restoration (Gillen et al. 2011).

2.3 Existing Environmental Plans

The development and implementation of a strategic plan for the ecological restoration of Dirk Hartog Island is a strategy within the Shark Bay World Heritage Property Strategic Plan 2008-2020 (DEC 2008b) which was endorsed by Western Australian Government and Commonwealth Environment Ministers. The purpose of this document in relation to weed management is to outline high level guidance to improve weed management and to facilitate a consistency in approach across all island partners and stakeholders. Previously, there have been no quarantine protocols implemented for Dirk Hartog Island or surrounding satellite islands during the period of pastoral use.

The Shark Bay World Heritage Property (WHP), including Dirk Hartog Island, was inscribed on the World Heritage List in 1991 for its natural heritage values. The Shark Bay World Heritage Property Strategic Plan 2008-2020 (DEC 2008b) provides a planning framework for managing the WHP and meeting its international, national and State obligations. The plan also outlines management goals, objectives, strategies and actions for conservation. As part of the strategies outlined in the WHP Strategic Plan, the draft Dirk Hartog Island National Park Ecological Restoration Strategic Plan (Gillen et al. 2011) was developed and is being implemented. This plan outlines the actions necessary to remove key pressures, including introduced flora and fauna species, to enable a suite of ten reintroduced and, potentially, two introduced native mammal species to be established on the island over the next 10-15 years, followed by ongoing monitoring and management (Gillen et al. 2011). Astron (2012a) prepared for consideration by DEC the final draft Dirk Hartog Island Biosecurity Plan to provide an assessment of risk, mitigation strategies for existing introduced species and to prevent further flora and fauna introductions. Figure 2 shows the relationship of this Weed Management and Action Plan to other planning and management documents relevant to Dirk Hartog Island.

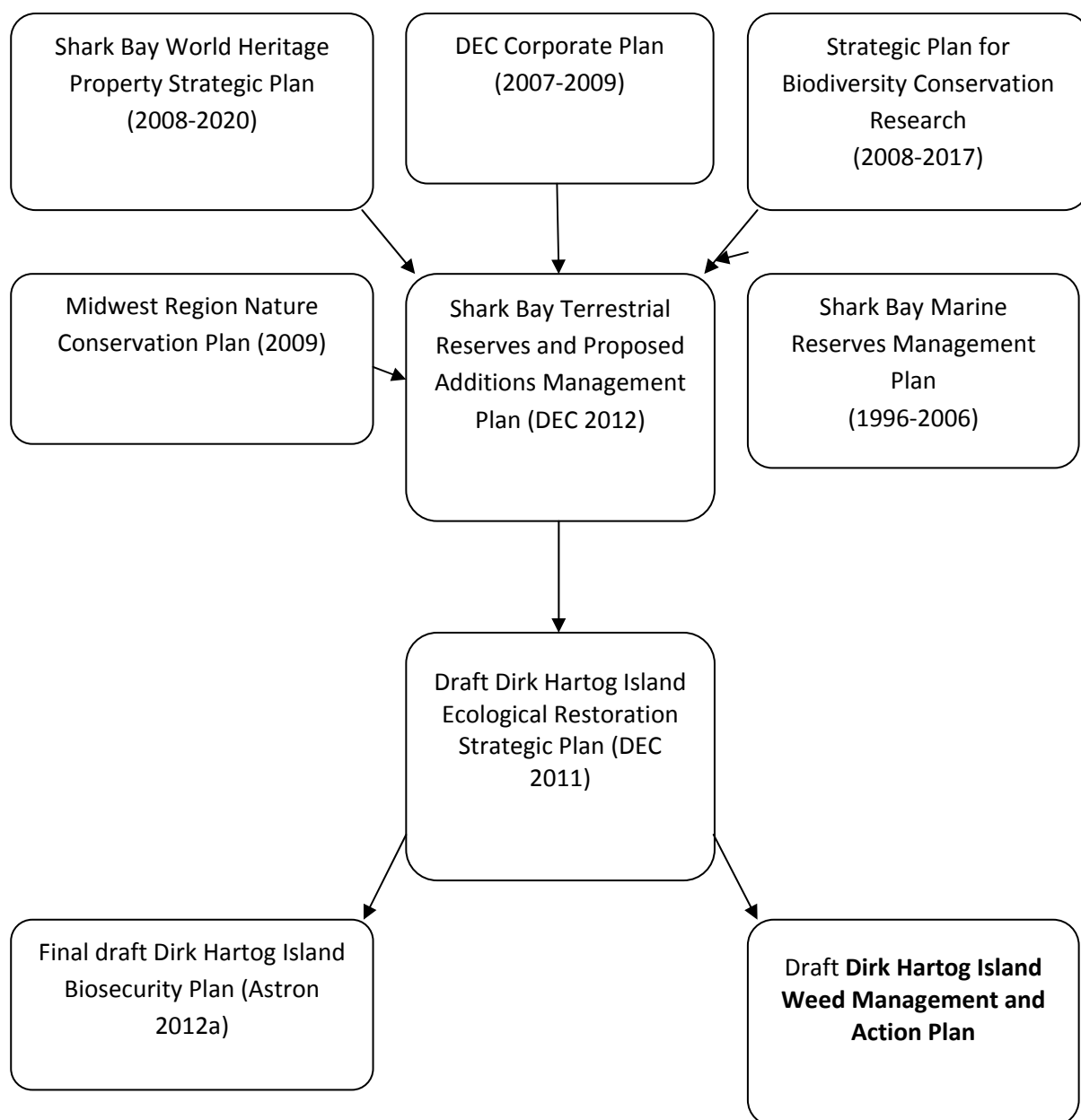


Figure 2: Relationship of this Weed Management and Action Plan to other planning documents.

2.4 Climate

The Shark Bay region has a semi-arid to arid climate, characterised by hot dry summers and mild winters (DEC 2012). Average maximum temperatures during summer in Denham (1988 to 2012), the closest weather station to Dirk Hartog Island, range from 29 °C to 31.8 °C. In winter average maximum temperatures in Denham are around 21 °C (Bureau of Meteorology (BoM) 2012a) (Figure 3). Mean annual rainfall (1893 to 2012) is 224.6 millimetres (mm) (BoM 2012a). The majority of rainfall occurs between May and August; however rainfall tends to occur each month throughout the year in small amounts (BoM 2012a) (Figure 3). Winds are generally southerly, shifting to south-westerly in the afternoon (Payne et al. 1980). Tropical cyclones are experienced infrequently, approximately once every five years, in the vicinity of Carnarvon and Shark Bay. Storm surge associated with passing cyclones is a major threat in the Shark Bay area (BoM 2012b).

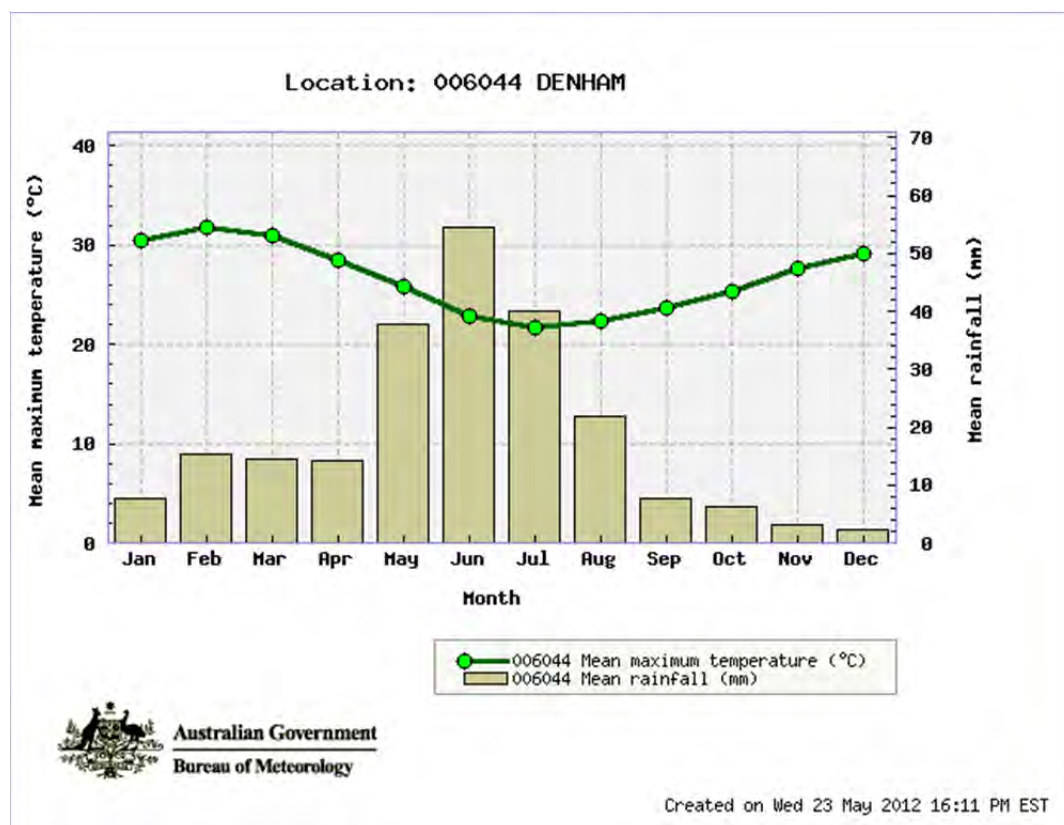


Figure 3: Mean maximum temperature (°C) and mean monthly rainfall (mm) at Denham weather station (006044) (BOM 2012a).

2.5 Vegetation and Flora

Dirk Hartog Island has been identified as one of the most species rich parts of the Shark Bay WHP. The western side of the island comprises steep limestone cliffs, with discontinuous beaches; while the eastern side comprises sandy, shallow bays and inlets (McCluskey and Fitzgerald 2010). The vegetation on Dirk Hartog Island comprises spinifex hummock grassland with low shrubs, and mixed open chenopod shrubland. This vegetation is interspersed by patches of bare drift sand and birridas (gypsum claypans) (DEC 2012a).

The Western Australian (WA) Herbarium lists 266 native flora species, including 13 Priority species (Gillen et al 2011). A species of *Eremophila* has since been removed from the Priority flora list reducing the total to 12. There is only one record of a dedicated flora and fauna survey conducted

on Dirk Hartog Island and as a result knowledge of the occurrence and distribution of native and introduced flora species on the island is very limited. Burbidge and George (1978) surveyed the island in 1972, recording 259 native flora species and 40 introduced flora species. More recently DEC (2012a) and Gillen et al. (2011), listed 40 introduced flora species on the island that have been lodged at the WA Herbarium, with 9 of these species additional to those recorded by Burbidge and George (1978). Eleven of the previously recorded weed species are rated as having a high ecological impact, determined by the Invasive Plant Prioritisation Process (IPPP) for the Mid West Region (DEC 2008a). All but one of these high impact species has also been rated with a rapid level of invasiveness. The feasibility of control of these species varies, with five species regarded as being highly feasible to control. A list of all species previously known to occur on Dirk Hartog Island and their corresponding ecological impact, invasiveness and feasibility of control is presented in Appendix A.

2.6 Fauna

Western Australia's offshore islands have been critical in the survival of many threatened species no longer found on the mainland (Burbidge 1999). Based on sub-fossil surveys, knowledge of extant species and historical collections, at least 13 species of non-volant mammal are known to have previously occurred on Dirk Hartog Island (Baynes 1990; McKenzie et al. 2000). Of these, ten species of terrestrial native mammal once present are now locally extinct on the island (Baynes 1990; McKenzie et al. 2000). It is also possible that two additional species, the banded hare-wallaby (*Lagostrophus fasciatus*) and rufous hare-wallaby (*Lagorchestes hirsutus*) were once on the island (Ride and Tyndale-Biscoe 1962), however no signs of these species have recently been observed (Baynes 2006). Only three smaller native mammals, the little long-tailed dunnart (*Sminthopsis dolichura*), sandy inland mouse (*Pseudomys hermannsburgensis*) and ash-grey mouse (*Pseudomys albocinereus*) are now present on Dirk Hartog Island. Dirk Hartog Island has a rich diverse reptile fauna of approximately 120 species and has the potential to support a diverse native mammal assemblage.

Threatened species listed under State or Commonwealth legislation are known from Dirk Hartog Island: the western spiny-tailed skink (*Egernia stokesii badia*), the Dirk Hartog Island southern emu-wren (*Stipiturus malachurus hartogi*), Dirk Hartog Island rufous fieldwren (*Calamanthus campestris hartogi*) and the Dirk Hartog Island white-winged fairy wren (*Malurus leucopterus leucopterus*). It should also be noted that the thick-billed grasswren (*Amytornis textilis*) is currently regarded as a Priority (P4) species, but a recent taxonomic revision indicates that the Dirk Hartog Island birds are sufficiently different to mainland birds and have been named *A. t. carteri*.

Terrestrial invertebrate fauna on the island, and the surrounding Shark Bay area, is poorly understood, however it is possible that a unique fauna may be present in the form of short range endemic species.

2.7 Environmental Pressures

2.7.1 Previous Disturbance

In 1850, a military camp was established at Quoin Bluff South on Dirk Hartog Island and pearling camps were established at Notch Point Bay, housing more than 50 pearlers in 1886 (R Cooper 1997 cited in DEC 2012a). Construction of a lighthouse at Cape Inscription began in 1908, and included a jetty at Turtle Bay to transport goods. The lighthouse was automated in 1917 and became unmanned.

Pastoral activities on Dirk Hartog Island began in the late 1800s and ceased in 2005. The first pastoral lease was issued in 1869 and over time the number of sheep on the island varied, estimated to reach 26,000 by the mid-1920s (R Cooper 1997 cited in DEC 2012a). In the early 1960s, the number of sheep and goat on the island was estimated to be 20,000. Several out-camps and associated infrastructure were constructed to assist pastoral operations, the remnants of which can still be seen today. The Dirk Hartog Island Pastoral Lease was purchased again in 1968; subsequently the number of sheep on the island was reduced to 6,000 and the water points in the northern half of the island were shut down. De-stocking of the island commenced in 2007 and ground/aerial shooting of goats has been practiced since 2008 (Gillen et al. 2011). The presence of stock on Dirk Hartog Island and their associated disturbance of the natural environment since 1869 has facilitated the establishment and spread of weed species, distributed across all habitats. The removal of pastoral animals and hence the predominant disturbance will potentially enhance native vegetation cover and limit further proliferation of weeds over time.

2.7.2 Future Disturbance

Proposed DEC developments, improved access and freehold landowners' developments will increase visitation levels, causing higher levels of disturbance and facilitating suitable habitats for weed proliferation. Future potential threats to Dirk Hartog Island biosecurity are linked to the proposed recreation and tourism developments, outlined by DEC (2012a) and summarised below.

- To develop a limited number of bush camping sites
- To develop an operations base at Herald Bay
- To develop the 'Mystery' recreation vehicle drive circuit connecting Sandy Point, Cape Inscription and Quoin Head
- To develop walk trails, from Cape Inscription lighthouse to Turtle Bay and short walks at historical features such as Quoin Bluff South and Notch Point
- To provide appropriate visitor risk management facilities and infrastructure at recreation sites
- To create vehicle pull-over bays on the main north-south track
- To create new vehicle access tracks and reinstate old tracks for DEC operational activities.

A clear future threat to Dirk Hartog Island in relation to introduced flora is the spread of existing populations, or the introduction of new populations, into areas that are currently weed free or nearly so. Weed invasions are often related to disturbances. They are generally introduced and spread by activities that involve the removal of natural vegetative cover, construction or maintenance of infrastructure, livestock and agriculture, cyclones and fire. They may also arrive naturally on birds and other transported animals, or in their droppings, or be wind blown to the island. All weed species should therefore be considered future threats to the island whether they are currently present or not.

2.7.3 Existing Weeds

DEC defines an environmental weed as “an introduced plant that establishes in natural ecosystems and adversely modifies natural processes, resulting in decline of invaded communities” (DEC 2012c). Weed species pose a threat to native species through displacement and destruction of natural habitat, and also impact on the aesthetic and recreational values of an area. Natural fire regimes can be significantly altered by monocultures of the widespread weed, buffel grass (*Cenchrus ciliaris*) (Marshall et al. 2012). Introduced diseases or plant pathogens possibly introduced on weeds can be harmful as native species or populations may not have the necessary defences to resist or recover.

A baseline weed survey conducted by Astron (2012b) recorded 49 weed species across the island, shown in Table 1 below. Nineteen of these species were recorded for the first time, meaning a total of 68 weed species have now been recorded on the island (Appendix A). The most abundant species is red brome (*Bromus rubens/madritensis*) and Mediterranean turnip (*Brassica tournefortii*) has the widest distribution. Other commonly encountered species that are widespread across the island are buffel grass (*Cenchrus ciliaris*), rough cat's tail (*Rostraria pumila*), birdwood grass (*Cenchrus setiger*), common sowthistle (*Sonchus oleraceus*) and false hawkbit (*Urospermum picroides*).

Weed species are present in all habitat types, with vegetation complexes such as *Melaleuca* shrublands and saline clay pans having lower weed abundance (Astron 2012b). The majority of weed species are widely distributed across the island; however some species with strict habitat requirements are restricted to their current locations. Weed levels are at their greatest abundance and species richness in the vicinity of historical infrastructure such as stockyards, water tanks and shearing sheds. Meanwhile, undisturbed vegetation immediately outside boundaries of stock activities express very low cover of weeds (Astron 2012b).

Red brome (*Bromus rubens/madritensis*) is a widespread grass in the southern wheatbelt area of Western Australia (WA Herbarium 2012; Hussey et al. 2007). It spreads easily and has a short seed bank lifespan. Red brome grows well in disturbed sites and open areas, outcompeting and displacing native vegetation. It produces prolific seed and large amounts of biomass which increase the risk of fire (WA Herbarium 2012). Further, the rough awns and florets of this species are a direct threat to grazing fauna as sharp florets can become lodged in the corners of the eyes, causing infections which can lead to a reduction in vision (Newman 2001).

Mediterranean turnip (*Brassica tournefortii*) grows and spreads rapidly, outcompeting native flora in sandy soils, roadsides, disturbed areas and grazed woodlands, shrublands and islands (WA Herbarium 2012, Hussey et al. 2007).

Buffel grass (*Cenchrus ciliaris*), which was introduced and spread by pastoral activities, is widespread across the island. This grass species is highly invasive, outcompetes native vegetation to form monocultures and has been estimated to have a seed bank lifespan ranging from 2 to 30 years (Marshall et al. 2012). It also poses a significant fire risk since the removal of most grazing animals. Birdwood grass (*Cenchrus setiger*) poses a similar threat, however this species spreads slower than buffel grass.

Rough cat's tail (*Rostraria pumila*) is an introduced grass common in the southern half of Western Australia from Eucla to Shark Bay (WA Herbarium 2012). It is found growing in sandy, clay and limestone areas and is associated with roadsides, sand dunes, cliff slopes and grazed woodlands (WA Herbarium 2012, Hussey et al. 2007).

Common sowthistle (*Sonchus oleraceus*) is a short lived annual widely distributed and very common across Western Australia. It spreads easily and has a short lived seed bank. This species is readily grazed in pastoral areas and is considered to be moderately salt tolerant (WA Herbarium 2012, Weeds Australia 2012). False hawkbit (*Urospermum picroides*) is another short lived annual that is distributed from Perth to Shark Bay (WA Herbarium 2012, Hussey et al. 2007). It grows on sandy soils, often over limestone or granite and prefers moist conditions.

One population of athel pine (*Tamarix aphylla*) occurs at the homestead. This species is listed as a Weed of National Significance (WoNS) by Weeds Australia (2012) and is a Priority 1 (P1) Declared Plant for the whole of WA (DAFWA 2012).

Weed species were assessed by Astron and DEC personnel at a local island scale according to the DEC Invasive Plant Prioritisation Process (IPPP) (DEC 2008a) variables of current distribution, potential distribution, ecological impact, invasiveness and feasibility of control (Astron 2012c). The outcome of this assessment for all species identified during the Baseline Weed Survey (Astron 2012b) is presented in Table 1.

Table 1: Weed species that are currently known to occur on Dirk Hartog Island and their associated ranking (Astron 2012c).

Scientific Name	Common Name	Potential Distribution	Current Distribution	Ecological Impact	Invasiveness	Feasibility of control
<i>Agave americana</i>	Century plant	L	L	L	S	H
<i>Asphodelus fistulosus</i>	Onion Weed	H	L	M	R	L
<i>Avena barbata</i>	Bearded oat	M	M	M	R	L
<i>Bidens bipinnata</i>	Bipinnate beggartick	M	L	U	M	L
<i>Bougainvillea glabra</i> *	Bougainvillea	N/A	N/A	N/A	N/A	N/A
<i>Brassica juncea</i>	Indian mustard	L	L	U	M	L
<i>Brassica tournefortii</i>	Mediterranean turnip	H	H	H	R	L
<i>Bromus diandrus</i>	Great brome	L	L	U	S	L
<i>Bromus rubens/madritensis</i>	Red brome	H	H	H	R	L
<i>Cakile maritima</i>	Sea rocket	H	H	L	R	L
<i>Cenchrus ciliaris</i>	Buffel grass	E	H	H	R	L
<i>Cenchrus setiger</i>	Birdwood grass	H	H	H	R	L
<i>Centaurea melitensis</i>	Cockspur	H	H	U	R	L
<i>Centaureum erythraea</i>	Common centaury	H	H	L	R	L
<i>Chenopodium murale</i>	Nettle-leaf goosefoot	M	M	L	M	L
<i>Cuscuta epithymum/planiflora</i>	Lesser dodder	M	M	L	M	L
<i>Cynodon dactylon</i>	Couch	L	L	H	M	H
<i>Cyperus rotundus</i>	Nut grass	U	U	U	S	U
<i>Diplotaxis muralis</i>	Wall Rocket	L	L	L	S	H
<i>Ehrharta longiflora</i>	Annual veldt grass	M	M	M	M	M
<i>Emex australis</i>	Doublegee	L	L	L	S	M
<i>Erodium aureum</i>		H	M	U	M	L
<i>Hordeum leporinum</i>	Barley grass	L	L	L	M	H
<i>Lupinus cosentinii</i> [^]	Lupin	H	L	M	M	H
<i>Lycopersicon esculentum</i>	Tomato	L	L	L	S	H

Scientific Name	Common Name	Potential Distribution	Current Distribution	Ecological Impact	Invasiveness	Feasibility of control
<i>Lysimachia arvensis</i>	Pimpernel	E	H	M	R	L
<i>Malva parviflora</i>	Marshmallow	L	L	L	S	M
<i>Medicago minima</i>	Small burr medic	L	L	L	S	M
<i>Medicago polymorpha</i>	Burr medic	M	L	U	S	M
<i>Melilotus indicus</i>		M	M	M	M	M
<i>Mesembryanthemum crystallinum</i>	Ice plant	L	L	H	M	M
<i>Musa acuminata/balbisiana</i>	Banana	L	L	L	S	H
<i>Nicotiana glauca</i>	Tree tobacco	L	L	U	R	M
<i>Olea europaea*</i>	Olive	N/A	N/A	N/A	N/A	N/A
<i>Polycarpon tetraphyllum</i>	Fourleaf allseed	M	L	L	R	L
<i>Polypogon monspeliensis</i>	Annual beardgrass	L	L	L	S	H
<i>Raphanus raphanistrum</i> [^]	Wild radish	H	L	H	R	H
<i>Reichardia tingitana</i>	False sowthistle	H	L	H	R	H
<i>Ricinus communis</i>	Castor oil plant	M	L	M	M	H
<i>Rostraria pumila</i>	Rough cat's tail	E	H	H	R	L
<i>Schinus terebinthifolius</i>	Japanese pepper	L	L	H	M	H
<i>Silene gallica</i>	French catchfly	H	H	M	R	L
<i>Silene nocturna</i>	Mediterranean catchfly	H	H	M	R	L
<i>Sisymbrium irio</i>	Smooth mustard	L	L	L	M	H
<i>Sisymbrium orientale</i>	Indian hedge mustard	L	L	L	M	H
<i>Solanum nigrum</i>	Black berry nightshade	L	L	L	M	H
<i>Sonchus oleraceus</i>	Common sowthistle	E	E	M	R	L
<i>Tamarix aphylla*</i>	Athel pine	N/A	N/A	N/A	N/A	N/A
<i>Urospermum picroides</i>	False hawkbit	H	H	M	R	L

[^]One individual detected and removed, therefore no longer known to occur.

*Species that were recorded solely at the homestead and not included in the ranking process.

2.7.4 Potential Weeds

There are an additional 43 weed species that have been recorded in the Shire of Shark Bay, but were not detected in Astron's weed survey (WA Herbarium 2012). These species can potentially spread to Dirk Hartog Island through a variety of means, such as, wind dispersal, transported via freight, vehicles and boats. If viable seed is transported to the island the potential of spread and proliferation is high due to the current high levels of weed infestation and disturbance. Furthermore, increased activity on the island will provide ample opportunities for weeds to be introduced and spread. An alert list of weed species that may potentially be introduced to the island is provided in Appendix B. This list includes two species of one occurrence each that were recorded in the Baseline Weed Survey (Astron 2012b) and removed by personnel. Current knowledge assumes that lupin (*Lupinus cosentinii*) and wild radish (*Raphanus raphanistrum*) no longer occur on Dirk Hartog Island but may germinate if a viable seed bank has remained. Included on the alert list are five species that pose a high risk to the biodiversity of Dirk Hartog Island due to their high ecological impact and rapid level of invasiveness.

African boxthorn (*Lycium ferocissimum*), which has not yet been recorded on the island but is known to occur on the adjacent mainland is a shrub with a vigorous vegetative regeneration strategy, and is known to disrupt seal, sea lion and short-tailed shearwater breeding on off-shore islands (WA Herbarium 2012; Hussey et al. 2007). This species was introduced to WA as a garden plant in the mid 1800s and has recently been included on the list of WoNS (Weeds Australia 2012).

Kapok (*Aerva javanica*) is a highly invasive weed species, which has not yet been recorded on Dirk Hartog Island but is present on the adjacent mainland (WA Herbarium 2012). This species is widespread in many vegetation types from Carnarvon to the Kimberley and throughout the Pilbara (Hussey et al. 2007). Kapok displaces native flora and its seed is spread by wind, animals and most likely vehicle and soil movement (Queensland Government 2012).

Ruby dock (*Acetosa vesicaria*) has been recorded in the Shire of Shark Bay, but not on Dirk Hartog Island. This species is widespread in the arid zone of WA and readily invades disturbed areas, potentially displacing native flora and reducing suitable habitats for native fauna. This species contains nitrates and oxalates which may also cause poisoning to grazing animals (Hussey et al. 2007, Weeds Australia 2011).

Mexican poppy (*Argemone ochroleuca*) is common in moist areas, along coarse sand banks and beds of major rivers and creeks and can also be found growing in pastures and wastelands (Hussey et al 2007). It is listed as a noxious weed that is toxic to stock and humans (Weeds Australia 2012) and is a P1 declared plant for the Shire of Shark Bay (DAFWA 2011).

Crownbeard (*Verbesina encelioides*) has been recorded on islands off the West Australian coast and the Geraldton Sandplains region (WA Herbarium 2012). It has also been recorded within the Shire of Shark Bay (K. Watson, DEC, pers. comm.). These locations and its preference for sandy soils qualify this species as a high risk species to Dirk Hartog Island.

2.7.5 Fire

There has been no documentation of fire history on Dirk Hartog Island; however satellite images indicate the occurrence of at least one fire prior to 1983 in the vicinity of Sandy Point (Gillen et al. 2011). The removal of stock from the island will allow vegetation biomass to increase, which poses a potentially increased wildfire risk to the island. Monocultures of buffel grass that were found on Dirk Hartog Island further increase the wildfire risk.

Many weed species respond positively to the disturbance caused by fire. The deep penetrating root system of buffel grass and long lifespan of individual tussocks allows this weed species to re-sprout following fire. It has been found that vegetation communities infested with buffel grass respond positively to fire, increasing the cover of buffel and decreasing the cover of native vegetation (Miller et al. 2010; Butler and Fairfax 2003). Dense cover of buffel grass further hinders the establishment of overstorey species, resulting in a significant change in vegetation structure. It has also been found that dense areas of buffel grass increases fine fuel loads and enhances fire severity, resulting in greater mortality of overstorey species (Miller et al. 2010).

3 Legislation and Guiding Policies

This Weed Management and Action Plan has been developed to provide guidance for weed management on Dirk Hartog Island. The legislation and policies listed below provide the risk assessment framework which in turn guides appropriate weed management actions for species found on the island. The risk assessment procedure detailed in section 5.1.3 utilises several acts, policies, procedures and strategies listed below.

3.1 State Government Legislation

Under the Australian Constitution, responsibility for the use and management of land rests primarily with the states and territories. The responsibility and coordination of weed legislation, regulation and policy at the Western Australian Government level is undertaken by various state government agencies which is summarised in Table 2 below.

Table 2: Western Australian legislation and responsible agency.

Legislation	Administered By
<i>Agricultural and Related Resources Protection Act 1976 (ARRP Act)</i>	Department of Agriculture and Food WA
<i>Biosecurity and Agriculture Management Act 2007 (BAM Act)</i>	Department of Agriculture and Food WA
<i>Biological Control Act 1986</i>	Department of Agriculture and Food WA
<i>Environmental Protection Act 1986 (EP Act)</i>	Department of Environment and Conservation
<i>Environmental Protection (Clearing of Native Vegetation) Regulations 2004</i>	Department of Environment and Conservation
<i>Wildlife Conservation Act 1950 (WC Act)</i>	Department of Environment and Conservation
<i>Conservation and Land Management Act 1984 (CALM Act)</i>	Department of Environment and Conservation

Currently in Western Australia, the principle legislation relating to weed management is the *Agricultural and Related Resources Protection Act 1976* (ARRP Act, sometimes can be referred to as ARRPA). Declared Plants are listed pursuant to Section 35 of the ARRP Act; and land managers are required to control these plants with regard to the class under which they are declared.

The *Biosecurity and Agriculture Management Act 2007* (BAM Act) was enacted on 12 October 2007, with the aim of implementing a single act that will eventually replace 17 existing Acts within the Agriculture Portfolio.

Biological Control Acts have been enacted in all states and territories. The Acts make provision for the declaration of target organisms (pests), being organisms that cause harm in a particular state or territory. The Acts also provide for biological control of target organisms by permitting the release of agent organisms in certain circumstances. The Biological Control Authority (WA) may, by publication of a Gazette Notice, declare organisms to be target organisms (s 18) or agent organisms (s 27) after nominations, submissions and reports.

The *Environmental Protection Act 1986* (EP Act) defines the need for environmental impact assessment and is the means by which development proposals likely to have significant impacts are refused or required to be modified. Further, under the EP Act is the *Clearing of Native Vegetation Regulations 2004* which provides an avenue for assessment of clearing of native vegetation activities for construction projects (e.g. infrastructure and developments) as well as farming or pastoral

activities. Ministerial requirements are often outcomes of environmental approval assessment processes (i.e. a Condition of approval) for weed management for projects approved under Part IV of the *EP Act 1986*, through either the Environmental Protection Authority (EPA) or Native Vegetation Clearing Permits, approved through DEC's Native Vegetation Protection Section.

DEC currently has no specific weed legislation regulatory responsibilities. The department has a responsibility for the conservation and protection of flora and fauna on all State lands and waters under the provisions of the *Wildlife Conservation Act 1950* (WC Act) and more specifically on DEC managed lands under section 33(1)(d) of the *Conservation and Land Management Act 1984* (CALM Act).

3.2 Australian Government Policy

The Australian Government has a number of policy initiatives to coordinate and prioritise weed management efforts at a national level. This includes the development and implementation of the Australian Weeds Strategy, and a number of national weed listings. These processes underpin an integrated approach for biosecurity at both a national and state government level.

The *Australian Weeds Strategy 2007* (AWS) takes a national approach to weed management problems of national significance, addressing environmental and agricultural weeds equally. Based on their impact or potential impact, weeds can be significant at a property, local, regional, state and/or national level. There are a number of recognised 'lists' of weeds of national interest. The nature of the weeds, and the resulting national actions required, determine which lists a species may appear.

- **WoNS:** identified by Australian governments because of their invasiveness, impacts on primary production and the environment, potential for spread and socioeconomic impacts. Each WoNS has a strategic plan and individual landowners and managers are ultimately responsible for managing WoNS (Weeds Australia 2012).
- **National Environmental Alert List:** complements the WoNS list and identified weed species that are in the early stages of establishment and have the potential to become a significant threat to biodiversity if they are not managed (Australian Government 2012a). Species on the Alert List are based on three criteria:
 - posing a high or serious potential threat to the environment
 - having limited distribution within Australia at present
 - being amenable to successful eradication or containment programmes.
- **Sleeper Weeds:** complements the WoNS list and 17 potential species were identified in 2003 by the Bureau of Rural Sciences (BRS), through consultation with the Australian Weeds Committee (Australian Government 2012b). BRS prioritised 10 species for which eradication was thought to be both desirable and feasible. Sleeper weeds are plants from overseas that have currently established only small wild populations but have the potential to spread widely and affect agricultural or natural environments. Huge environmental damage and control costs can be prevented if these weeds are eradicated before they become widespread. That is, they are plants that appear benign for many years, but which may suddenly spread rapidly following certain natural events such as flood, fire, drought, climate change, or change in land or water management. Sleeper weeds are not always recognised as a significant problem, even though the potential threat they pose to industry, people or the environment may be extreme.

3.3 State Government Policy

A number of policy arrangements have been implemented to support the legislative framework in Western Australia.

The Environmental Weed Strategy for Western Australia (EWSWA) was funded through the Natural Heritage Trust (NHT) and was prepared by consultants and a Steering Committee comprised of various government agencies and community groups concerned with environmental weed management. The strategy itself is still considered relevant but Appendix 3, (i.e. the "List of Environmental Weed Species of Actual and Potential Significance in WA") is out dated and has now been replaced by the DEC's Invasive Plant Prioritisation Process (IPPP 2008).

The Invasive Plant Prioritisation Process (IPPP) for DEC (DEC 2008a) was developed to supersede the weed ratings in the Environmental Weed Strategy for Western Australia (1999). The prioritisation process considers both a 'species-led' and an 'asset-based' approach to priority setting for weed management on DEC-managed lands. Prioritisation results from the species-led approach within a DEC region should be utilised as a guide only and do not diminish any other requirements (statutory or otherwise) of land managers or developers, such as Declared Plants requirements, as set out in the *ARRP Act* or Ministerial requirements under Part IV of the *EP Act*. The threat and risk posed to biodiversity values will differ depending on the unique characteristics of each site and associated land management practice or operation and this means priorities will need to be adjusted accordingly. An asset-based approach to invasive plant prioritisation is still in development and once finalised will support the species-based approach.

DEC developed the Good Neighbour Policy (GNP) to provide some specific information about the most common cross-boundary issues between lands managed by the Department and neighbouring landholders. The GNP formally states the Department's aim to build and maintain good relations with all of its neighbours, and to set out the way in which the Department deals with common cross-boundary issues. Section 3 of the GNP deals specifically with weeds.

4 Objectives

This document specifies a framework of target areas for weed management, surveillance and monitoring, and requisite methodology and evaluation procedures to achieve the following weed management objectives:

- To identify new weed species to Dirk Hartog Island
- To prevent the establishment of new weed species new to Dirk Hartog Island
- Eradicate identified priority weed species
- To reduce the distribution, extent, abundance and foliar cover of identified priority weed species
- To monitor temporal trends in identified priority weed species distribution, abundance and cover in selected areas

4.1 Target Species

The 15 priority weed species presented in Table 3, and weed species that are new to the island, are identified as a focus for management and monitoring within the Dirk Hartog Island National Park. Species priority was determined using weed risk matrices provided by the DEC (2012b) based on an assessment of IPPP variables (DEC 2008a) assessed at an island scale (Astron 2012c). The ranking and recorded distribution was considered for each priority species to allocate either an eradication, control or monitoring management objective.

Table 3: List of priority weed species ranking and their associated management objective

Scientific Name	Common Name	Ranking (example management action ¹) (Astron 2012b)	Objective
<i>Cynodon dactylon</i>	Couch	Low (B,C,D)	Eradicate
<i>Ricinus communis</i>	Castor oil plant	Low (B,C,D)	Eradicate
<i>Schinus terebinthifolius</i>	Japanese pepper	Low (B,C,D)	Eradicate
<i>Lupinus cosentinii</i>	Lupin	Low (B,C,D)	Eradicate
<i>Raphanus raphanistrum</i>	Wild radish	High (H,I)	Eradicate
<i>Mesembryanthemum crystallinum</i>	Ice plant	Low (B,C,D)	Control
<i>Polycarpon tetraphyllum</i>	Fourleaf allseed	Low (D)	Control
<i>Reichardia tingitana</i>	False sowthistle	High (H,I)	Control*
<i>Brassica tournefortii</i>	Mediterranean turnip	Low (D)	Monitor
<i>Bromus rubens/madritensis</i>	Red brome	Low (D)	Monitor
<i>Cenchrus ciliaris</i>	Buffel grass	Low (D,E)	Monitor
<i>Cenchrus setiger</i>	Birdwood grass	Low (D,E)	Monitor
<i>Lysimachia arvensis</i>	Pimpernel	Low (D)	Monitor
<i>Rostraria pumila</i>	Rough cat's tail	Low (D,E)	Monitor
<i>Sonchus oleraceus</i>	Common sowthistle	Low (D)	Monitor

*Objective for management of false sowthistle was identified as control by DEC independent of ranking procedure.

B=monitor only

C=improve general weed management

D=protect

E=targeted control to reduce infestations at priority sites

H=eradication

I=eradication

One individual each of lupin and wild radish were recorded and consequently removed by Astron personnel during the baseline weed survey (Astron 2012b). The recorded locations of these two species are listed below and will need to be monitored for any re-emergence.

- *Lupinus cosentinii* (lupin)

Eastings: 705095; Northings: 7160941

- *Raphanus raphanistrum* (wild radish)

Eastings: 717153; Northings: 7121800

¹ Recommended management actions from the ranking process are on a regional scale. Management objectives selected for priority species were based on island conditions.

5 Design

Integrated Weed Management (IWM) requires that the whole site context and range of management options are considered when developing the management rationale and selecting management actions (Bottrell 1979). IWM can be divided into two broad categories; prevention, and control and eradication, summarised in Table 4.

Table 4: Summary of aspects of Integrated Weed Management.

Category	Aspects
Prevention	Prevention is the most cost effective way to manage weeds. Preventing the proliferation of weeds relies upon: <ul style="list-style-type: none"> • Weed hygiene measures • Education and awareness • Early detection and response.
Control and eradication	The three recognised methods for the control and eradication of weeds are: <ul style="list-style-type: none"> • Biological control* • Manual and mechanical control • Chemical treatment.
* Biological control was not considered a feasible option for the priority species identified within the Dirk Hartog Island National park. Application of biological control typically requires significant investment in research and development and is therefore not detailed in this WMP.	

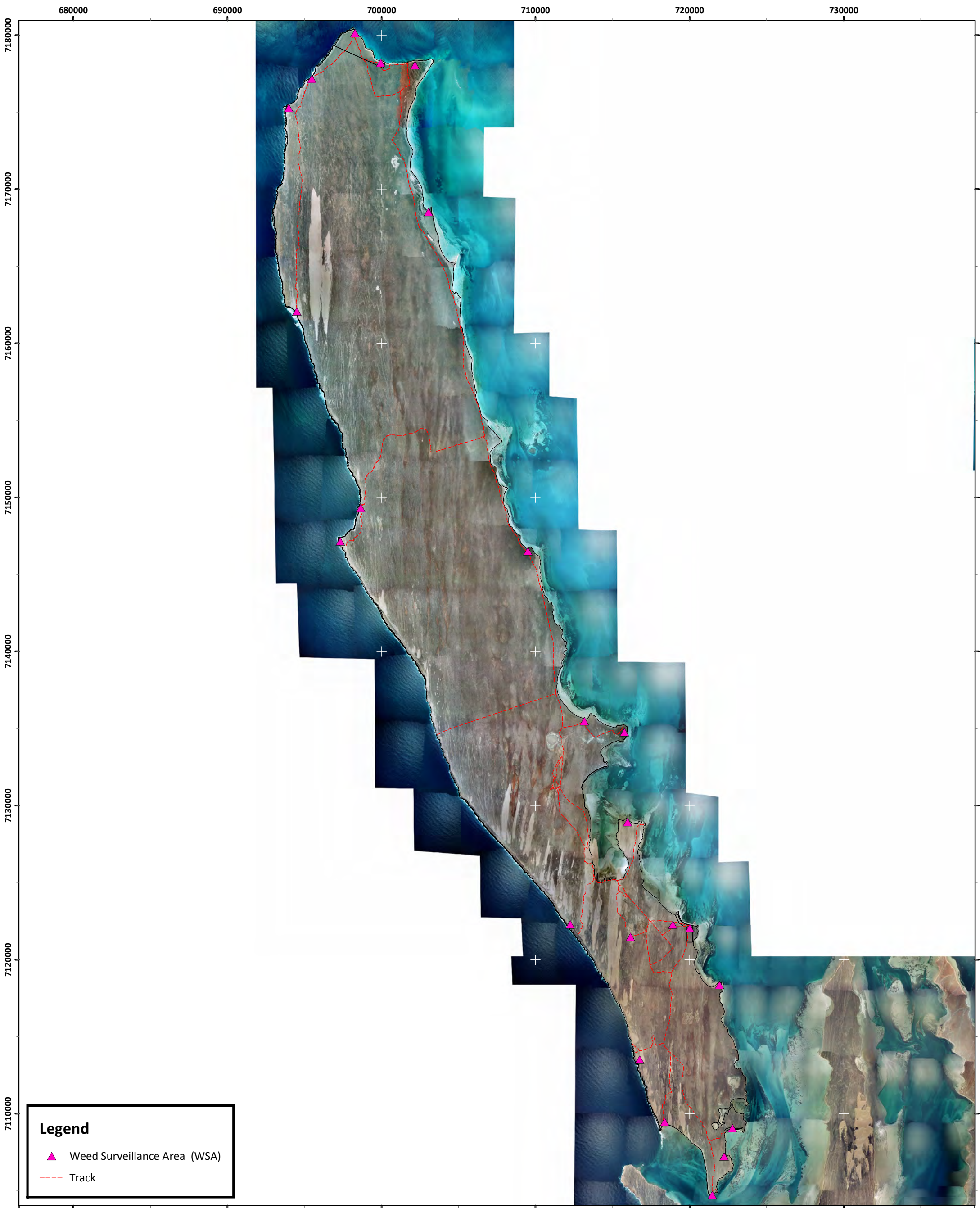
Applying an integrated approach, the methodology recommended in this Weed Management and Action Plan includes methods for the prevention, early detection (surveillance), control and monitoring of weed species. Monitoring is an additional management tool required to facilitate active adaptive management.

An IWM framework has been developed to allow adaptive responses to be undertaken in order to achieve management objectives, described in Table 5. Weed Surveillance Areas (WSAs), displayed in Figure 4 are surveyed to detect new weed introductions, whereas control and eradication is undertaken within Weed Management Areas (WMAs), Figure 5. Weed Monitoring Sites (WMSs), shown in Figure 6 are surveyed to record trends in weed levels.

Table 5: Weed management framework

Spatial unit	Delineation	Action	Potential outcome	Adaptive response
Weed Surveillance Area (WSA)	Asset-based: Informed by current and proposed development and tourist destinations listed by DEC (2012a) and may be updated as proposed developments progress. Delineated by applying a 50 m buffer to the boundary of existing and proposed disturbance features (Figure 4).	Survey areas to detect new weed introductions to the island and prevent further proliferation. Further, detect and control introductions of 'eradicate' and 'control' species.	Detection of new to island weed species, 'eradicate' species or 'control' species.	Weed species rated to assess feasibility of control. If rating dictates 'eradicate' or 'control' action the weed data informs the delineation of a WMA within the WSA.
Weed Management Area (WMA)	Species-led: the recorded location of 'eradicate' and 'control' priority species with a 25 m buffer (Figure 5).	Undertake control of known populations of 'eradicate' and 'control' species. Conduct opportunistic surveillance to detect proliferation of weed species and introductions of new species.	New occurrence of the 'eradicate' or 'control' species.	Weed data informs a new WMA or an increase in the area of current WMA.
			Proliferation of existing population.	Weed data informs an increase in the area of current WMA. New control methods are explored
			Detection of new to island weed species or a different 'eradicate' or 'control' species.	Weed species rated to assess feasibility of control. If rating dictates 'eradicate' or 'control' action the weed data informs the delineation of a WMA within the WSA.
Weed Monitoring Site (WMS)	Old infrastructure locations where disturbance has been removed and weed levels delineated using aerial photography (Figure 6).	Undertake surveys to identify trends of 'monitor' species. Conduct opportunistic surveillance to detect new weed introductions and new occurrences of 'eradicate' and 'control' species.	Detection of new to island weed species, 'eradicate' species or 'control' species.	Weed species rated to assess feasibility of control. If rating dictates 'eradicate' or 'control' action the weed data informs the delineation of a WMA within the WSA.
	Ecologically sensitive areas under potential threat from weed ingress.	Define ecologically sensitive areas that are potentially threatened by weed ingress.	Creation of weed monitoring sites to assess weed trends in ecologically sensitive areas.	Allocation of resources to protect ecologically sensitive areas.

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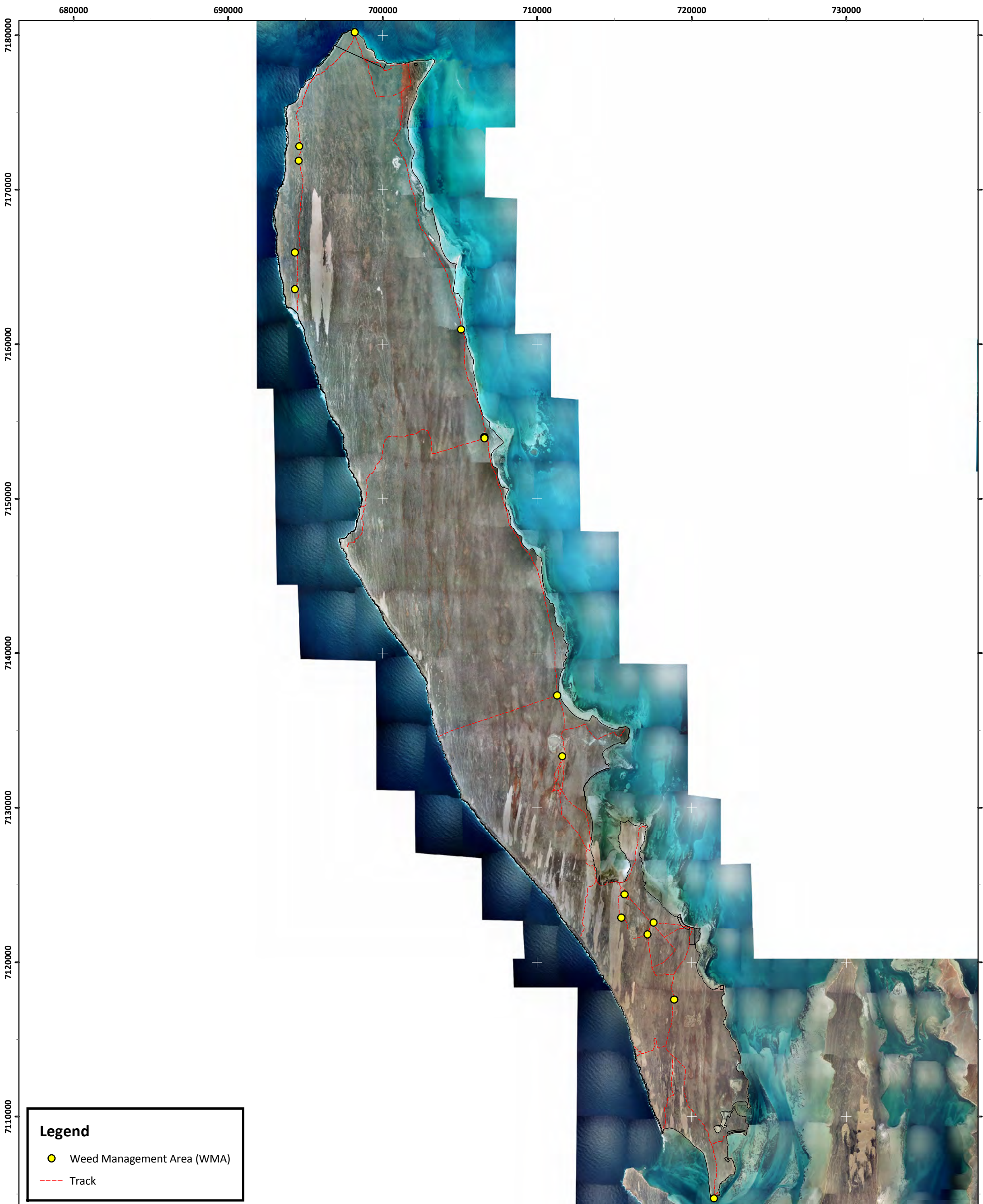
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Figure 4: Weed Surveillance Areas



Author: S. Moore	Date: 20-11-2012
Drawn: Y. Hua	15206-12FMV1Rev0_121120_Figure_4

Datum: GDA 1994
 Projection: MGA Zone 49



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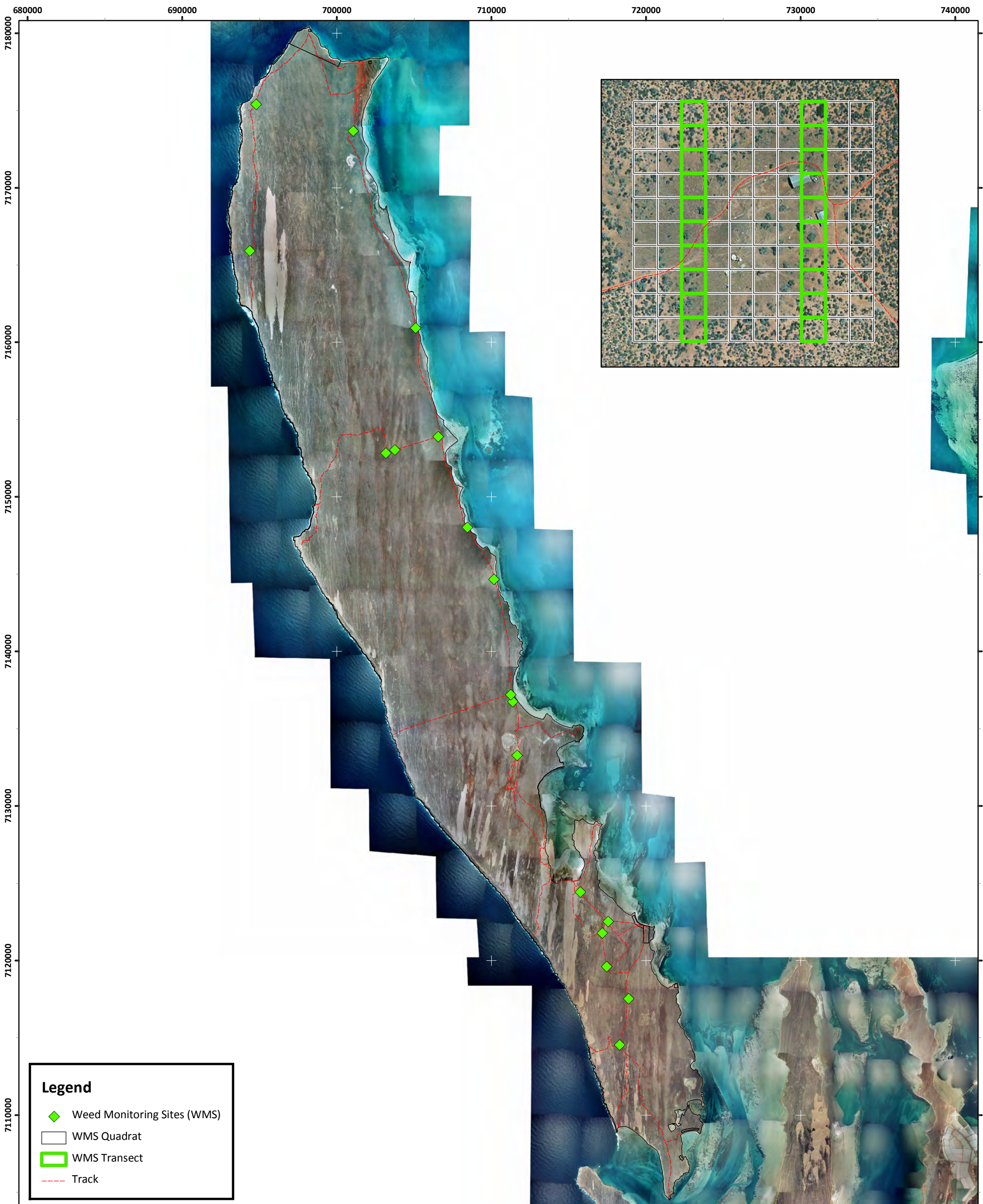
Figure 5: Weed Management Areas



Author: S. Moore	Date: 20-11-2012
Drawn: Y. Hua	15206-12FMV1Rev0_121120_Figure_5

Datum: GDA 1994
 Projection: MGA Zone 49

Metres



Legend

- ◆ Weed Monitoring Sites (WMS)
- WMS Quadrat
- WMS Transect
- Track

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Figure 6: Weed Monitoring Sites



Author: S. Moore	Date: 20-11-2012
Drawn: C. Smith	15206-12FMV1Rev0_121120_Figure_6

Datum: GDA 1994
 Projection: MGA Zone 49

0 2,500 5,000 10,000 15,000 Metres

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5.1 Strategies

5.1.1 Prevention

Dirk Hartog Island has a natural water barrier. However there are a multitude of pathways and entry points that provide possible introduction opportunities for new weed species. Boat access and general tourism to Dirk Hartog Island is likely to increase over time with the planned development of private tourism facilities and the establishment of permanent DEC operations on the island. A significant threat to the natural values of Dirk Hartog Island is from DEC and associated personnel, other landholders and visitors bringing weed seeds and propagules ashore. DEC personnel should refer to the quarantine and hygiene measures outlined in the final draft Dirk Hartog Island Biosecurity Plan (Astron 2012a) and the DEC Biosecurity Protocols.

Thorough hygiene measures are applicable to all actions undertaken by DEC and associated personnel and for all species targeted in this Weed Management and Action Plan. Quarantine and hygiene measures outlined in the Biosecurity Plan (Astron 2012a) should be adhered to by DEC for all personnel, vehicles, machinery and equipment operating on Dirk Hartog Island.

Future developments on Dirk Hartog Island will increase movement of equipment and personnel between the mainland and the island, increasing the risk of introducing new weed species. A weed quarantine and hygiene procedure will need to be incorporated into development proposals.

Introduced flora can be spread via seed movement on the wind or in soil, attachment of sticky or hairy seeds to animals, or movement of vegetative matter by vehicles, boats and equipment. To prevent new weed introductions to the island thorough inspection for weed seeds and propagules prior to departure should be undertaken on all DEC transport vessels and equipment. Further, on-island inspection and cleaning will assist in limiting the spread of current weeds. The anticipated increase in tourist levels associated with future developments may lead to further disturbance in areas of high activity. Disturbance is the main contributing factor in weed germination and proliferation and it is recommended that DEC focus their efforts on minimising future disturbance and degradation.

Weed hygiene recommendations are listed below:

- mainland pre-departure inspection and cleaning of transport vessels, equipment and machinery
- on island inspection and cleaning of equipment, vehicles and machinery
- thorough inspection and cleaning of personnel and equipment post weed control
- personal inspection and cleaning of clothing and personal protective equipment
- track inspection and maintenance
- camp inspection and maintenance, including the installation of permanent drop toilets and regular waste management.

Any environmental impact assessment associated with ground disturbance or construction activities should include an assessment of the risk of introducing or spreading weeds.

Conducting surveillance in designated WSAs and opportunistically within WMAs and WMSs will determine the efficacy of weed hygiene measures, except for those weed species established through natural movement (i.e. wind and seabirds).

5.1.2 Control and Eradication

Controlling weeds requires application of cultural, biological or chemical measures aimed at reducing the abundance or extent of a weed species. Eradication aims to completely remove the priority weed from the island, with no further re-occurrences over a long time period. Eradication is dependent on a low probability of reintroduction, and depending on the seed store present and duration of seed viability, may be difficult to demonstrate over the five year timeframe of this Weed Management and Action Plan.

A combination of cultural and chemical control measures should be applied for 'eradicate' and 'control' weed species, displayed in Table 6.

Table 6: Weed control measures for integrated weed management.

Category	Technique	Description	Prerequisite
Cultural	Manual removal	Manual removal involves removal of weeds from infested areas by hand. Manual removal can be time and labour intensive and may only be practical for individual plants or small infestations. However manual removal is the most effective option for reducing the impact of seeding plants. When used to progress an 'eradicate' objective it is important that all flowers and seed heads are collected and disposed of responsibly to reduce the risk of dispersal and regeneration.	Experienced personnel
	Mechanical removal	Mechanical removal, such as tillage, grading or slashing, involves removal of weeds (or prevention of seed set) from infested areas using machinery. Mechanical removal is an effective option for controlling large areas of weeds and in particular woody weeds. It is also an effective option for digging and deep burial of small areas of weeds. e.g couch.	Experienced personnel, Suitable machinery (e.g. dozers, mowers/slathers).
Chemical	Herbicide Application	Chemical treatment involves the application of herbicide directly to a weed plant or areas of weed infestation. Chemical treatment with herbicides is recognised as a cost effective method for the control of weeds. Effective chemical treatment requires that herbicide application: <ul style="list-style-type: none"> • is undertaken using the appropriate rate specified by the label and at the appropriate growth stage; • achieves an adequate coverage; and • is timed to optimise uptake and effectiveness. 	Experienced personnel, Pesticide Licence Department of Health (WA)

5.1.3 Risk Assessment

New weed species to Dirk Hartog Island will be cross referenced against the databases presented in Table 7 to determine applicable policy classifications. The priority of new weed species will be determined using weed risk matrices provided by DEC (Astron 2012b) based on an assessment of Invasive Plant Prioritisation Process (IPPP) (DEC 2008a) variables assessed at an island scale (Astron 2012c).

Table 7: Details of database searches for weed risk assessment.

Database Name	Search Focus	Search Area
FloraBase (WA Herbarium 2012)	Alien species	Western Australia
Environmental Weed List - Midwest Region (DEC 2008a)	Environmental weeds IPPP rating	Midwest Region
Declared Plants Gazette (DAFWA 2012)	Declared Plants	Western Australia and Shire of Shark Bay
Weeds Australia (2012)	WoNS	Australia
Australian Government (2012a, 2012b)	National Environmental Alert List and Sleeper Weeds.	Australia

5.2 Actions

5.2.1 Surveillance

The objective of surveillance within a WSA is to identify and eradicate new weed introductions to the island and prevent further proliferation. Surveillance will also detect any new occurrences of 'eradicate' and 'control' priority species. Further detail is provided in the Action Plan (Appendix C).

WSAs provide a spatial unit against which management objectives can be measured and evaluated. The entire WSA is systematically traversed using a handheld GPS or trimble unit to navigate the boundary and record weed data. A Weed Record Point (WRP) (refer to Section 5.3) will be recorded in the event a new weed introduction and 'eradicate' or 'control' species is detected. Photographic evidence, specimen collection and control will immediately follow.

WSAs are dynamic areas in that the detection of a weed species may lead to the delineation of a new WMA within the WSA if the weed species is rated as feasible to control. The area outside the new WMA will remain a WSA for continued surveillance.

Surveillance can also be undertaken opportunistically outside designated WSAs, WMAs and WMSs and is also implemented in conjunction with control at WMAs and monitoring at WMSs. Further, dedicated surveillance of seabird rookeries should be carried out as they are a potential natural vector for weed seed dispersal, especially that of ice plant.

Preparation and use of identification guides for all island users.

5.2.2 Control

The objective of weed control within a WMA is to reduce or eradicate the population of 'eradicate' and 'control' priority species contained within it. The Action Plan presented in Appendix C provides the location of WMAs and recommended control methods.

WMAs provide a spatial unit against which management objectives can be measured and evaluated. Prior to control of a weed species, data will be recorded and a photograph taken to provide temporal comparisons of the effectiveness of control measures. A WRP is recorded every 5 m and for every separate weed population detected within the WMA. Further, the spatial extent will be measured for each population.

A WMA is a dynamic area that can increase in size upon detection of new weed populations or spread of the previously recorded population. Weed data previously collected will inform the

boundary of the WMA upon the next scheduled inspection. Opportunistic weed surveillance is also conducted within WMAs and detection of a new introduction to the island or WMA may lead to the delineation of a new WMA.

All WMAs are subject to follow up audits to ensure the efficacy of control methods. Visual audits should be carried out no earlier than two weeks after control has been undertaken.

5.2.3 Monitoring

The objective of monitoring within a WMS is to identify and analyse temporal trends within and across sites to determine if removal of disturbance associated with grazing has an impact on weed levels at the selected sites. Further detail for WMSs and the selected 'monitor' species is provided in the Action Plan (Appendix C).

WMSs consist of a single 250 m x 250 m quadrat, overlaid with a 25 m x 25 m grid cell vector. Sites are surveyed by selecting a pair of 25 m x 250 m transects, which in itself are viewed as consisting of 10 contiguous 25 m x 25 m cells. Transects run parallel to each other in either a north-south or east-west orientation, based on the best fit for each WMS. The third and eighth 25 m grid cell from the boundary of the quadrat signifies the start point of each transect.

Transects are to be surveyed systematically using a handheld GPS or Trimble unit to navigate and record WRPs for all 'monitor' species encountered in each 25 m x 25 m grid cell. A photographic monitoring point will be established to provide a visual record of temporal weed trends. Opportunistic WRPs will be collected in the event a new weed introduction to the island or a new occurrence of 'control' or 'eradicate' species is detected. Detection may lead to the delineation of a new WMA.

The recorded locations of the individuals of lupin and wild radish should be continually monitored to detect any re-emergences from a remaining seedbank.

5.2.4 Education and Awareness

The early detection of weed species is critical to prevent weed establishment and proliferation. There are many tools available to DEC personnel, such as the Weed Alert List (Appendix B) and Weed Fact sheets (Appendix D), to increase knowledge, identification skills and early detection. Clear dissemination of information in high activity areas will inform island visitors of current weed issues and provide them with the knowledge to contribute to management objectives. A list of recommended educational tools is provided in Table 8.

Table 8: Educational tools to increase knowledge of the weed status of Dirk Hartog Island.

Tool	Information Provided	Distribution Source
Weed Alert List	List of weed species recorded in the Shire of Shark Bay, but not recorded on Dirk Hartog Island. All species on this list have the potential to be introduced to the island. DEC personnel need to be vigilant in identifying any occurrences of these species.	<ul style="list-style-type: none"> • Provided in Appendix B • DEC island personnel
Weed Fact Sheets	Description and photographs of each of the 13 priority species to aid in detection and identification.	<ul style="list-style-type: none"> • Provided in Appendix D • DEC island personnel
Information posters	Display relevant information for tourists to be aware of current weed issues and management actions.	<ul style="list-style-type: none"> • DEC signage at checkpoints at all major entry points. • Camp sites

Tool	Information Provided	Distribution Source
Interactive tourist information centres	Proposed by DEC, these centres should provide relevant information on current weed issues and management actions. The centres should be interactive and educational, to allow tourists the opportunity to contribute to weed management and provide an opportunity for reporting weeds.	Proposed locations are Cape Ransonnet, DEC operations base at Herald Bay and Cape Inscription

5.2.5 Timing

As a guideline, weed control, surveillance and monitoring should be undertaken at a time of year when weeds are actively growing and are easily detectable in the field. For the Shire of Shark Bay area, the optimal timing is between May and August, when rainfall is historically at its highest for the year. Optimal control action timing for 'eradicate' and 'control' species will vary depending on their different life forms. Recommended timing for action for each species is presented in the Action Plan (Appendix C).

Recommended scheduling for weed control, surveillance and monitoring is:

- control - up to four times per year, as required to prevent seed set, at regular intervals over the high rainfall period
- surveillance - twice per year
- monitoring - annually.

5.3 Data Collection and Management

Data capture requirements should ideally be undertaken using the Weed Record Point (WRP) standardised method. A single WRP is recorded for the densest occurrence (highest foliar cover) of each weed species in a 5 m x 5 m area. The WRP data will be captured via handheld GPS, Trimble unit or recorded manually using WRP field data sheets. For each WRP the following attributes should be recorded:

- recorder name
- survey date
- eastings and northings
- species
- number individuals (Count 1 -10, then standard categories of 15; 20; 25; 50; 75; 100; 100; 250; 500; 1000; 2500 and 5000)
- foliar cover (per cent) (Standard categories <5%, 5-30%, 30-75% and >75%)
- specimen id number
- comments
- photographic records should be collected as required.

As an alternative to the WRP method, data collection should comply with DEC's Standard Operating Procedure (SOP) No.:22.1 (Brown et al. 2011).

WRP data collected from all WMAs, WSAs and WMSs will be entered into a dedicated database in a format consistent with DEC file management SOP No: 1.4 (Moller 2009). Data will be subjected to a series of quality assurance checks including:

- species to be verified by a botanist
- confirmation of positional accuracy of weed record point coordinates by field personnel or through comparison with track log data.

To assist in data interpretation, weed data should be contrasted with data on meteorological conditions provided by the Bureau of Meteorology (BoM 2012).

5.3.1 Control and Surveillance Data Analysis

Interpretation of data collected from WMAs will determine the effectiveness of weed control activities. A management response will be implemented if data indicates that control techniques are not reducing the population size of 'eradicate' and 'control' species.

Interpretation of data collected from WSAs will determine the effectiveness of prevention techniques. A management response will be required if new introductions to the island are detected or occurrences of 'eradicate' and 'control' species are detected.

To assist in data interpretation, weed data should be contrasted with data on meteorological conditions provided by the Bureau of Meteorology (BoM 2012).

5.3.2 Monitoring Site Data Analysis

Mean values and 95% confidence intervals for weed species frequency per unit area will be calculated with data collected from WMS transects, using standard formulae for systematic sampling designs. Temporal trends in each 'monitor' weed species distribution, abundance and cover may then be determined through comparison of mean values and 95% confidence intervals overtime.

To assist in data interpretation, weed data should be contrasted with data on meteorological conditions provided by the Bureau of Meteorology (BoM 2012).

5.3.3 Effort

The output of all weed control, surveillance and monitoring activities undertaken must be recorded, including at a minimum:

- date (commencement and completion)
- participants
- task description
- location
- effort (accumulated hours per person, resources)
- limitations (access constraints, detectability)
- data links (GIS data, excel files, photographs etc.).

6 Implementation

6.1 Roles and Responsibilities

All DEC personnel, including contract staff employed by DEC, volunteers and other researchers have an important role in the successful implementation of this Weed Management and Action Plan, outlined in Table 9.

Table 9: DEC roles and responsibilities for the Dirk Hartog Island Weed Management and Action Plan.

Role	Responsibility
DHI Management Committee	<p>Provide direction and guidance on all aspects of the Dirk Hartog Island Restoration Strategic Plan. The committee shall report to the Director of Nature Conservation to the Director General and consist of the;</p> <ul style="list-style-type: none"> • Project Manager (Chair); • Science Division representative (Project Leader Fauna Conservation); • Science Division representative (Cat project); • Regional Manager Midwest or delegate; • Regional Leader PVS Midwest; • District Manager Shark Bay; • District Nature Conservation Coordinator; and • Project Officer (Executive Officer).
DHI Project Manager	<ul style="list-style-type: none"> • Oversees the delivery of weed control, surveillance and monitoring. • Co-ordinates flora and fauna restoration activities and the education and awareness program. • Provides support and resources for implementation of activities and programs. • Reviews and updates the design of the Weed Management and Action Plan
DHI Project Officer	Provides day to day supervision of and/or undertakes weed management activities.
Other DEC staff, volunteers, contractors/researchers	Awareness and acceptance of Weed Management and Action Plan. Carry out weed management activities in adherence to protocols implemented by DEC.

6.2 Stakeholder Consultation

Dirk Hartog Island has a number of stakeholders and landowners and effective communication and understanding of responsibilities will assist in the successful implementation of this Weed Management and Action Plan. Table 10 outlines the key partners and stakeholders and their role in communication.

Table 10: Communication priorities for partners and stakeholders.

Partners/Stakeholders	Role	Delivery mechanism
Landowners, lessees and private operators	Awareness of weed issues and DEC objectives and communication within their operations. Voluntary involvement in weed management activities.	<ul style="list-style-type: none"> Dissemination of communication media such as brochures and fact sheets.
Shire of Shark Bay	Support the communication and promotion of the Weed Management and Action plan in the broader community. Voluntary involvement in weed management activities.	<ul style="list-style-type: none"> Tourist and contractor information dissemination. Consideration of signage at launching facilities.
Tourists/Visitors	Awareness of weed issues and DEC objectives. Co-operate with DEC personnel and procedures whilst on island.	<ul style="list-style-type: none"> Provision of information at appropriate contact points.

6.3 Weed Action Plan

A total of 15 species were selected from the ranking procedure outlined in the Baseline Weed Survey (Astron 2012b) and used to inform a Weed Action Plan, provided in Appendix C. The Weed Action Plan clearly outlines the location of WMAs, WSAs and WMSs and agreed management methods, including control methods to be utilised for 'eradicate' and 'control' priority species and the required resources. A brief summary of further information provided in the Action Plan is listed below:

- WMAs, WSAs and WMSs site names, locations and target species
- control treatment methods
- scheduling and resources.

6.4 Work Approvals

Under the *Health (Pesticides) Regulations 2011*, any contract company employed to undertake weed control on the island is required to be registered as a Pest Management Business with the Department of Health (DoH). The technician undertaking on-ground weed control activities must hold a current WA Pest Management Technician Licence (DoH 2012).

6.5 Constraints

There are challenges which present several limitations and obstacles that will potentially impact on the effectiveness of this plan and the strategies contained therein:

- Dirk Hartog Island is not a single tenure island and all island partners and stakeholders must develop a cohesive and collaborative team approach with a consistent, supportive and unwavering attitude to all strategies and biosecurity programs.
- The island has many entry points and pathways for potential invaders.
- There has not been a comprehensive systematic biological survey of Dirk Hartog Island. It is an important principle of successful island biosecurity that an inventory is made of what is present, both native and introduced flora. Whilst the Baseline Weed Survey (Astron 2012b)

adequately recorded the occurrence of weed species along main access tracks, a large area of the island remains inaccessible and therefore unsurveyed. Further, the status of native vegetation is unknown and the impacts of weed species on the native flora cannot be identified. This also includes adequate vegetation mapping, which is required to analyse any correlation of specific habitats and the occurrence of weeds.

- The large size of the island and accessible eastern coastline will limit the effectiveness of policing all entries and also make broad scale monitoring difficult.

As is common with all weed management activities, there is a risk that current and planned eradications may not be successful.

Weed management outcomes may be limited by environmental constraints, such as geography or climate. However economic constraints, such as inadequate resourcing, and social constraints such as limited expertise or capacity, are also commonly recognised as having a significant bearing on the success of integrated weed management programs. Suggested actions to manage a selection of potential environmental, economic and social constraints to weed management are presented in Table 11.

Table 11: Constraints to effective integrated weed management programs.

Category	Constraint	Suggested Action
Geography	Unsafe or difficult to access terrain	Reduce management level according to rationalised priority.
Climate	Limited access due to flooding/water logging	Recommence weed control and monitoring when safe to do so.
	Difficulty coordinating control and monitoring to coincide with weed expression and proliferation	Consider a combination of rainfall triggered and time period triggered management responses. Maintain dedicated weed control teams with the ability to respond rapidly and implement an annual program schedule.
Economy	Insufficient resources	Adjust the management level according to rationalised priority.
		Review the weed management budget allocation or partitioning of budget allocation according to strategic objectives and targets.
Social	Inability to identify weed species	Undertake training or develop resources to increase personnel awareness of weed risk and identification.
		Engage qualified and experienced external contractors.
	Limited availability of qualified contractors	Maintain internal, or dedicated external contractor/s, and/or weed control teams.

7 Evaluation and Reporting

7.1 IUCN Monitoring and Evaluation Procedure

The WMP is to be evaluated using a procedure developed by the International Union for the Conservation of Nature (IUCN) (Figure 7). The IUCN procedure incorporates six elements ‘review’, ‘planning’, ‘inputs’, ‘process’, ‘outputs’ and ‘outcomes’ that are applied in an iterative cycle providing an adaptive management system (Hockings et al. 2006). The evaluation procedure is based on the methodology known as Plan-Do-Check-Act (PDCA) as described in AS/NS ISO 14001:2004 (Standards Australia 2007).

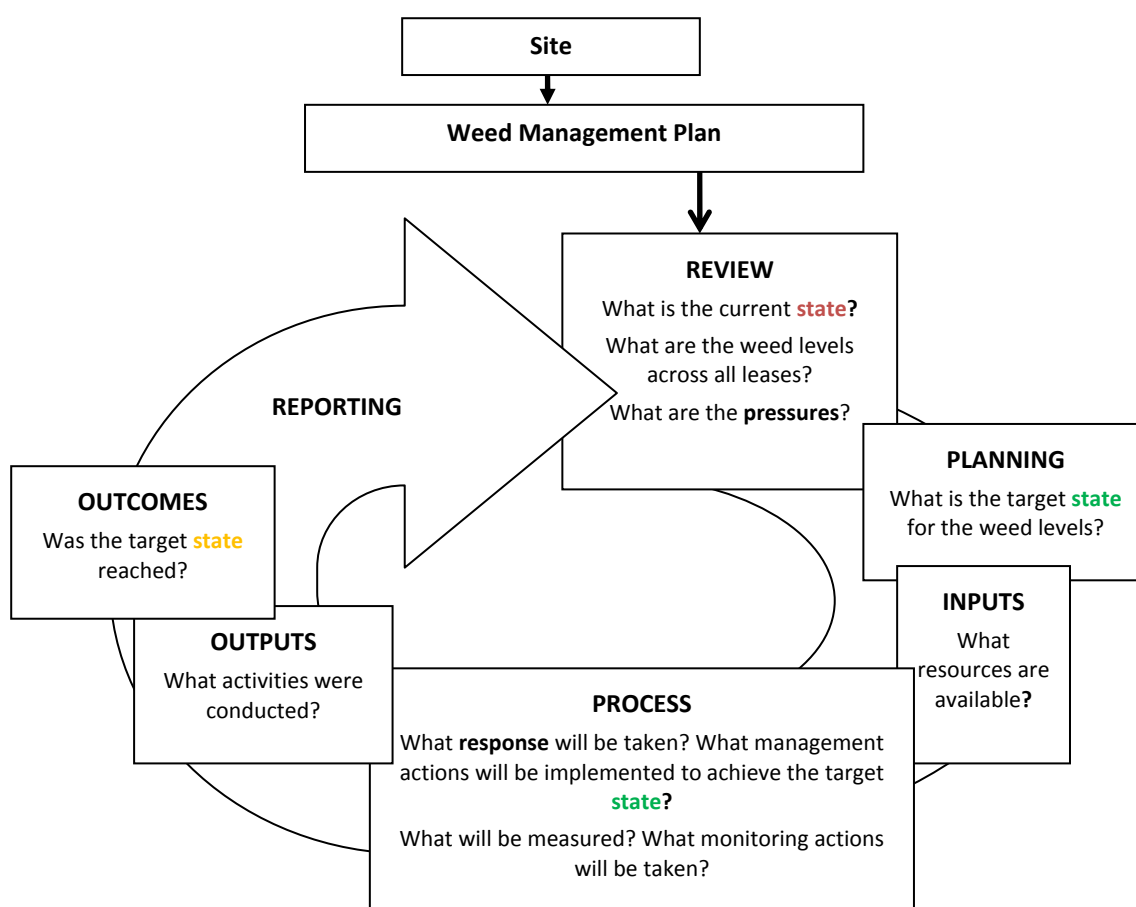


Figure 7: Schematic flowchart of the IUCN Monitoring and Evaluation framework proposed for the Dirk Hartog Island Weed Management and Action Plan (adapted from Hockings et al. 2006).

Due to the dynamic nature of weed proliferation, the biology of typical weed species and the variable nature of climate within an arid location like Dirk Hartog Island, a five year period is considered an appropriate evaluation timeframe for the Weed Management and Action Plan. However, to ensure adaptive management, evaluation of performance should occur annually within this five year evaluation period. This will allow for adjustment where required, such as revision of management triggers, priority species or objectives should new events, such as new weed proliferations occur.

7.2 Key Performance Indicators

Key Performance Indicators (KPIs) to achieve weed management objectives are outlined in Table 12.

Table 12: Dirk Hartog Island Weed Management Key Performance Indicators.

Objective	Weed Species	Key Performance Indicator (KPI)	Timeframe
Prevention	New introductions to the island	No new weed introductions	On-going
		No proliferation of new weed introductions	On-going
Eradicate	Couch (<i>Cynodon dactylon</i>) Castor oil plant (<i>Ricinus communis</i>) Japanese pepper (<i>Schinus terebinthifolius</i>)	75 % reduction of 'eradicate' species within WMAs.	Within 2 years
		100 % eradication of 'eradicate' species within WMAs	Within 5 years
		No re-occurrences of 'eradicate' species	On-going
		No new occurrences of 'eradicate' species	On-going
Control	Ice plant (<i>Mesembryanthemum crystallinum</i>) Fourleaf allseed (<i>Polycarpon tetraphyllum</i>) False sowthistle (<i>Reichardia tingitana</i>)	50 % reduction of the extent of 'control' species within WMAs.	Within 2 years
		Minimum 75 % reduction of the extent of 'control' species within WMAs.	Within 5 years
		No spread of 'control' species within WMAs.	On-going
		No new occurrences of 'control' species	On-going
Monitor	Mediterranean turnip (<i>Brassica tournefortii</i>) Red brome (<i>Bromus rubens/madritensis</i>) Buffel grass (<i>Cenchrus ciliaris</i>) Birdwood grass (<i>Cenchrus setiger</i>) Pimpernel (<i>Lysimachia arvensis</i>) Rough cat's tail (<i>Rostraria pumila</i>) Common sowthistle (<i>Sonchus oleraceus</i>)	Annual completion of weed data collection at WMSs. Temporal trends identified for 'monitor' species within and across WMSs	5 years

7.3 Performance Measures

Table 13 outlines the measurable attributes that will determine whether KPIs are being met.

Table 13: Dirk Hartog Island Weed Management Performance Measures.

Objective	Measure	Indicator	Performance criteria
Prevention	Presence	Weed Record Point	Species is assessed as new to Dirk Hartog Island based on comparison to the species inventory for Dirk Hartog Island (Astron 2012b). DHI Project Manager will undertake a risk assessment before determining whether the species will be categorised as an 'eradicate' or 'control' species.
Eradicate and Control	Presence	Weed Record Point, Photograph	Ongoing detection of a species within WMA. Visual comparison and audit of efficacy of control method.
	Cover/Abundance	Measure of foliar cover/Number of plants	Change in foliar cover and/or number of plants recorded for a weed species within a WMA compared to previous record.
	Extent	Size of WMA	Change in distribution (extent of occurrence) for a weed species within a WMA.
	Distribution	Count of WMAs	Change in count of WMAs for a weed species
Monitor	Distribution	Mean occurrence within WMS Count of WMSs within which species was recorded.	Change in distribution (extent of occurrence) for a weed species within a WMS Change in total number of WMSs within which the species was recorded.
	Abundance	Mean abundance within WMS.	Change in mean abundance for a weed species within a WMS
	Cover	Mean cover of species within WMS.	Change in foliar cover recorded for a weed species within a WMS

7.4 Reporting

7.4.1 Management Response

The Dirk Hartog Island Project Manager and/or Project Officer are responsible for initiating a management response to the following situations:

- Detection of a new weed species to the island or a new occurrence of an 'eradicate' or 'control' species.
- Visual weed audits detect ineffective control methods.

7.4.2 Annual Reporting

The objective of annual reporting will be to present the findings of weed control, surveillance and monitoring against the objectives of the Weed Management and Action Plan to the DHI Management Committee. The recommended reporting framework and information to include is outlined below:

- Introduction:
 - Brief description of weed management activities completed in the reporting year.
 - Summary of meteorological conditions during reporting year.
- Methods:
 - Summary of methods used during weed management activities.
- Outputs:
 - Summary of effort dedicated to weed management activities.
 - Number of hours of weed surveillance completed.
 - Number of hours of weed control completed.
 - Number of hours of weed monitoring completed.
 - Area of treatment completed for 'eradicate' and 'control' species.
 - Number of populations treated.
- Outcomes:
 - Summary of results of weed management activities, including:
 - detection of new introductions to the island or new occurrences of 'control' or 'eradicate' species within WMSs and outside
 - recorded species distribution, abundance and cover in WMAs
 - changes in species distribution, abundance and cover in WMAs
 - period of time since observation of 'eradicate' species in WMAs
 - temporal trends within WMSs
 - adaptive management responses initiated.
- Discussion:
 - Analysis of the progress of the weed management program towards achieving the objectives of the Weed Management Plan.

- Recommendations:
 - Identify improvement opportunities and adaptive management responses if objectives are not being met.

As data is accumulated, progressive monitoring reports may include temporal analysis of trends in weed occurrence.

7.5 Term of the Weed Management Plan

This Weed Management and Action Plan will have a term of five years duration. Upon expiry of this plan, a report will be produced assessing the fulfilment of the objectives outlined in Section 4 and KPIs presented in Table 12. Following this report, weed management objectives and methods will be reviewed and the management program updated.

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Appendix A: List of Weed Species and their IPPP Rating

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Table A.1: Weed species historically recorded on Dirk Hartog Island (Burbidge and George 1978; DEC 2012a) and their associated IPPP ranking (Astron; 2012c; DEC 2008a).

Scientific name	Common Name	Recorded in previous survey (Burbidge and George 1978)	Lodged in WA Herbarium (DEC 2012a)	Recorded in Baseline Weed Survey (Astron 2012b)	Invasive Plant Prioritisation Process (IPPP) Rating (Astron 2012c; DEC 2008a)		
					Ecological Impact*	Invasiveness#	Feasibility of Control^
<i>Agave americana</i>	Century plant			Y	L	S	H
<i>Arctotheca calendula</i>	Cape weed	Y	Y		H	R	L
<i>Asphodelus fistulosus</i>	Onion weed	Y		Y	M	R	L
<i>Avena barbata</i>	Bearded oat	Y	Y	Y	H	R	H
<i>Bidens bipinnata</i>	Bipinnate beggartick	Y	Y	Y	U	R	L
<i>Bougainvillea glabra</i>	Bougainvillea			Y	NOT ASSESSED		
<i>Brassica tournefortii</i>	Mediterranean turnip	Y	Y	Y	H	R	L
<i>Briza minor</i>	Shivery grass	Y	Y		U	R	H
<i>Bromus diandrus</i>	Great brome	Y	Y	Y	H	R	H
<i>Bromus rubens/madritensis</i>	Red brome			Y	H	R	L
<i>Bromus hordeaceus</i>	Soft brome	Y			U	S	H
<i>Cakile maritima</i>	Sea rocket	Y	Y	Y	U	R	L
<i>Cenchrus ciliaris</i>	Buffel grass	Y	Y	Y	H	R	H
<i>Cenchrus setiger</i>	Birdwood grass	Y	Y	Y	H	R	M
<i>Centaurea melitensis</i>	Maltese cockspur	Y	Y	Y	H	R	H
<i>Centaureum erythraea</i>	Common centauray			Y	L	R	L
<i>Cerastium glomeratum</i>	Mouse ear chickweed	Y			U	M	U
<i>Chenopodium murale</i>	Nettleleaf goosefoot	Y	Y	Y	L	R	U
<i>Cuscuta epithymum/planiflora</i>	Lesser dodder			Y	L	M	L

Scientific name	Common Name	Recorded in previous survey (Burbridge and George 1978)	Lodged in WA Herbarium (DEC 2012a)	Recorded in Baseline Weed Survey (Astron 2012b)	Invasive Plant Prioritisation Process (IPPP) Rating (Astron 2012c; DEC 2008a)		
					Ecological Impact*	Invasiveness#	Feasibility of Control^
<i>Cynodon dactylon</i>	Couch	Y	Y	Y	H	R	M
<i>Diplotaxis muralis</i>	Wall rocket	Y	Y	Y	L	S	H
<i>Ehrharta brevifolia</i>	Annual veldt Grass	Y	Y		U	R	L
<i>Ehrharta brevifolia var. cuspidata</i>	Veldtgrass		Y		U	R	L
<i>Ehrharta longiflora</i>	Annual veldt grass			Y	M	M	M
<i>Emex australis</i>	Doublegee	Y	Y	Y	L	R	H
<i>Erodium aureum</i>				Y	U	M	L
<i>Erodium cicutarium</i>	Common storksbill	Y	Y		L	R	L
<i>Helichrysum luteoalbum**</i>	Jersey cudweed		Y	Y	L	M	H
<i>Hordeum leporinum</i>	Barley grass	Y	Y	Y	U	R	H
<i>Hornungia procumbens</i>	Oval purse		Y		L	R	L
<i>Hypochaeris glabra</i>	Smooth cat's ear	Y	Y		U	R	L
<i>Juncus bufonius</i>	Toad rush	Y	Y		L	R	L
<i>Lolium loliaceum</i>	Stiff ryegrass	Y			U	R	H
<i>Lupinus cosentinii</i>	Lupin			Y	NOT ASSESSED		
<i>Lycopersicon esculentum</i>	Tomato			Y	L	S	H
<i>Lysimachia arvensis</i>	Pimpernel	Y	Y	Y	U	R	H
<i>Malva parviflora</i>	Marshmallow		Y	Y	L	S	H
<i>Malva pseudolavatera</i>		Y			NOT LISTED		
<i>Medicago minima</i>	Small burr medic			Y	L	S	M

Scientific name	Common Name	Recorded in previous survey (Burbridge and George 1978)	Lodged in WA Herbarium (DEC 2012a)	Recorded in Baseline Weed Survey (Astron 2012b)	Invasive Plant Prioritisation Process (IPPP) Rating (Astron 2012c; DEC 2008a)		
					Ecological Impact*	Invasiveness#	Feasibility of Control^
<i>Medicago polymorpha</i>	Burr medic	Y	Y	Y	U	R	U
<i>Melilotus indicus</i>		Y	Y	Y	U	M	U
<i>Mesembryanthemum crystallinum</i>	Ice plant			Y	H	M	M
<i>Musa acuminata/balbisiana</i>	Banana			Y	L	S	H
<i>Nicotiana glauca</i>	Tree tobacco	Y		Y	L	R	H
<i>Olea europaea</i>	Olive			Y	NOT ASSESSED		
<i>Orobanche minor</i>	Lesser broomrape		Y		U	R	L
<i>Oxalis corniculata</i>	Yellow wood sorrel	Y	Y		U	S	H
<i>Poa annua</i>	Annual winter grass	Y	Y		L	R	H
<i>Polycarpon tetraphyllum</i>	Four-leaf allseed	Y	Y	Y	L	M	U
<i>Polypogon monspeliensis</i>	Annual beardgrass		Y	Y	M	M	U
<i>Raphanus raphanistrum</i>	Wild radish			Y	NOT ASSESSED		
<i>Reichardia tingitana</i>	False sowthistle			Y	H	R	H
<i>Ricinus communis</i>	Castor oil plant	Y	Y	Y	H	M	H
<i>Rostraria cristata</i>	Annual cat's tail	Y	Y		U	U	U
<i>Rostraria pumila</i>	Rough cat's tail			Y	H	R	L
<i>Schinus terebinthifolia</i>	Japanese pepper			Y	H	M	H
<i>Silene gallica</i>	French catchfly	Y	Y	Y	L	R	U
<i>Silene nocturna</i>	Mediterranean catchfly			Y	M	R	L

Scientific name	Common Name	Recorded in previous survey (Burbridge and George 1978)	Lodged in WA Herbarium (DEC 2012a)	Recorded in Baseline Weed Survey (Astron 2012b)	Invasive Plant Prioritisation Process (IPPP) Rating (Astron 2012c; DEC 2008a)		
					Ecological Impact*	Invasiveness#	Feasibility of Control^
<i>Sisymbrium erysimoides</i>	Smooth mustard		Y		U	U	U
<i>Sisymbrium irio</i>	London rocket	Y		Y	U	U	U
<i>Sisymbrium orientale</i>	Indian hedge mustard	Y	Y	Y	U	U	U
<i>Solanum americanum</i>	Glossy nightshade	Y			U	R	H
<i>Solanum nigrum</i>	Blackberry nightshade		Y	Y	U	R	H
<i>Sonchus oleraceus</i>	Common sowthistle	Y	Y	Y	U	R	L
<i>Spergularia diandra</i>	Lesser sand spurry		Y		L	R	U
<i>Spergularia rubra</i>	Sand spurry	Y	Y		L	R	U
<i>Tamarix aphylla</i>	Athel tree			Y	U	U	U
<i>Urospermum picroides</i>	False hawkbit	Y	Y	Y	H	R	U

N.B. IPPP ratings for Midwest Region listed for weeds from previous surveys, Dirk Hartog Island ratings listed for weeds recorded solely during Baseline Weed Survey

** not listed as an alien on FloraBase (WA Herbarium 2012)

*Ecological Impact: H=high, M=moderate, L=low

#Invasiveness: R=rapid, M=moderate, S=slow

^Feasibility of Control: control costs (per ha) and duration

Appendix B: Weed Alert List

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Table B.1: Alert list of weed species recorded in the Shire of Shark Bay (WA Herbarium 2012) and not known to be present Dirk Hartog Island.

Family	Scientific name	Common name
Polygonaceae	<i>Acetosa vesicaria</i>	Ruby dock
Amaranthaceae	<i>Aerva javanica</i>	Kapok bush
Asteraceae	<i>Arctotheca calendula</i>	Cape weed
Papaveraceae	<i>Argemone ochroleuca</i>	Mexican poppy
Poaceae	<i>Avena ludoviciana</i>	
Poaceae	<i>Briza minor</i>	Shivery grass
Poaceae	<i>Cenchrus echinatus</i>	Burrgrass
Caryophyllaceae	<i>Cerastium glomeratum</i>	Mouse ear chickweed
Asteraceae	<i>Conyza bonariensis</i>	Flaxleaf fleabane
Scrophulariaceae	<i>Dischisma arenarium</i>	
Boraginaceae	<i>Echium plantagineum</i>	Paterson's curse
Poaceae	<i>Ehrharta brevifolia</i>	Annual veldt grass
Poaceae	<i>Ehrharta brevifolia</i> var. <i>cuspidata</i>	
Poaceae	<i>Ehrharta calycina</i>	Perennial veldt grass
Poaceae	<i>Eragrostis barrelieri</i>	
Geraniaceae	<i>Erodium cicutarium</i>	Common storksbill
Aizoaceae	<i>Galenis pubescens</i>	Coastal galenia
Asteraceae	<i>Hedypnois rhagadioloides</i>	Cretan weed
Asteraceae	<i>Helianthus annuus</i>	Sunflower
Brassicaceae	<i>Hornungia procumbens</i>	Oval Purse
Hypericaceae	<i>Hypericum perforatum</i>	St John's Wort
Asteraceae	<i>Hypochoeris glabra</i>	Smooth catsear
Cyperaceae	<i>Isolepis marginata</i>	Coarse club-rush
Juncaceae	<i>Juncus bufonius</i>	Toad rush
Poaceae	<i>Lamarckia aurea</i>	Goldentop
Poaceae	<i>Lolium loliaceum</i>	Stiff ryegrass
Fabaceae	<i>Lupinus cosentinii</i> *	Lupin
Solanaceae	<i>Lycium ferocissimum</i>	African boxthorn
Fabaceae	<i>Medicago truncatula</i>	Barrel medic
Onagraceae	<i>Oenothera drummondii</i>	Beach evening primrose
Orobanchaceae	<i>Orobanche minor</i>	Lesser broomrape
Oxalidaceae	<i>Oxalis pes-caprae</i>	Soursob
Poaceae	<i>Parapholis incurva</i>	Coast barbgrass
Passifloraceae	<i>Passiflora foetida</i>	Stinking passion flower
Poaceae	<i>Pentameris airoides</i>	False hairgrass
Poaceae	<i>Phalaris minor</i>	Lesser canary grass
Poaceae	<i>Poa annua</i>	Winter grass
Portulacaceae	<i>Portulca oleracea</i>	Purslane

Family	Scientific name	Common name
Brassicaceae	<i>Raphanus raphanistrum</i> *	Wild radish
Poaceae	<i>Rostraria pumila</i>	Rough cat's tail
Poaceae	<i>Schismus arabicus</i>	Araby grass
Poaceae	<i>Schismus barbatus</i>	Kelch grass
Brassicaceae	<i>Sisymbrium erysimoides</i>	Smooth mustard
Caryophyllaceae	<i>Spergularia diandra</i>	Lesser sand spurry
Caryophyllaceae	<i>Spergularia rubra</i>	Sand spurry
Asteraceae	<i>Verbesina encelioides</i>	Crownbeard

* Species recorded on the island during the Baseline Weed Survey (Astron 2012b) and removed.

Appendix C: Weed Action Plan

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**Dirk Hartog Island National Park
Weed Management and Action Plan (2013 - 2018)
Appendix C - Weed Action Plan**

November 2012

Prepared for
Department of Environment and Conservation



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Department of Environment and Conservation

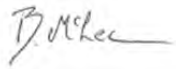
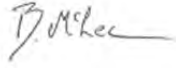
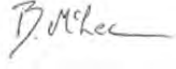
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1 Introduction

The Dirk Hartog Island Weed Action Plan (WAP) outlines the agreed objectives and methods for the management of identified high priority weed species within the Dirk Hartog Island National Park. The overarching aim of the document is to guide the planning and implementation of a weed management program which has been developed with the intention of achieving the goals and objectives of the Dirk Hartog Island Weed Management Plan (WMP).

The document is intended to be used by DEC personnel and/or contractors responsible for the planning and implementation of the weed management program. A pre-requisite of implementing all recommendations of the WAP is for all personnel to have read and understood the guidelines provided in the WMP.

2 Management Framework

2.1 Target Species

There were 49 weed species recorded on Dirk Hartog Island during the Baseline Weed Survey (Astron 2012b). These species were assessed according to the IPPP to identify the highest priority species for management (Astron 2012b). Fifteen species were identified as a priority for management and then further grouped according to management objectives identified in the WMP (Astron 2012a) (Table 1). Maps depicting the distribution of each of the priority species are presented in Figures C.1.1 - C.1.13.

Table 1: Priority weed species recommended for management on Dirk Hartog Island.

Scientific Name	Common Name	Ecological Impact	Objective
<i>Cynodon dactylon</i>	Couch	High	Eradicate
<i>Ricinus communis</i>	Castor oil plant	Moderate	Eradicate
<i>Schinus terebinthifolius</i>	Japanese pepper	High	Eradicate
<i>Lupinus cosentinii</i>	Lupin	Moderate	Eradicate
<i>Raphanus raphanistrum</i>	Wild Radish	High	Eradicate
<i>Mesembryanthemum crystallinum</i>	Ice plant	High	Control
<i>Polycarpon tetraphyllum</i>	Fourleaf allseed	Low	Control
<i>Reichardia tingitana</i>	False sowthistle	High	Control
<i>Brassica tournefortii</i>	Mediterranean turnip	High	Monitor
<i>Bromus rubens/madritensis</i>	Red brome	High	Monitor
<i>Cenchrus ciliaris</i>	Buffel grass	High	Monitor
<i>Cenchrus setiger</i>	Birdwood grass	Moderate	Monitor
<i>Lysimachia arvensis</i>	Pimpernel	High	Monitor
<i>Rostraria pumila</i>	Rough cat's tail	Moderate	Monitor
<i>Sonchus oleraceus</i>	Common sowthistle	High	Monitor

2.2 Weed Management Areas

A species-led approach was used to delineate WMAs for the six species selected by the prioritisation process for eradication or control, based on data recorded during the Baseline Weed Survey (Astron 2012b). The delineation of WMAs was based on the occurrence of 'eradicate' or 'control' species recorded during the Baseline Weed Survey (Astron 2012b). The locations and target species of each WMA (excluding freehold land) is presented in Table 2 and Figure C.2.

Table 2: Weed Management Area target species and locations on Dirk Hartog Island.

Target Species	WMA Name	Easting (Datum: GDA 1994 MGA Zone 49)	Northing (Datum: GDA 1994 MGA Zone 49)
<i>Cynodon dactylon</i> (Couch)	Couch WMA 1	718887	7117570
	Couch WMA 2	715664	7124386
<i>Ricinus communis</i> (Castor oil plant)	Castor oil plant WMA 1	694345	7165938
<i>Schinus terebinthifolius</i> (Japanese pepper)	Japanese pepper WMA 1	706603	7153913
<i>Mesembryanthemum crystallinum</i> (Ice plant)	Ice plant WMA 1	721453	7104696
	Ice plant WMA 2	717555	7122563
	Ice plant WMA 3	711642	7133309
	Ice plant WMA 4	711308	7137267
	Ice plant WMA 5	706593	7153977
<i>Polycarpon tetraphyllum</i> (Fourleaf allseed)	Fourleaf allseed WMA 1	706620	7153969
	Fourleaf allseed WMA 2	698217	7180191
	Fourleaf allseed WMA 3	694336	7163560
<i>Reichardia tingitana</i> (False sowthistle)	False sowthistle WMA 1	715464	7122877
	False sowthistle WMA 2	694616	7172794
	False sowthistle WMA 3	694586	7171871

One individual each of lupin and wild radish were recorded and consequently removed by Astron personnel during the baseline weed survey (Astron 2012b). The recorded locations of these two species are listed below and included in Figure C.2. These areas will need to be monitored for any new emergences from a possible seedbank.

- *Lupinus cosentinii* (lupin)

Eastings: 705095; Northings: 7160941

- *Raphanus raphanistrum* (wild radish)

Eastings: 717153; Northings: 7121800

2.3 Weed Surveillance Areas

Weed Surveillance Areas (WSAs) provide a spatial framework where introductions of new weed species to areas of high risk of introduction to the island can be detected and eradicated. The location of WSAs has been informed by assets such as current and proposed developments and tourist destinations listed by DEC (2012a). The weed species known to occur in each of the WSAs were recorded by Astron (2012b) during the Baseline Weed Survey. Dirk Hartog Island WSAs are presented in Table 3 and depicted in Figures C.3.1 -C.3.4.

Table 3: Weed Surveillance Area locations on Dirk Hartog Island.

Weed Surveillance Area	Weed Surveillance Area Location(s)	Map	Time Required per Survey - 2 personnel (hours)	Site	Site Name
WSA 1	DEC Operations Base at Herald Bay (including proposed Barge Landing)	Figure C.3.1	2	WSA 1a	DEC Headquarters
WSA 2	Existing/Proposed Development and Tourist Destinations	Figure C.3.2	28	WSA 2a	Cape Inscription (including Lighthouse & walk trails)
				WSA 2b	Turtle Bay Lookout (including walk trails)
				WSA 2c	Charlies Harbour
				WSA 2d	Quoin Bluff South (including walk trails)
				WSA 2e	Zuytdorp Cliff Lookout
				WSA 2f	Blowholes
				WSA 2g	Surf Point
WSA 3	Campsites	Figure C.3.3	38	WSA 3a	Mystery Beach
				WSA 3b	West Point
				WSA 3c	Urchin Point
				WSA 3d	Cape Levillain Bay
				WSA 3e	Withnell Point
				WSA 3f	Louisa Bay
				WSA 3g	Quoin Head
				WSA 3h	Notch Point
WSA 4	Current entry points to Dirk Hartog Island	Figure C.3.4	10	WSA 4a	Airstrip
				WSA 4b	Cape Ransonnet
WSA 5	Freehold/lease 50 m buffer zones	Figure C.3.5	16	WSA 5a	Sunday Island Bay (Lot 304)
				WSA 5b	Sunday Island Bay (Lot 305)
				WSA 5c	Homestead
				WSA 5d	Tumbledown Point
				WSA 5e	Rubbish Dump

2.4 Weed Monitoring Sites

Weed Monitoring Sites (WMSs) provide a spatial unit where the trends of weed populations of seven 'monitor' species at historical pastoral locations can be determined since disturbance has been removed. WMSs are primarily located at old stockyards and infrastructure on Dirk Hartog Island. WMSs are listed in Table 4 and depicted in Figure C.4.

Table 4: Weed Monitoring Site target species and locations on Dirk Hartog Island.

Weed Monitoring Species	Sites	Eastings (Datum: GDA 1994 MGA Zone 49)	Northings (Datum: GDA 1994 MGA Zone 49)
<i>Brassica tournefortii</i> (Mediterranean turnip) <i>Bromus rubens/madritensis</i> (Red brome) <i>Cenchrus ciliaris</i> (Buffel grass) <i>Cenchrus setiger</i> (Birdwood grass) <i>Lysimachia arvensis</i> (Pimpernel) <i>Rostraria pumila</i> (Rough cat's tail) <i>Sonchus oleraceus</i> (Common sowthistle)	WMS 1	718285	7114571
	WMS 2	718874	7117561
	WMS 3	717440	7119637
	WMS 4	717155	7121798
	WMS 5	717543	7122549
	WMS 6	715749	7124446
	WMS 7	711657	7133293
	WMS 8	711361	7136770
	WMS 9	711244	7137225
	WMS 10	710149	7144687
	WMS 11	708424	7148047
	WMS 12	703163	7152858
	WMS 13	703743	7153066
	WMS 14	706549	7153925
	WMS 15	705089	7160949
	WMS 16	701047	7173697
	WMS 17	694763	7175421
	WMS 18	718285	7114571

3 Methodology

3.1 Hygiene

Prevention and early intervention are the most cost effective techniques that can be deployed for weed management. Thorough weed hygiene measures are applicable to all DEC tenure areas on Dirk Hartog Island, all actions undertaken by DEC personnel and for all species considered in the WAP. There is potential for field personnel undertaking weed treatment unintentionally dispersing weed material through the environment. Inspection and cleaning of clothing and personal protective equipment should occur to ensure no transfer of weed seeds or propagules from areas of high weed occurrence. In order to prevent the proliferation of 'eradicate' and 'control' species any seed heads should be removed where practicable, double bagged and incinerated.

3.2 Weed Control Methods

3.2.1 Management

Prior to applying control actions to weeds on Dirk Hartog Island, standardised data collection, according to the method selected from the options proposed in the WMP should occur. Photographic records may also be taken as required. Weed control provides an opportunity to conduct weed monitoring by using GIS tracklogs and waypoints to record areas subjected to manual or chemical treatment. Weed control actions also should allow for the detection of species new to a particular location or the island itself.

There are two broad options for controlling weeds considered within the Dirk Hartog Island WAP; manual and chemical. A summary of specific weed control actions for six priority species identified for control actions is presented in Table 5.

3.2.2 Manual Control

Manual control is the removal of the whole plant or certain plant parts (i.e. flowers/seed heads). Whole plant removal requires the entire root system to remain intact and be completely removed. Partial removal of weeds (i.e. flowers/ seed heads) must be followed up with a chemical treatment. Manual control is only feasible for isolated occurrences of weed individuals or low abundance patches (i.e. 5 individuals per weed record point), depending on time allocated. This method significantly reduces the likelihood of plants regenerating from root stock which is known to occasionally occur after chemical treatment. Target species and circumstances where manual control is applicable are listed in Table 5.

3.2.3 Chemical Control

Chemical control involves the application of herbicide directly to a weed plant or areas of broad scale weed infestation. Effective chemical treatment requires:

- Adequate spray coverage of target species
- Appropriate technique according to the target species
- Appropriate dilution rate of the herbicide (always follow the product label instructions).

To achieve optimal results, the application of herbicide should be undertaken at the appropriate growth stage of the plant, and this is often specified on the product label. Foliar application of Roundup® Biactive® (glyphosate 360 g L-1) or other approved non-selective herbicide is absorbed

through leaves and stems and translocates throughout the plant system. This method is best applied when weeds are actively growing to ensure effective uptake of the chemical and translocation to the roots. Back pack spray units are the recommended spraying device. Basal bark or cut stump methods for treating weeds such as trees or shrubs can be used in place of the foliar spray technique where appropriate. Often these methods use other approved herbicides than Roundup®. If weeds are not actively growing, manual control methods can be applied where appropriate.

Contracted personnel must be trained Pest Management Technicians and licensed with the Department of Health, Western Australia. Personnel without chemical training and licences must only use manual control methods. The Material Safety Data Sheet (MSDS) for all recommended chemicals involved in weed control are presented as an attachment at the end of this WAP. The product label and MSDS should be referred to at all times when undertaking herbicide use.

Where herbicide is applied, the efficacy should be confirmed by a follow up inspection. Plants that have not died should be hand pulled or controlled using another herbicide option.

3.2.4 Action Plans for Eradicate and Control Species

Action plans for species 'eradicate' and 'control' species are presented in Table 5 - 10.

Table 5: Weed Action Plan - couch.

Weed Action Plan – couch eradication					
Management objective	75 % reduction of couch within two years. Eradication of couch within five years. No new occurrences of couch.				
Species biology	Perennial rhizomatous/stoloniferous grass favouring warm and moist environments and resistant to drought and water logging. Flowers from June to February. Reproduces via seed, rhizomes and stolons. Seed is dispersed by water, ants and wind. Can also proliferate as a result of slashing. Seedbank persistence can be up to 3 - 4 years.				
Control methods	Application of herbicide to all populations according to herbicide label directions. Small infestations may be dug out ensuring the removal of all rhizomes and stolons. Material should be buried to a depth of at least 500 mm.				
Recommended herbicide, species specific materials and personal protective equipment	Glyphosate or Fusilade® Forte Gum boots, disposable overalls, respirator with an organic vapour cartridge, face shield, goggles.				
Management actions	Year 1	Year 2	Year 3	Year 4	Year 5
	Application of herbicide to all populations or, Mechanical removal if practicable. Follow up monitoring visit 4 weeks post weed control. Repeat application where control has not been effective.	Application of herbicide to all populations. Follow up monitoring visit 4 weeks post weed control. Repeat application where control has not been effective.	Application of herbicide to all populations. Follow up monitoring visit 4 weeks post weed control. Repeat application where control has not been effective. Two control visits likely to be adequate for the year.	Application of herbicide to all populations. Follow up monitoring visit 4 weeks post weed control. Repeat application where control has not been effective. Two control visits likely to be adequate for the year.	Application of herbicide to all populations. Follow up monitoring visit 4 weeks post weed control. Repeat application where control has not been effective. Two control visits likely to be adequate for the year.

Weed Action Plan – couch eradication						
Optimal Timing		Control/monitoring visits in November, December, January and February.	Control/monitoring visits in November, December, January and February.	Control/monitoring visits between November and February.	Control/monitoring visits between November and February.	Control/monitoring visits between November and February.
Estimated time requirements (total personnel hours)	per control visit	6	6	6	6	5
	per year	24	24	12	12	10
Costs (inclusive of chemical)	per control visit	\$350	\$350	\$350	\$350	\$300
	per year	\$1400	\$1400	\$700	\$700	\$600

Table 6: Weed Action Plan - castor oil plant.

Weed Action Plan – castor oil plant eradication					
Management objective	Removal of all known plants after 2 years. Removal of any additional seedlings prior to seed set. Monitor for regrowth from year 2 to 5.				
Species biology	Perennial shrub/small tree that takes less than one year to reach flowering. Flowering can occur all year round, but predominantly from November to March. Fruit is produced from November to June. Reproduces via seed and is dispersed by water, ants and explosive action. Seedbank persistence can be of medium length ranging from 1 to 10 years.				
Control methods	Application of herbicide to all populations. Plants can be foliar sprayed according to label directions. Total coverage of the plant is required. The cut stump method can be used for effective control, ensuring that the stump is treated as soon as it has been cut. Plants can be destroyed by mechanical treatment, which is the best method for small infestations. Hand pull or dig out plants where practicable and remove as much of the root system as possible.				
Recommended herbicide, species specific materials and personal protective equipment	2,4D Amine, Garlon600, compatible surfactant. Gum boots, disposable overalls, apron, goggles, face shield, respirator with an organic vapour cartridge, chain or cable, hand saw, chainsaw, chainsaw chaps.				
Management actions	Year 1	Year 2	Year 3	Year 4	Year 5
	Application of herbicide to all populations. Follow up monitoring visit 4 weeks post weed control. Repeat application where control has not been effective.	Application of herbicide to all populations. Follow up monitoring visit 4 weeks post weed control. Repeat application where control has not been effective.	Monitor populations for regeneration. Control if required. Two control visits likely to be adequate for the year.	Monitor populations for regeneration. Control if required. Two control visits likely to be adequate for the year.	Monitor populations for regeneration. Control if required. Two control visits likely to be adequate for the year.
Optimal Timing	Control/monitoring visits in September, October, November and December.	Control/monitoring visits in September, October, November and December.	Control/monitoring visits between September and December.	Control/monitoring visits between September and December.	Control/monitoring visits between September and December.

Weed Action Plan – castor oil plant eradication						
Estimated time requirements (total personnel hours)	per control visit	12	12	12	10	10
	per year	48	48	24	20	20
Costs (inclusive of chemical)	per control visit	\$650	\$650	\$650	\$550	\$550
	per year	\$2600	\$2600	\$1300	\$1100	\$1100

Table 7: Weed Action Plan - Japanese pepper.

Weed Action Plan – Japanese pepper eradication					
Management objective	Removal of all known plants after two years. Removal of any additional seedlings prior to seed set. Monitor for regrowth from year 2 to 5.				
Species biology	Perennial tree/shrub that flowers all year round, but with main flush in autumn and a smaller flush in spring. Fruit ripening follows immediately after flowering. Female trees produce large amounts of fruit that may persist ripe for up to 8 months. The seed is dispersed by birds and mammals. Seed has short seedbank persistence, ranging from a few days up to one year. The plant responds to damage by sprouting new growth from the damaged area. Seedlings take 3 years to flower and produce seeds.				
Control methods	Control all known plants using the basal bark method. Follow up monitoring visit 4 weeks post weed control and repeat application where control has not been effective. Hand pull seedlings where practicable. Avoid physical interference (i.e. pruning, cutting, root disturbance) until trees are confirmed dead as species known to sucker.				
Recommended herbicide, species specific materials and personal protective equipment	Access or Garlon and diesel. Gum boots, disposable overalls, apron, goggles, face shield, respirator with an organic vapour cartridge, chain or cable, hand saw, chainsaw, chainsaw chaps.				
Management actions	Year 1	Year 2	Year 3	Year 4	Year 5
	Control all known plants. Follow up monitoring visit 4 weeks post weed control. Repeat herbicide application where control has not been effective.	Control all known plants. Follow up monitoring visit 4 weeks post weed control. Repeat herbicide application where control has not been effective.	Monitor populations for regeneration. Control if required. Two visits likely to be adequate for the year.	Monitor populations for regeneration. Control if required. Two visits likely to be adequate for the year.	Monitor populations for regeneration. Control if required. Two visits likely to be adequate for the year.

Weed Action Plan – Japanese pepper eradication						
Optimal Timing		Control/monitoring visits in March and April, August and September.	Control/monitoring visits in March and April, August and September.	Control/monitoring visits between March and April or August and September.	Control/monitoring visits between March and April or August and September.	Control/monitoring visits between March and April or August and September.
Estimated time requirements (total personnel hours)	per control visit	6	6	6	5	5
	per year	24	24	12	10	10
Costs (inclusive of chemical)	per control visit	\$350	\$350	\$350	\$300	\$300
	per year	\$1400	\$1400	\$700	\$600	\$600

Table 8: Weed Action Plan - ice plant.

Weed Action Plan – ice plant control						
Management objective		50 % reduction of the extent of ice plant in WMAs within 2 years. Minimum 75 % reduction of the extent of ice plant in WMAs within 5 years.				
Species biology		Annual succulent herb, able to absorb significant water from soil and outcompete most other species. Flowering can occur all year round, but predominantly from September to December. Fruiting can occur all year round, but predominantly from October to January. Reproduces via seed and is dispersed by animals and possibly water and wind. Seedbank persistence can be of long length; over 20 years.				
Control methods		Application of herbicide to all populations according to label directions. Remove any seed heads, double bag and incinerate. Hand pull or dig out where practicable and remove as much of the root system as possible.				
Recommended herbicide		Glyphosate and Pulse® surfactant.				
Management actions		Year 1	Year 2	Year 3	Year 4	Year 5
		Application of herbicide to all populations. Follow up visit 4 weeks post weed control. Repeat application where control has not been effective.	Application of herbicide to all populations. Follow up visit 4 weeks post weed control. Repeat application where control has not been effective.	Application of herbicide to all populations. Follow up visit 4 weeks post weed control. Repeat application where control has not been effective.	Application of herbicide to all populations. Follow up visit 4 weeks post weed control. Repeat application where control has not been effective.	Application of herbicide to all populations. Follow up visit 4 weeks post weed control. Repeat application where control has not been effective. Two visits likely to be adequate for the year.
Optimal Timing		Control visits in June, July, August and September.	Control visits in June, July, August and September.	Control visits in June, July, August and September.	Control visits in June, July, August and September.	Control visits in June, July, August and September.
Estimated time requirements (personnel)	per control visit	14	14	14	14	14

Weed Action Plan – ice plant control						
hours)	per year	56	56	56	28	28
Costs (inclusive of chemical)	per control visit	\$750	\$750	\$750	\$750	\$700
	per year	\$3000	\$3000	\$3000	\$1500	\$1400

Table 9: Weed Action Plan - fourleaf allseed.

Weed Action Plan – fourleaf allseed control						
Management objective		50 % reduction of the extent of fourleaf allseed in WMAs within 2 years. Minimum 75 % reduction of the extent of fourleaf allseed in WMAs within 5 years.				
Species biology		Annual erect, prostrate or spreading herb. Flowering can occur from May to January but predominantly in winter and spring. Reproduces via seed and is dispersed by water and wind. Seedbank persistence can be from 2 to 4 years.				
Control methods		Application of herbicide to all populations according to label directions. Remove any seed heads, double bag and incinerate. Hand pull or dig out where practicable and remove as much of the root system as possible.				
Recommended herbicide		Glyphosate.				
Management actions		Year 1	Year 2	Year 3	Year 4	Year 5
		Application of herbicide to all populations. Follow up monitoring visit 4 weeks post weed control. Repeat application where control has not been effective.	Application of herbicide to all populations. Follow up monitoring visit 4 weeks post weed control. Repeat application where control has not been effective.	Application of herbicide to all populations. Follow up monitoring visit 4 weeks post weed control. Repeat application where control has not been effective.	Application of herbicide to all populations. Follow up monitoring visit 4 weeks post weed control. Repeat application where control has not been effective.	Application of herbicide to all populations. Follow up monitoring visit 4 weeks post weed control. Repeat application where control has not been effective. Two visits likely to be adequate for the year.
Optimal Timing		Control visits in June, July, August and September.	Control visits in June, July, August and September.	Control visits in June, July, August and September.	Control visits in June, July, August and September.	Control visits in June, July, August and September.
Estimated time requirements (personnel)	per control visit	16	16	16	16	16

Weed Action Plan – fourleaf allseed control						
hours)	per year	64	64	64	32	32
Costs (inclusive of chemical)	per control visit	\$850	\$850	\$850	\$850	\$800
	per year	\$3400	\$3400	\$3400	\$1700	\$1600

Table 10: Weed Action Plan - false sowthistle.

Weed Action Plan – false sowthistle control						
Management objective		50 % reduction of the extent of false sowthistle in WMAs within 2 years. Minimum 75 % reduction of the extent of false sowthistle in WMAs within 5 years.				
Species biology		Short lived erect annual or perennial herb. Flowering can occur from August to October. Reproduces via seed and is dispersed by water and wind. Seedbank persistence is relatively short, 1 - 2 years duration.				
Control methods		Application of herbicide to all populations according to label directions. Remove any seed heads, double bag and incinerate. Hand pull or dig out where practicable and remove as much of the root system as possible.				
Recommended herbicide		Glyphosate.				
Management actions		Year 1	Year 2	Year 3	Year 4	Year 5
		Application of herbicide to all populations. Follow up monitoring visit 4 weeks post weed control. Repeat application where control has not been effective.	Application of herbicide to all populations. Follow up monitoring visit 4 weeks post weed control. Repeat application where control has not been effective.	Application of herbicide to all populations. Follow up monitoring visit 4 weeks post weed control. Repeat application where control has not been effective.	Application of herbicide to all populations. Follow up monitoring visit 4 weeks post weed control. Repeat application where control has not been effective.	Application of herbicide to all populations. Follow up monitoring visit 4 weeks post weed control. Repeat application where control has not been effective. Two visits likely to be adequate for the year.
Optimal Timing		Control visits in June, July, August and September.	Control visits in June, July, August and September.	Control visits in June, July, August and September.	Control visits in June, July, August and September.	Control visits in June, July, August and September.
Estimated time requirements (personnel)	per control visit	17	17	17	17	17

Weed Action Plan – false sowthistle control						
hours)	per year	68	68	68	34	34
Costs (inclusive of chemical)	per control visit	\$900	\$900	\$900	\$900	\$850
	per year	\$3600	\$3600	\$3600	\$1800	\$1700

3.3 Surveillance Methods

The Dirk Hartog Island Weed Management Plan defines weed surveillance as a methodology for the early detection of weed species. Two forms of surveillance are possible; systematic and opportunistic (Table 6). Systematic weed surveillance should be primarily performed at delineated WSAs, where the area is thoroughly traversed by foot and inspected for any weed species that are new to island; and for 'control' or 'eradicate' species.

Weed surveillance may be performed opportunistically for potential occurrences outside WSAs. Should new to island, "control" or "eradicate" species be detected, standardised data collection, including photographs and specimen collection, should occur. If practicable, appropriate control methods can then be employed.

Notification of the occurrence of weed species that meet the above criteria must be lodged with the project manager to facilitate the creation of a new WMA, based on the locality of the weed occurrence. Each species that is new to Dirk Hartog Island must then be prioritised using the IPPP matrix.

Table 11: Weed surveillance protocols.

Monitoring Type	Location	Description
Systematic Weed Surveillance	Delineated WSAs	Identification of weed occurrences methodically, including through systematic surveys undertaken by suitably trained personnel.
Opportunistic Weed Surveillance	Whole of Dirk Hartog Island	Identification of weed occurrences by unstructured means, including opportunistic identification and identification by non-specialist personnel.

3.4 Monitoring Methods

Weed monitoring involves recording data for target species at selected WMSs. Opportunistic surveillance can be undertaken simultaneously to detect new weed introductions. Monitoring is conducted within a pair of 25 m x 250 m unmarked transects, which consist of 10 contiguous unmarked 25 m x 25 m cells. Monitoring occurs between the third and eighth 25 m grid cell of the transects.

Survey transects are to be uploaded onto handheld GIS Trimble units for field personnel when monitoring is undertaken. Weed monitoring data should be captured according to a standardised method outlined in the WMP. Data should be collected to represent the occurrence of each weed species observed within each 25 m cell. Photographic records will be taken at each WMS, from a permanent position identified by a star picket and facing south west.

Data is collected across each transect and within transect cells according to the following protocol:

- Two suitably qualified personnel walking parallel to each other, approximately 10 m apart;
 - Recording the presence of each weed species observed within each of the 25 m x 25 m transect cells; or
 - Recording a "no weeds present" point within each of the 25 m x 25 m transect cells where weeds are absent

Measurable indicators include the weed presence or absence across sites as well as trends such as changes in weed distribution, abundance, foliar cover or seeded occurrences over time.

4 Scheduling

Two personnel are required to undertake weed control, surveillance and monitoring tasks. Personnel travel to weed management locations by light vehicle and traverse within locations by foot.

Weed management actions should be scheduled for the active growth period of the species. Herbicide application should occur up to four times per year, once per each month of the optimal treatment period. Control visits may be reduced to twice annually for some species where the abundance and cover has been significantly reduced. Should warm and dry conditions follow significant rainfall, many annual plants will rapidly senesce and set seed. To ensure the correct identification and capture of weed species with a short life cycle and quick response to rainfall, timely scheduling of weed management activities is required. Effective uptake of herbicides is significantly affected in drought or heat-stressed plants.

Weed surveillance should occur twice annually and should coincide with the active growth period of plants, following winter rainfall. Weed monitoring should occur at least once a year during spring. Opportunistic weed monitoring can be undertaken at all times.

5 Resources

Estimates of annual time and cost requirements for weed control, surveillance and monitoring tasks includes travel time from DEC headquarters at Herald Bay (Table 12). Time estimates for 'eradicate' and 'control' weed species to undergo treatment are based on herbicide application within WMAs. Up to one week may be initially required to perform weed control actions for all WMAs, depending on the level of intensity required. Four visits to each WMA is recommended annually, meaning up to four weeks' worth of control visits should be initially expected. Annual time requirements and costs will decrease as successful weed control actions reduce weed abundance and density of the 'control' and 'eradicate' species. Some WMAs may only require two visits per year in the latter stages of the five year WAP. Manual control activities will increase field effort hours, but will improve the likelihood of successful weed control and eradication. One hour of field effort per person for each of the 18 WMSs and one hour per WSAs is considered appropriate.

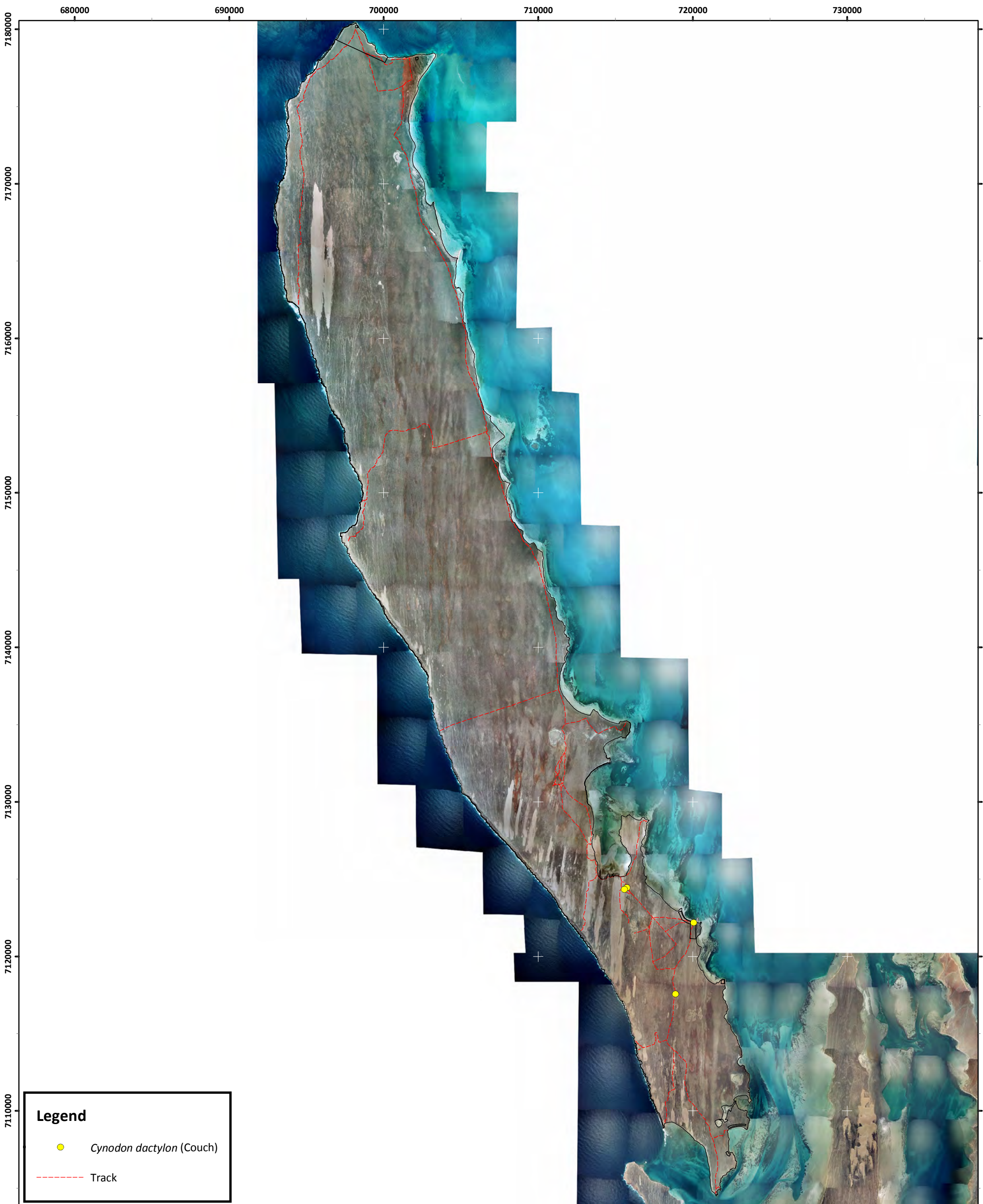
Table 12: Required resources for weed management.

Weed Management Action	Human Resources	Estimated Annual Time Requirements					Estimated Annual Cost Requirements					Materials and Resources Requirements
		Year 1	Year 2	Year 3	Year 4	Year 5	Year 1	Year 2	Year 3	Year 4	Year 5	
Control	Two experienced, pesticide licensed field officers or contractors.	20 days	20 days	17 days	10 days	10 days	\$15400	\$15400	\$12700	\$7400	\$7000	Data collection: GIS Trimble unit GPS unit Field data sheet Camera Weed notes, field ID guide Personal Protective Equipment Minimum Control Requirements: Spill kit, PVC gloves, riggers gloves, backpack sprayers, herbicide, species specific equipment.
Surveillance	Two experienced and qualified field officers or contractors.	12 days per year					\$9400 per year					GIS Trimble unit GPS unit Field data sheet Camera Weed notes, field ID guide Personal Protective Equipment
Monitoring	Two experienced and qualified field officers or contractors.	4 days per year					\$3200 per year					GIS Trimble unit GPS unit Field data sheet Camera Weed notes, field ID guide Personal Protective Equipment

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Figures

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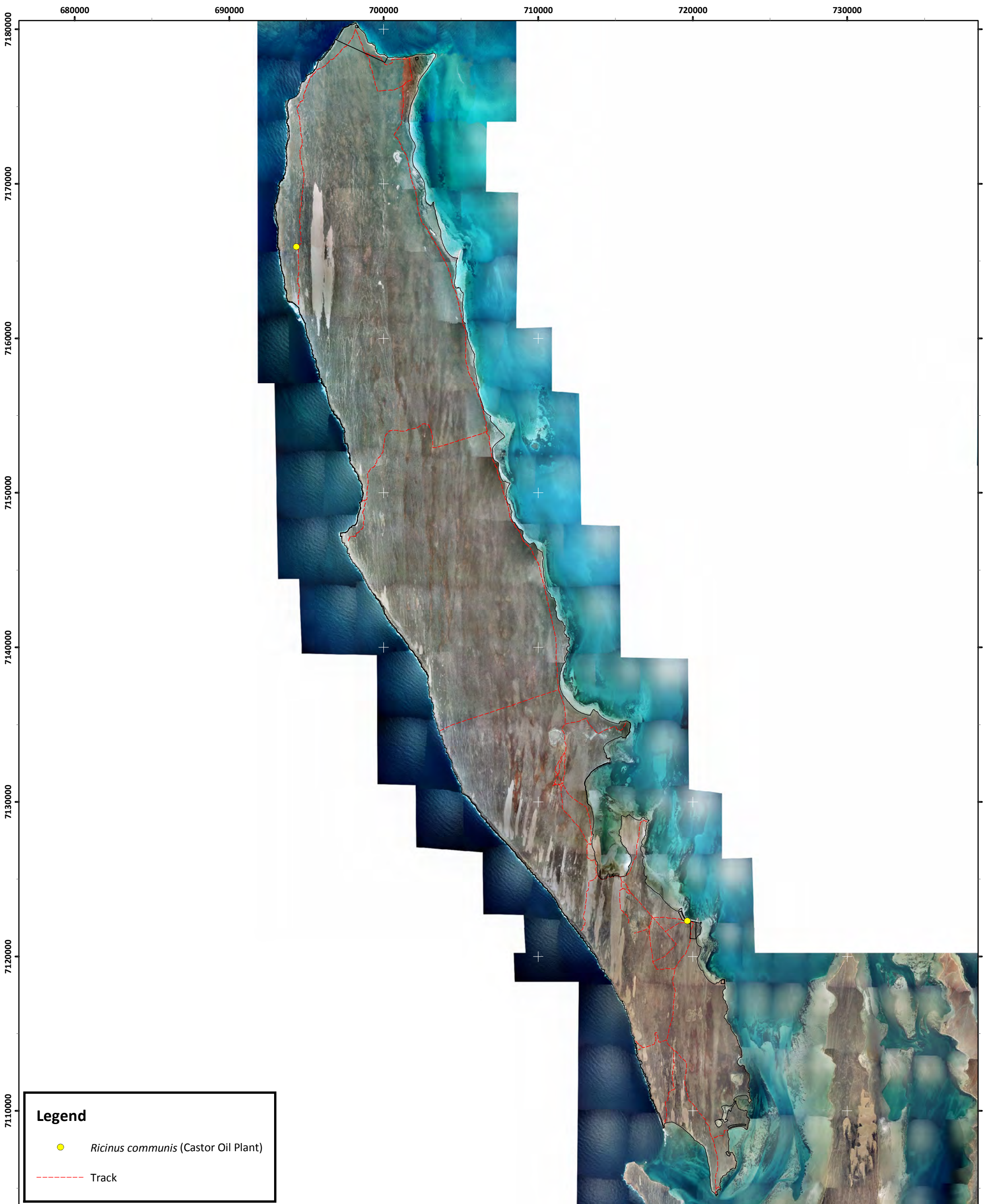
Figure C.1.1: Weed Record Point distribution for *Cynodon dactylon* (Couch)

Author: S. Moore	Date: 20-11-2012
Drawn: Y. Hua	15206-12FMV1Rev0_121120_Figure_C11

Datum: GDA 1994
 Projection: MGA Zone 49

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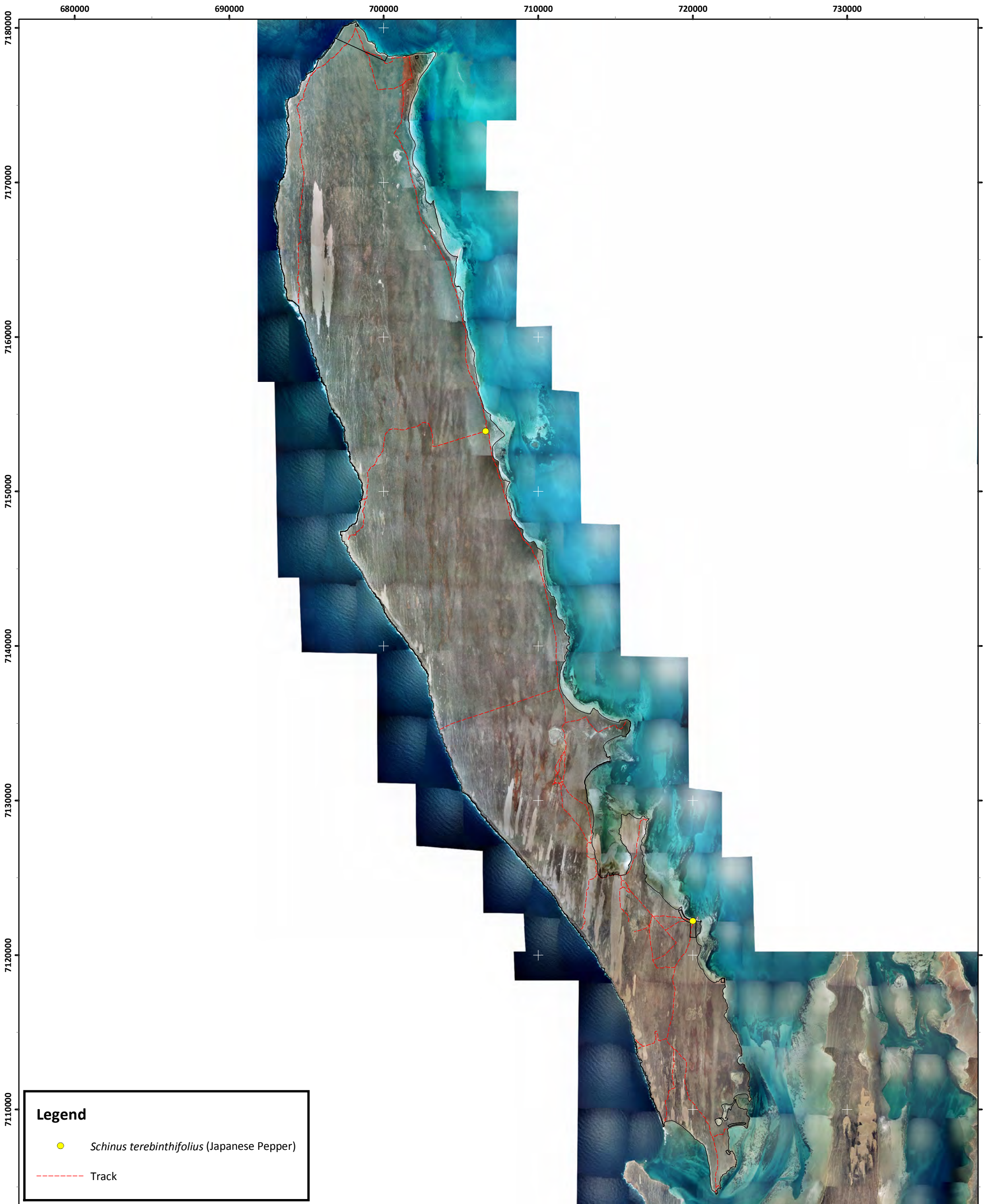
Appendix C.1.2: Weed Record Point distribution for *Ricinus communis* (Castor Oil Plant)



Author: S. Moore	Date: 20-11-2012
Drawn: Y. Hua	15206-12FMV1Rev0_121120_Figure_C12

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Figure C.1.3: Weed Record Point distribution for *Schinus terebinthifolius* (Japanese Pepper)



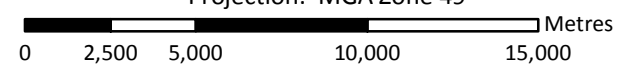
Author: S. Moore

Date: 20-11-2012

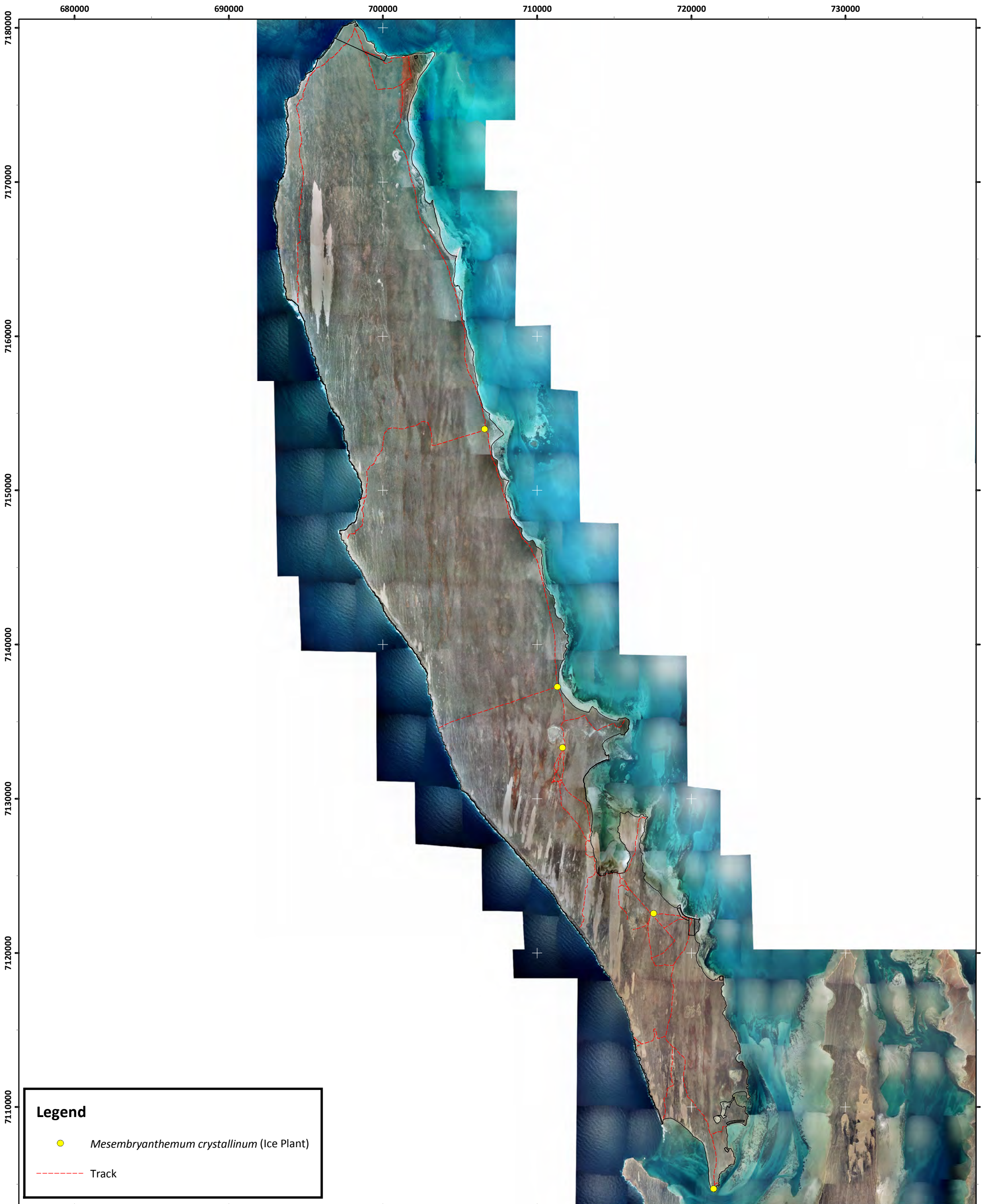
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Figure C.1.4: Weed Record Point distribution for *Mesembryanthemum crystallinum* (Ice Plant)



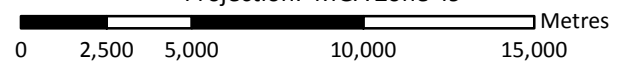
Author: S. Moore

Date: 20-11-2012

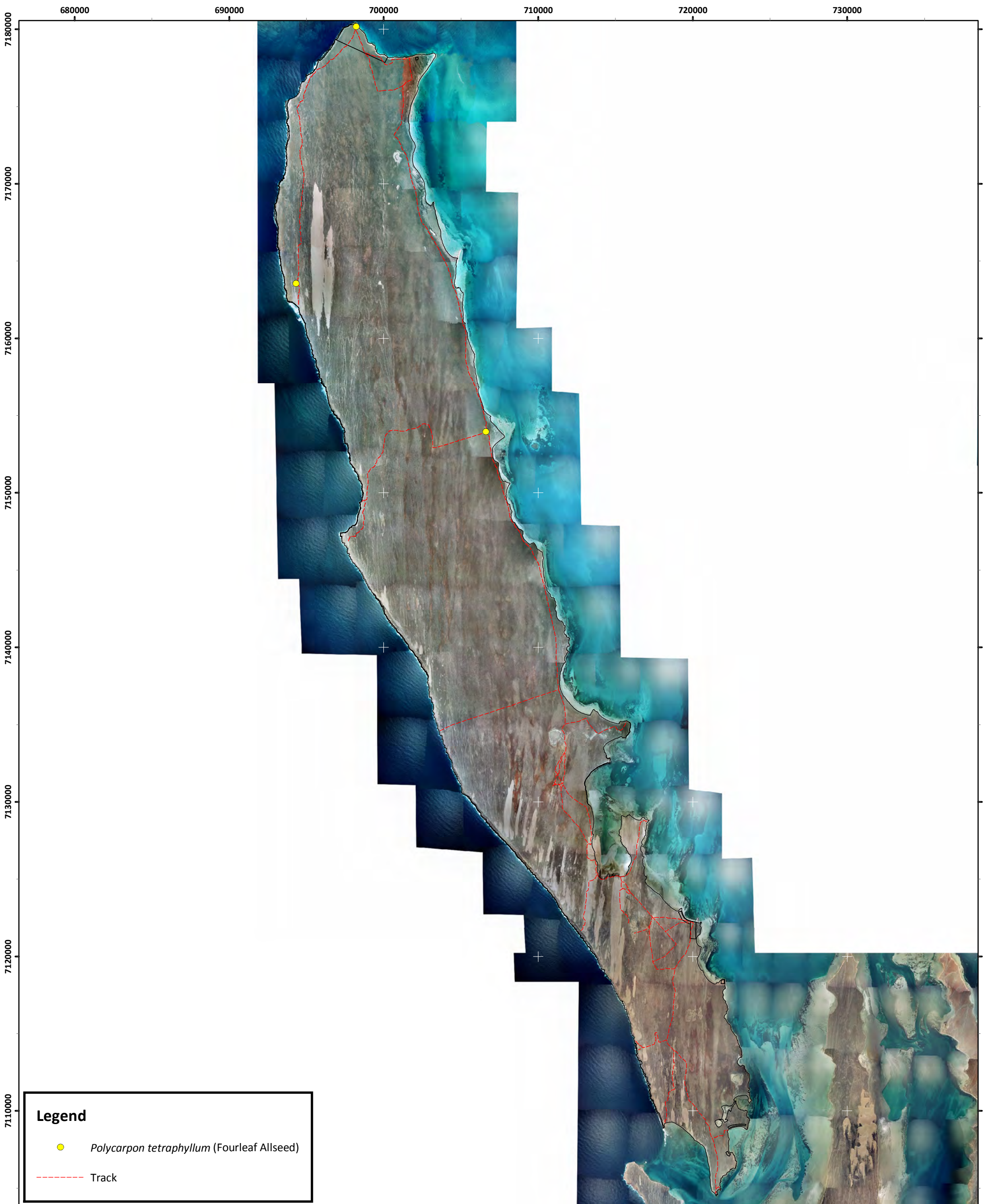
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Legend

- *Polycarpon tetraphyllum* (Fourleaf Allseed)
- - - Track

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Figure C.1.5: Weed Record Point distribution for *Polycarpon tetraphyllum* (Fourleaf Allseed)

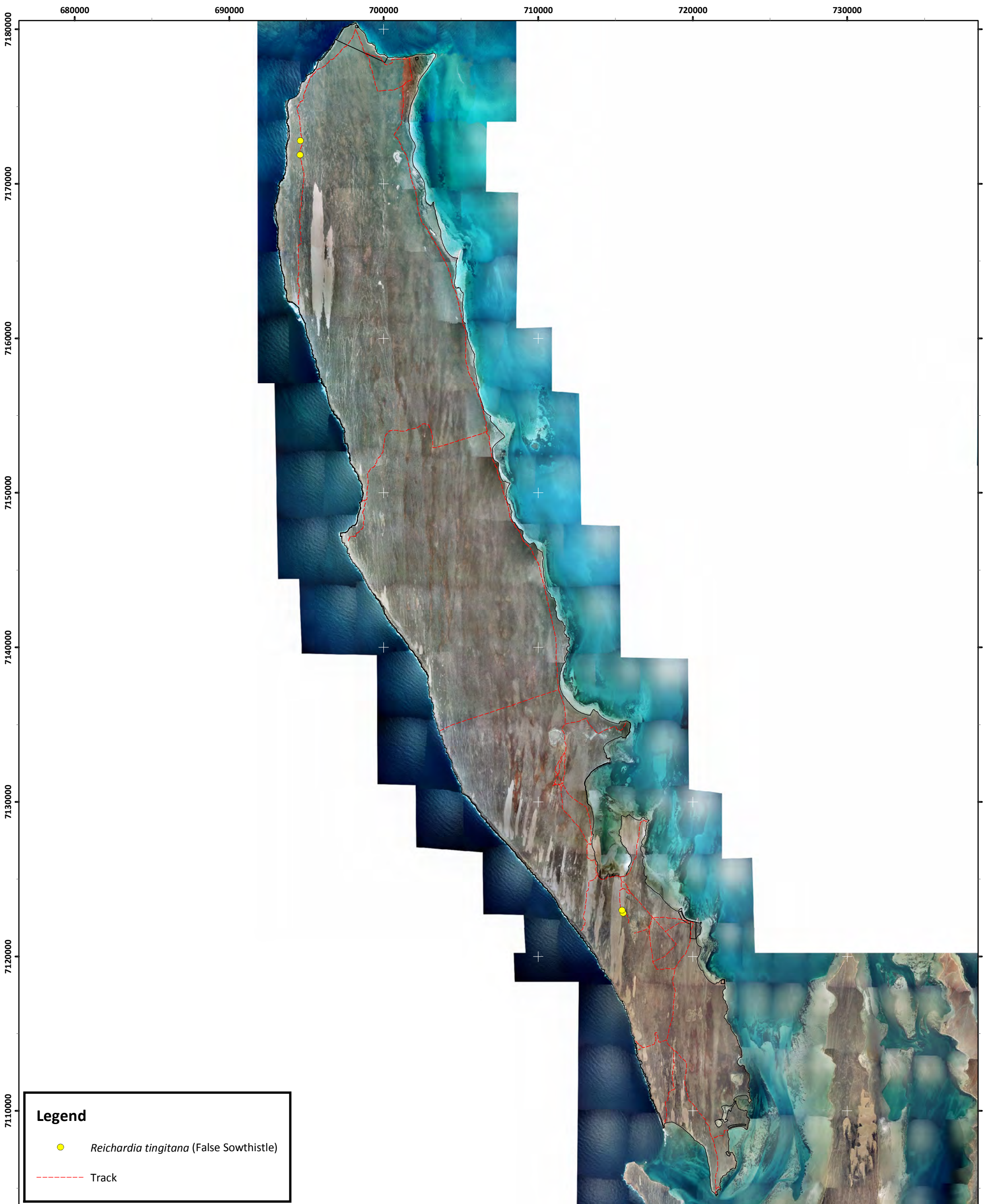


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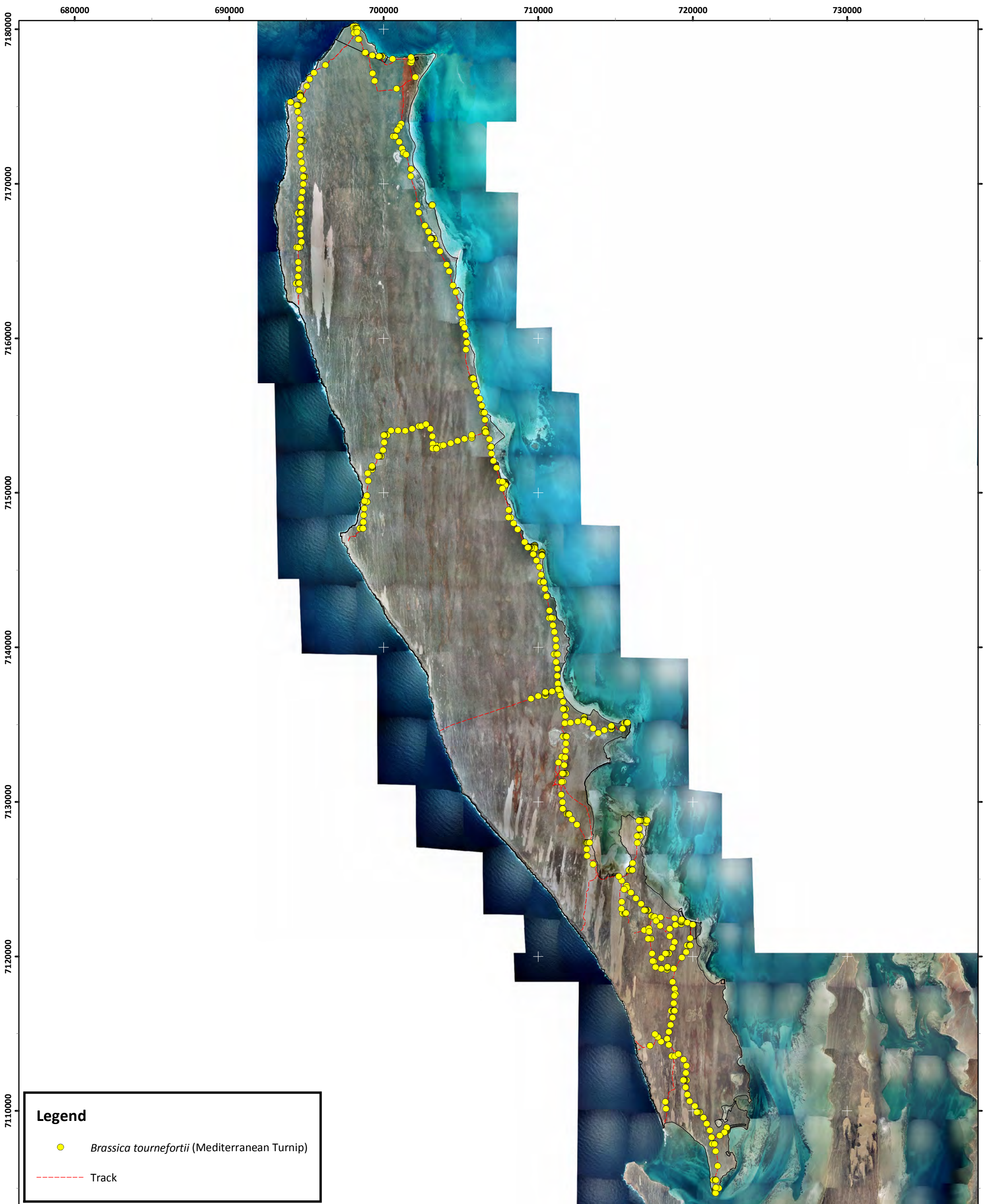
Figure C.1.6: Weed Record Point distribution for *Reichardia tingitana* (False Sowthistle)

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Drawn: Y. Hua	15206-12FMV1Rev0_121120_Figure_C16

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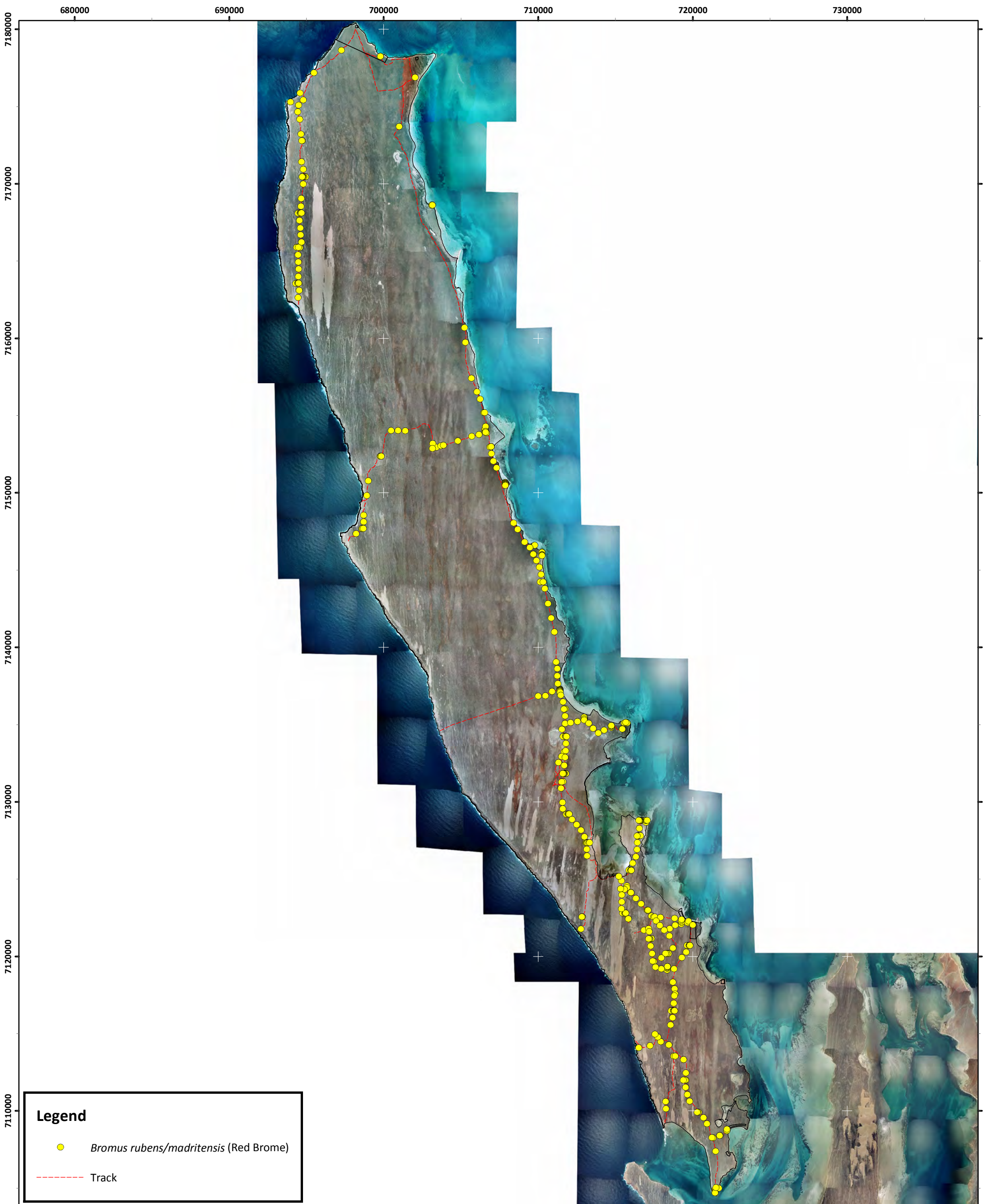
Figure C.1.7: Weed Record Point distribution for *Brassica tournefortii* (Mediterranean Turnip)

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Figure C.1.8: Weed Record Point distribution for *Bromus rubens/madritensis* (Red Brome)



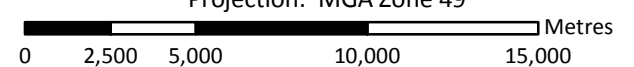
Author: S. Moore

Date: 20-11-2012

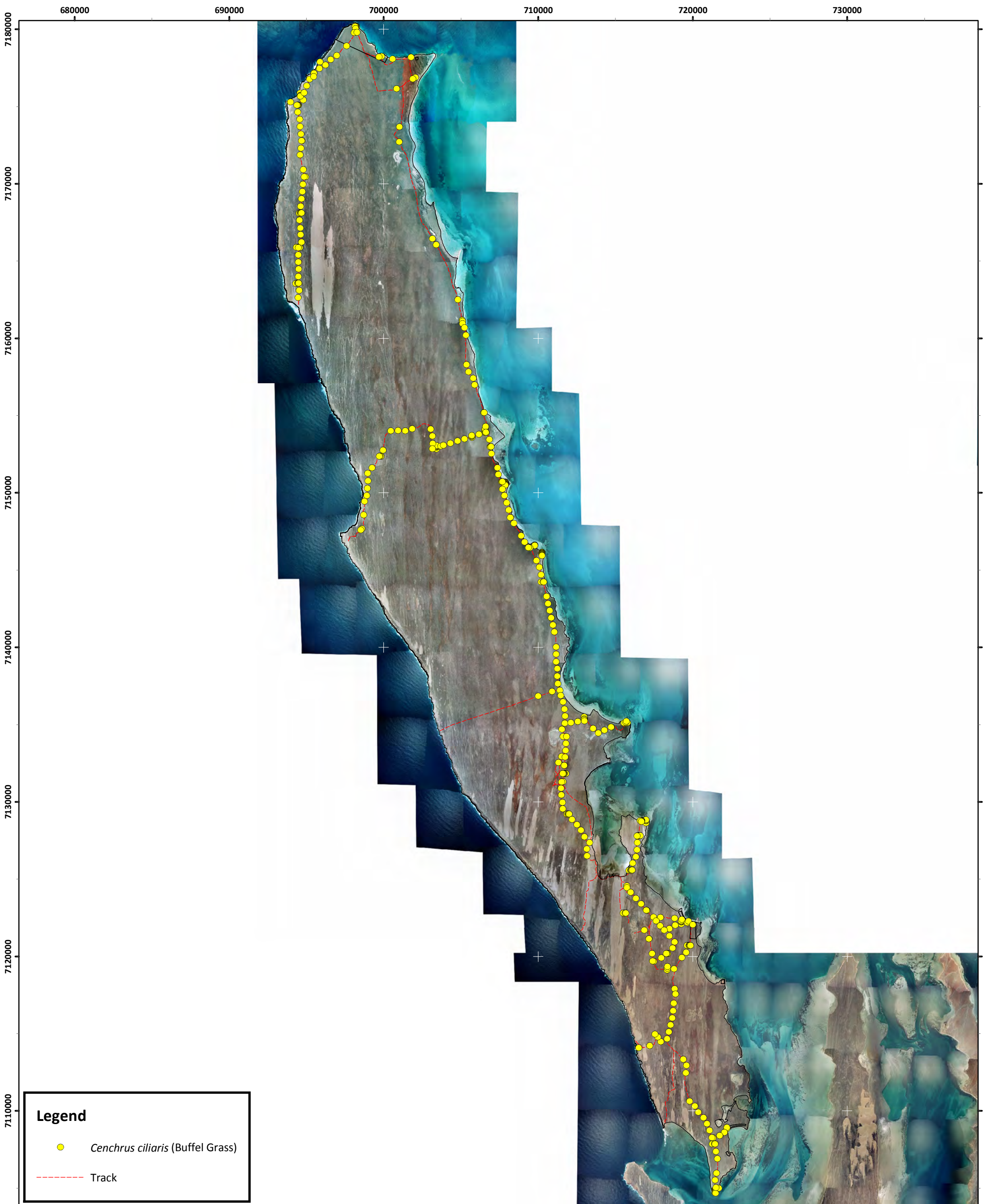
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Figure C.1.9: Weed Record Point distribution for *Cenchrus ciliaris* (Buffel Grass)

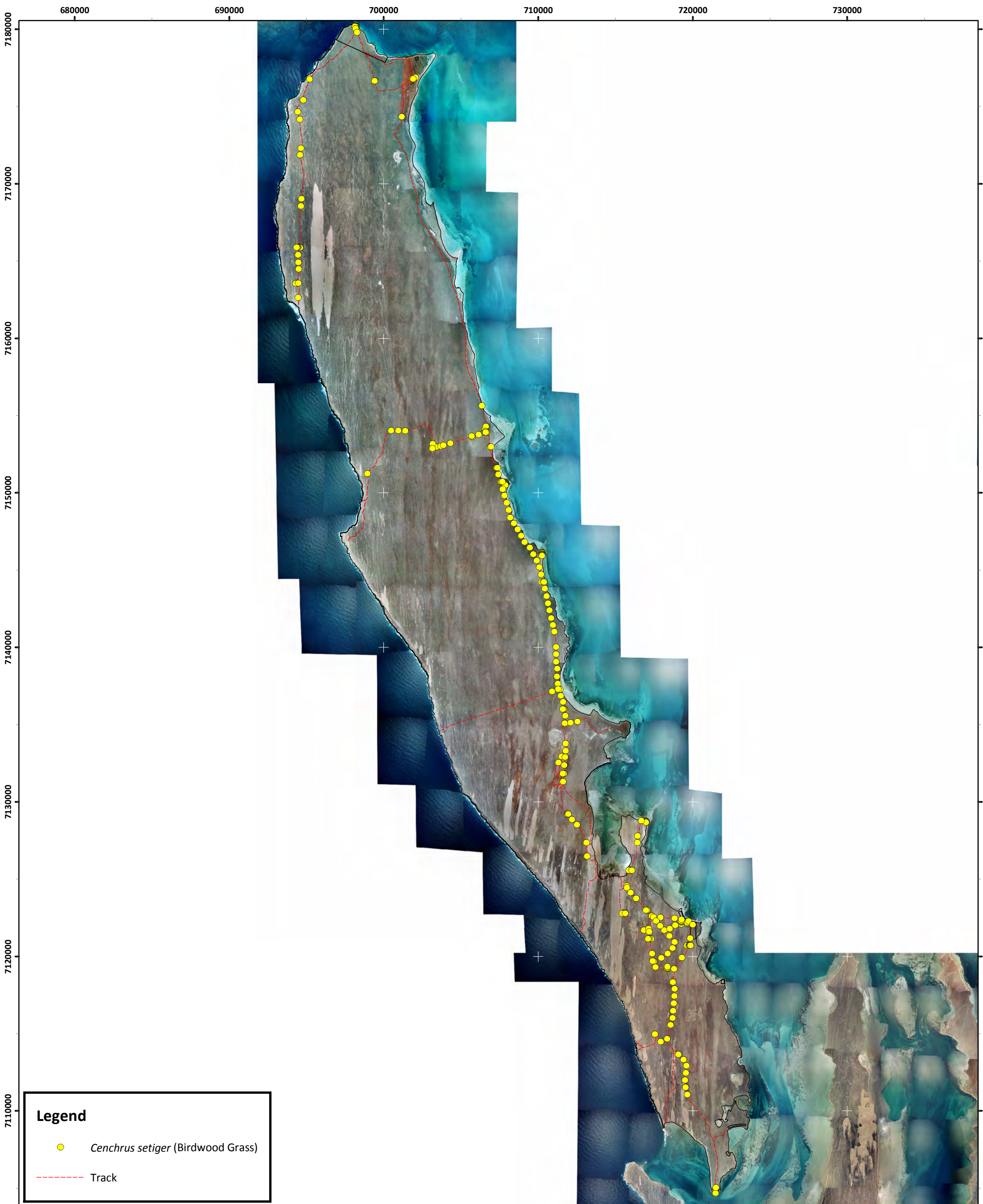


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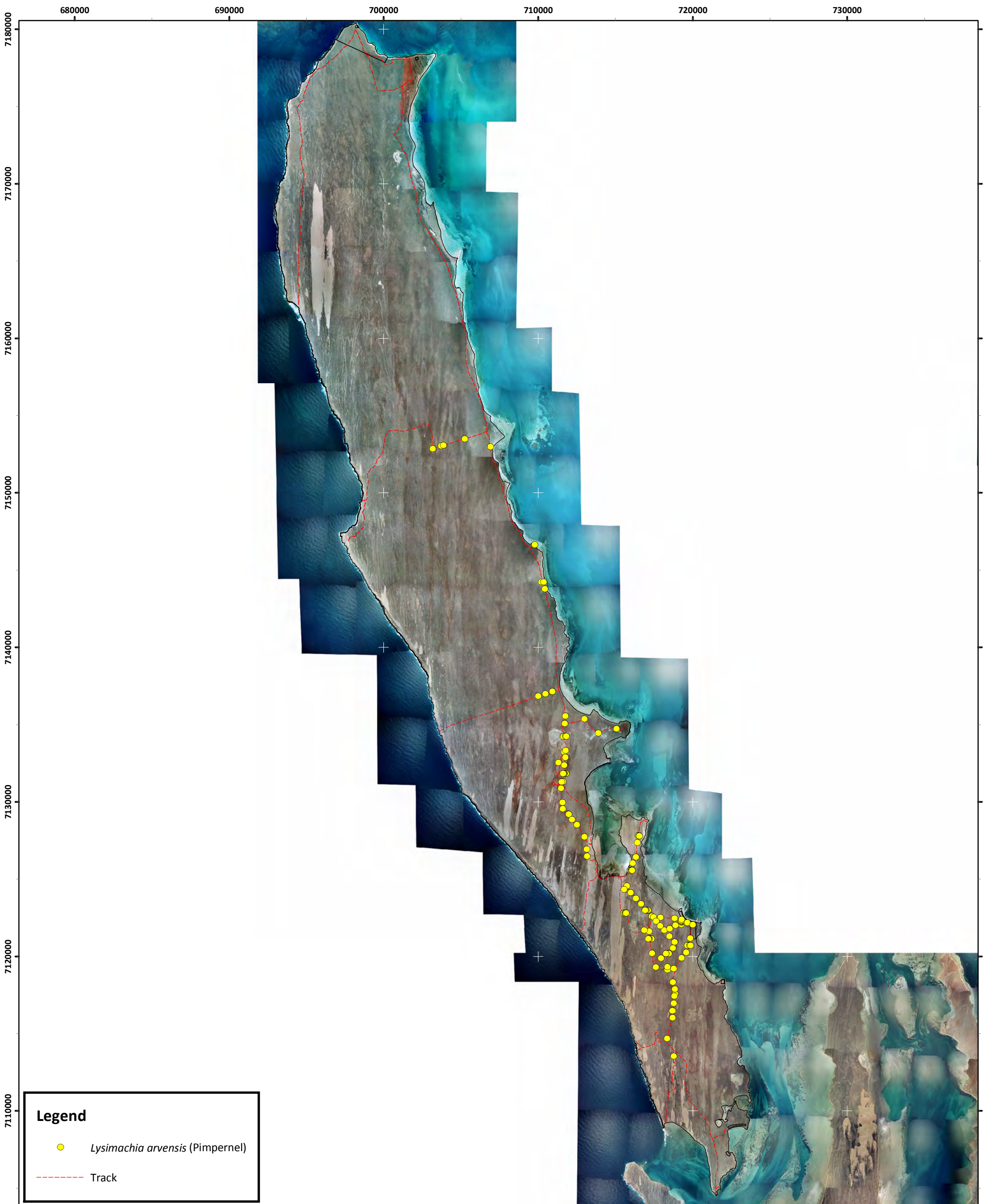


Figure C.1.10: Weed Record Point distribution for *Cenchrus setiger* (Birdwood Grass)

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Figure C.1.11: Weed Record Point distribution for *Lysimachia arvensis* (Pimpernel)



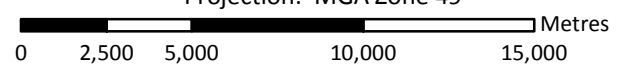
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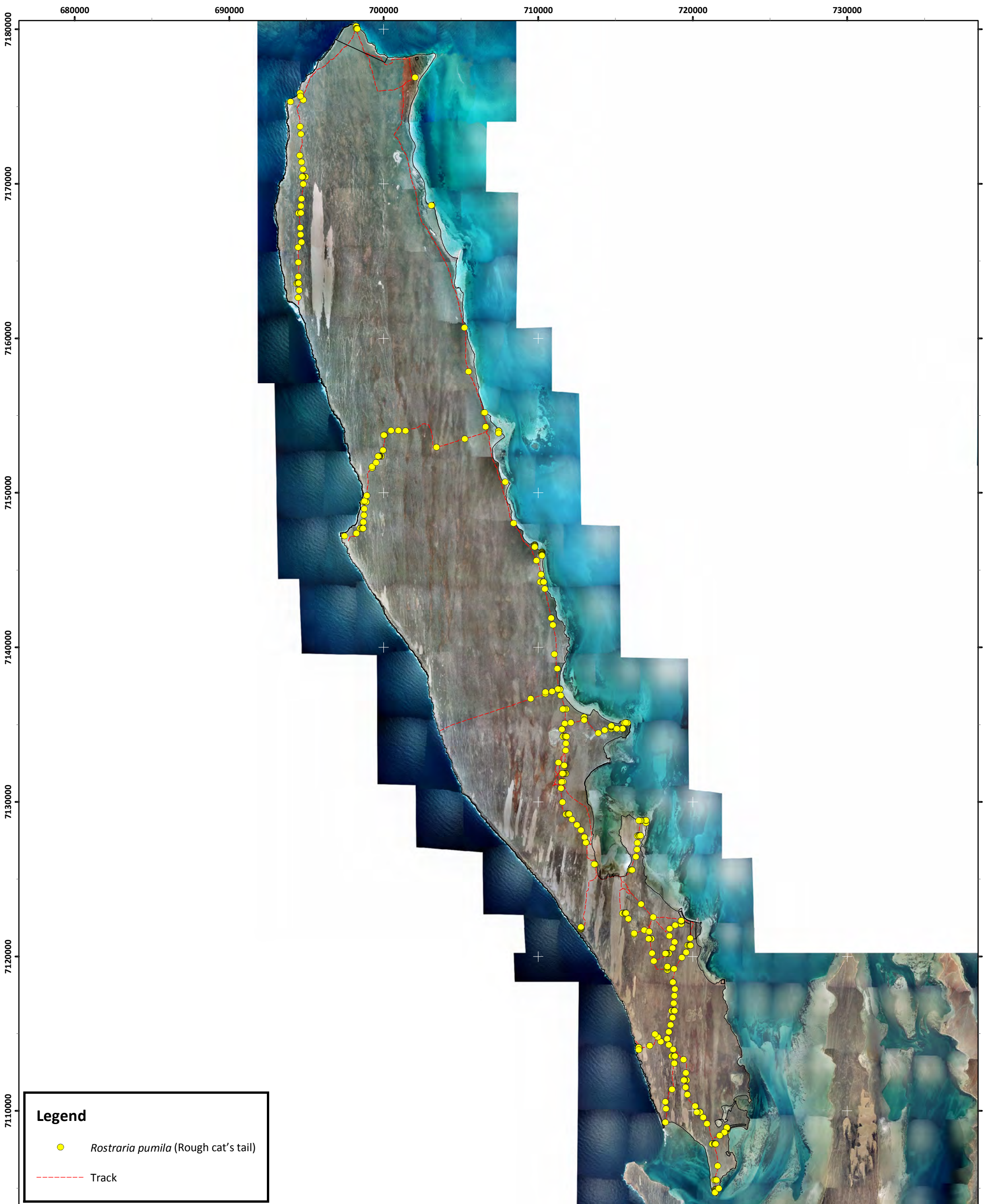
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Figure C.1.12: Weed Record Point distribution for *Rostraria pumila* (Rough cat's tail)

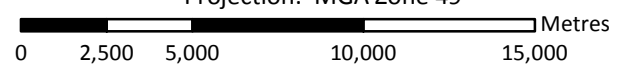
Author: S. Moore

Date: 20-11-2012

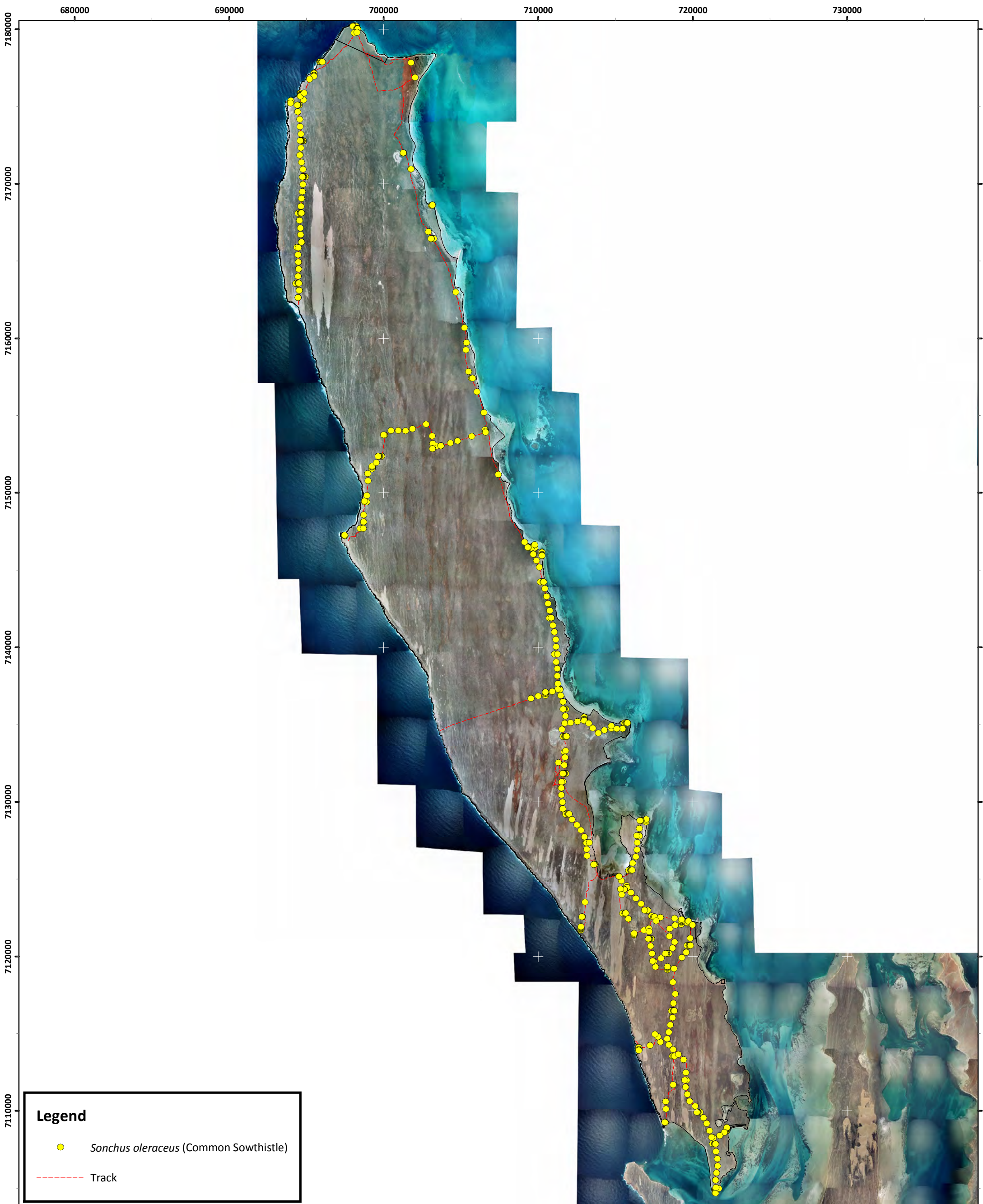
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Figure C.1.13: Weed Record Point distribution for *Sonchus oleraceus* (Common Sowthistle)



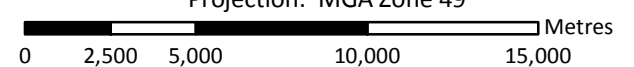
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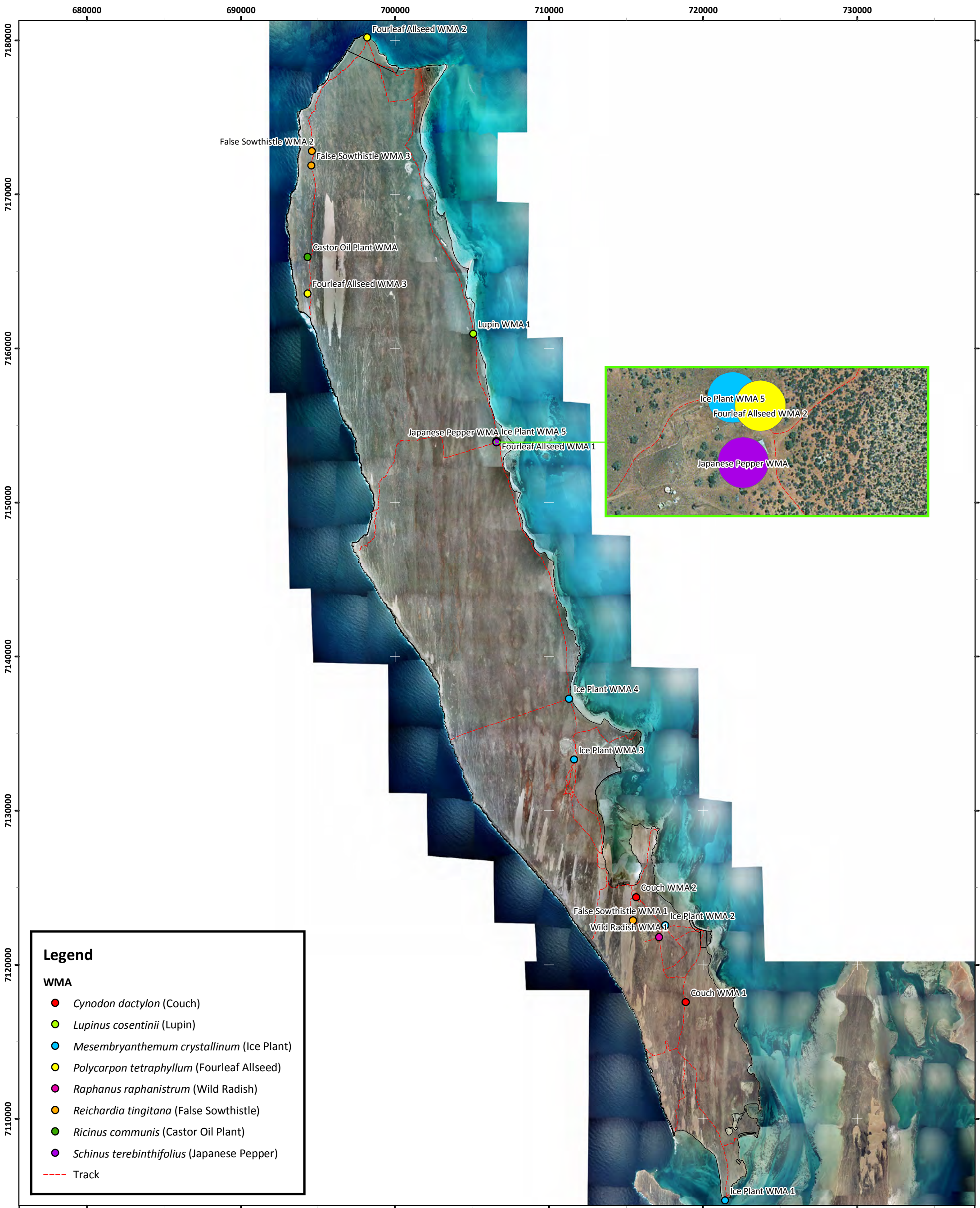
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Figure C.2: Weed Management Areas (WMAs)



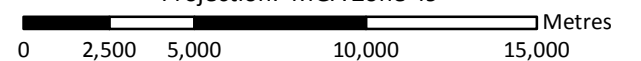
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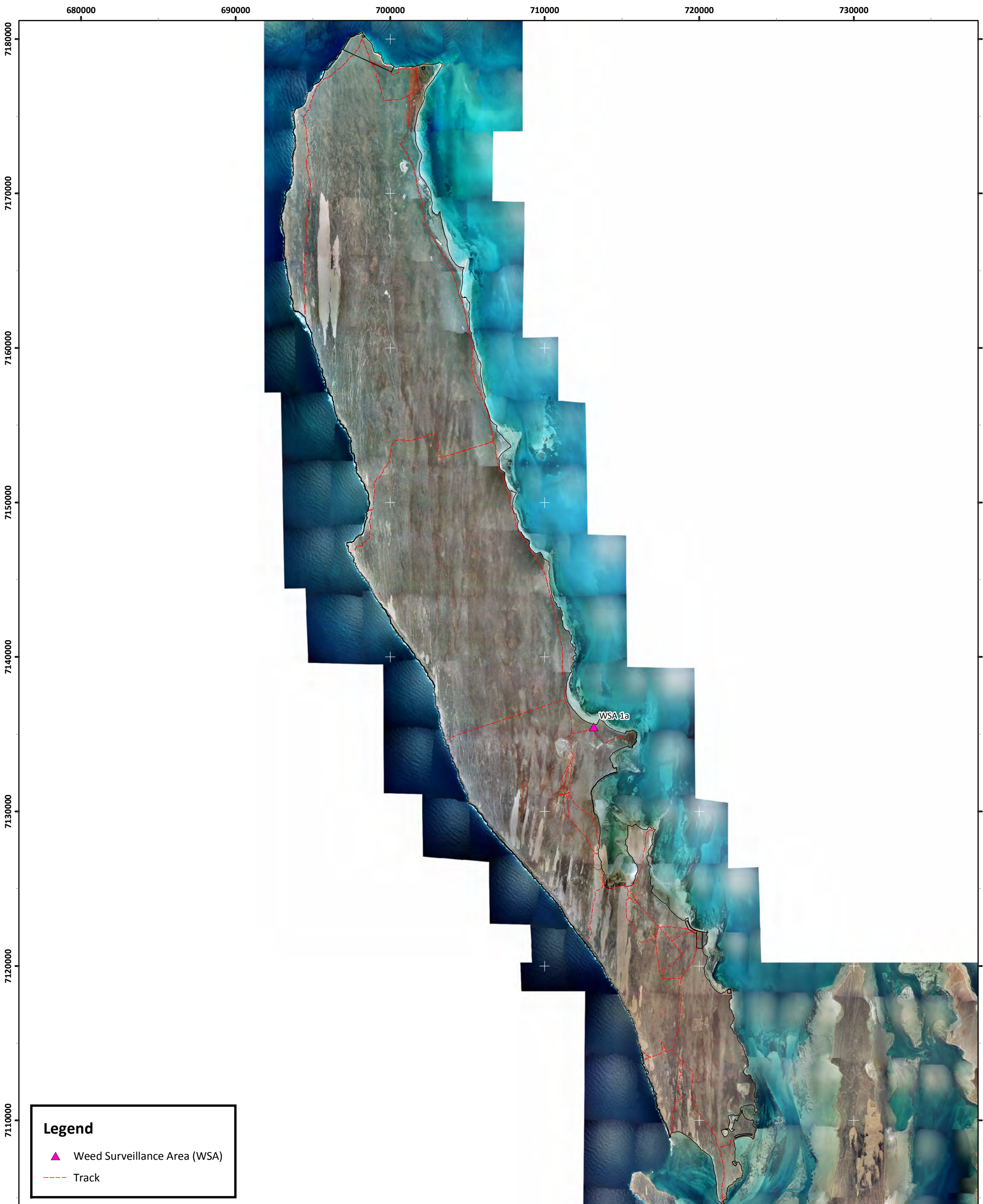
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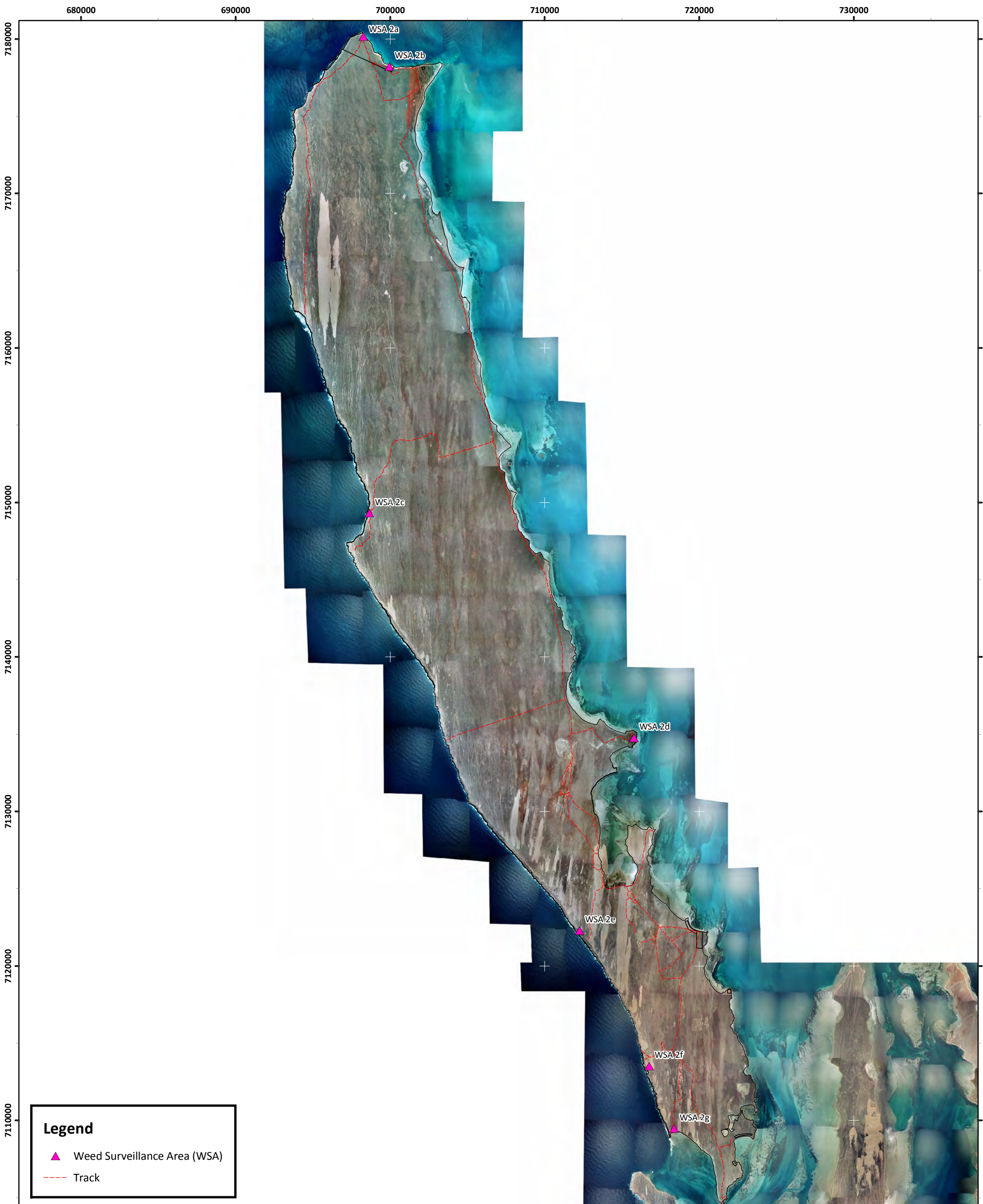
Figure C.3.1: Weed Surveillance Area 1 – DEC Operations



Author: S. Moore	Date: 20-11-2012
Drawn: Y. Hua	15206-12FMV1Rev0_121120_Figure_C31

Datum: GDA 1994
 Projection: MGA Zone 49

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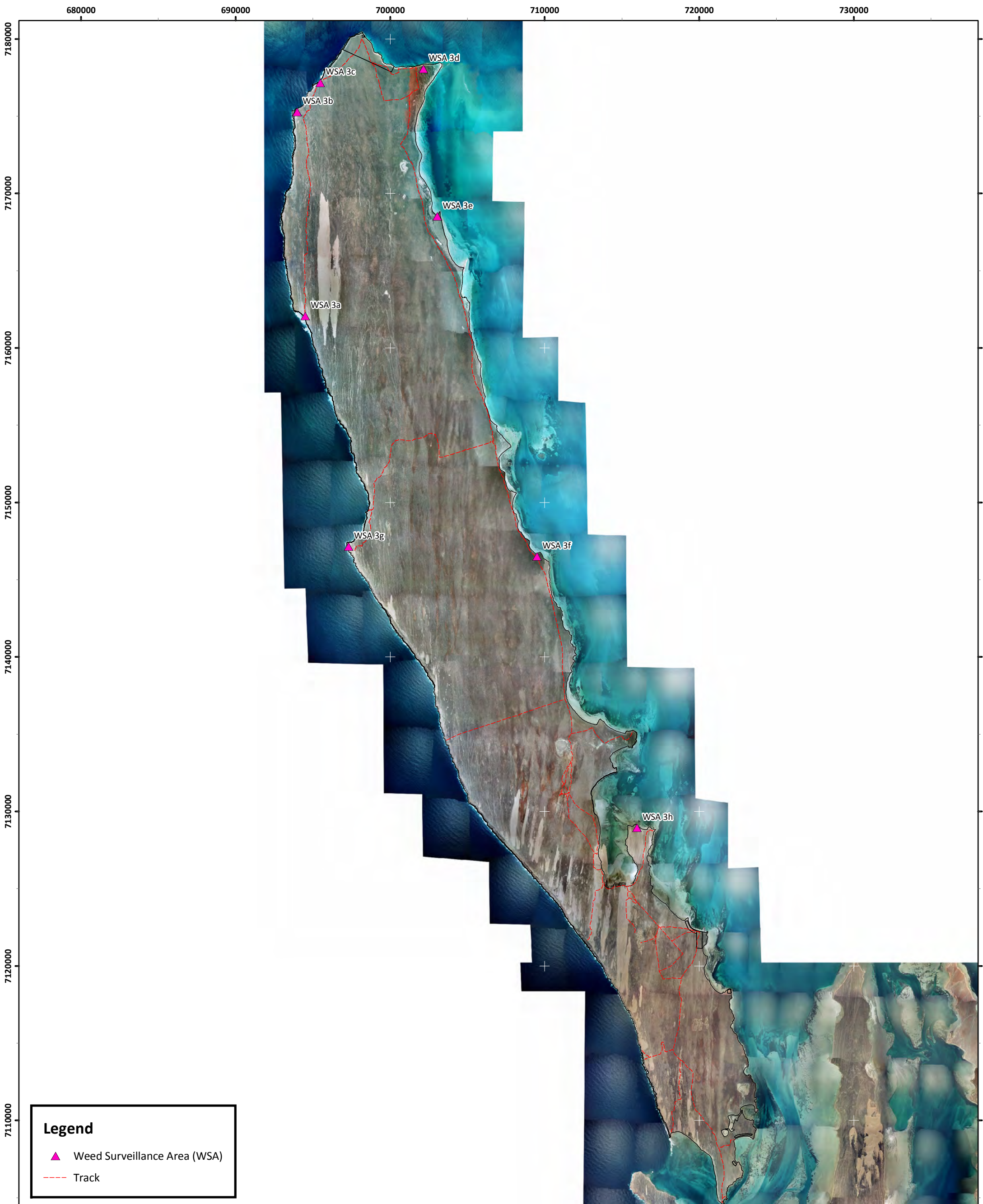
Figure C.3.2: Weed Surveillance Area 2 – Existing/Proposed Developments



Author: S. Moore	Date: 20-11-2012
Drawn: Y. Hua	15206-12FMV1Rev0_121120_Figure_C32

Datum: GDA 1994
 Projection: MGA Zone 49

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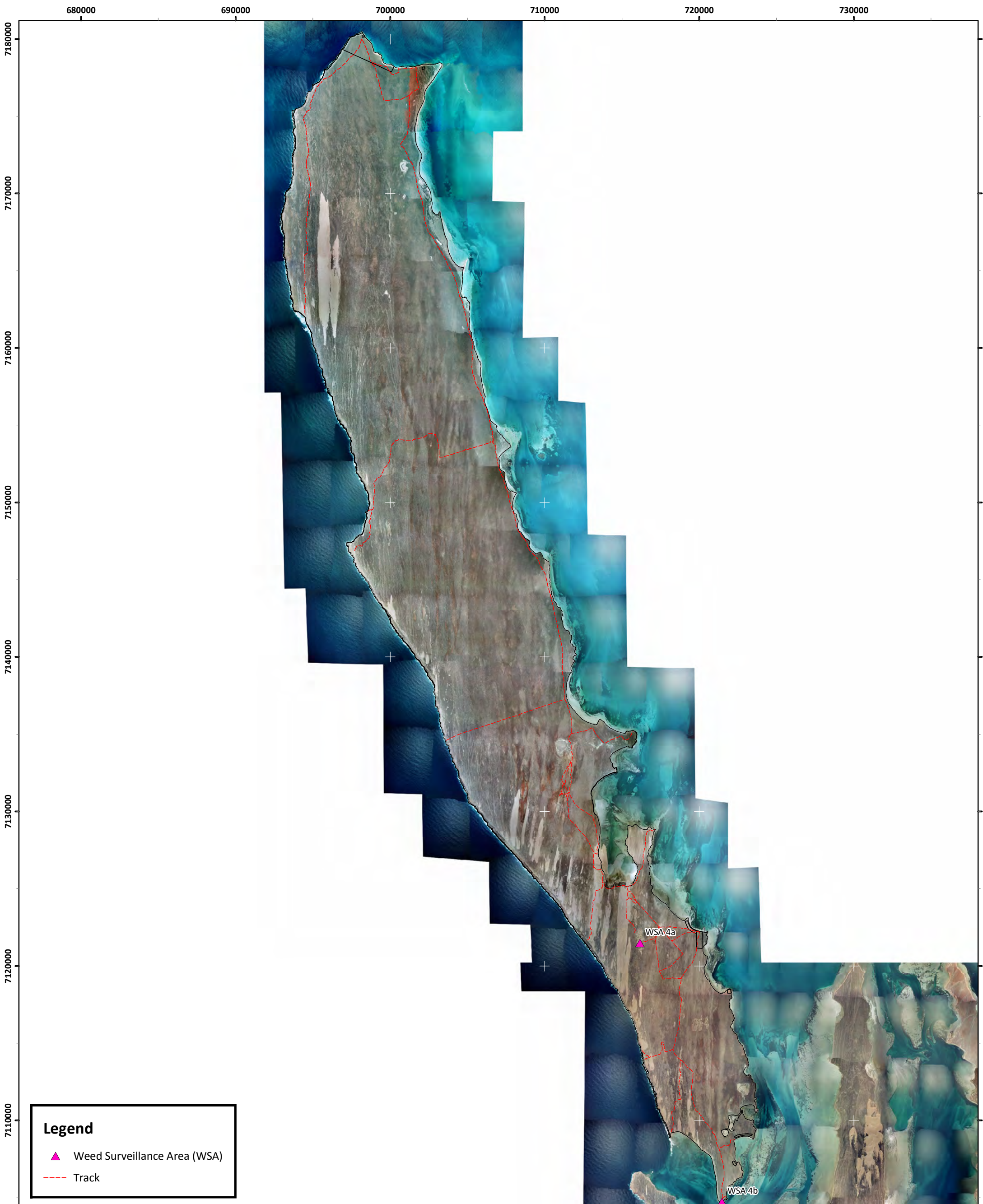
Figure C.3.3: Weed Surveillance Area 3 – Campsites



Author: S. Moore	Date: 20-11-2012
Drawn: Y. Hua	15206-12FMV1Rev0_121120_Figure_C33

Datum: GDA 1994
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Figure C.3.4: Weed Surveillance Area 4 – Entry Points

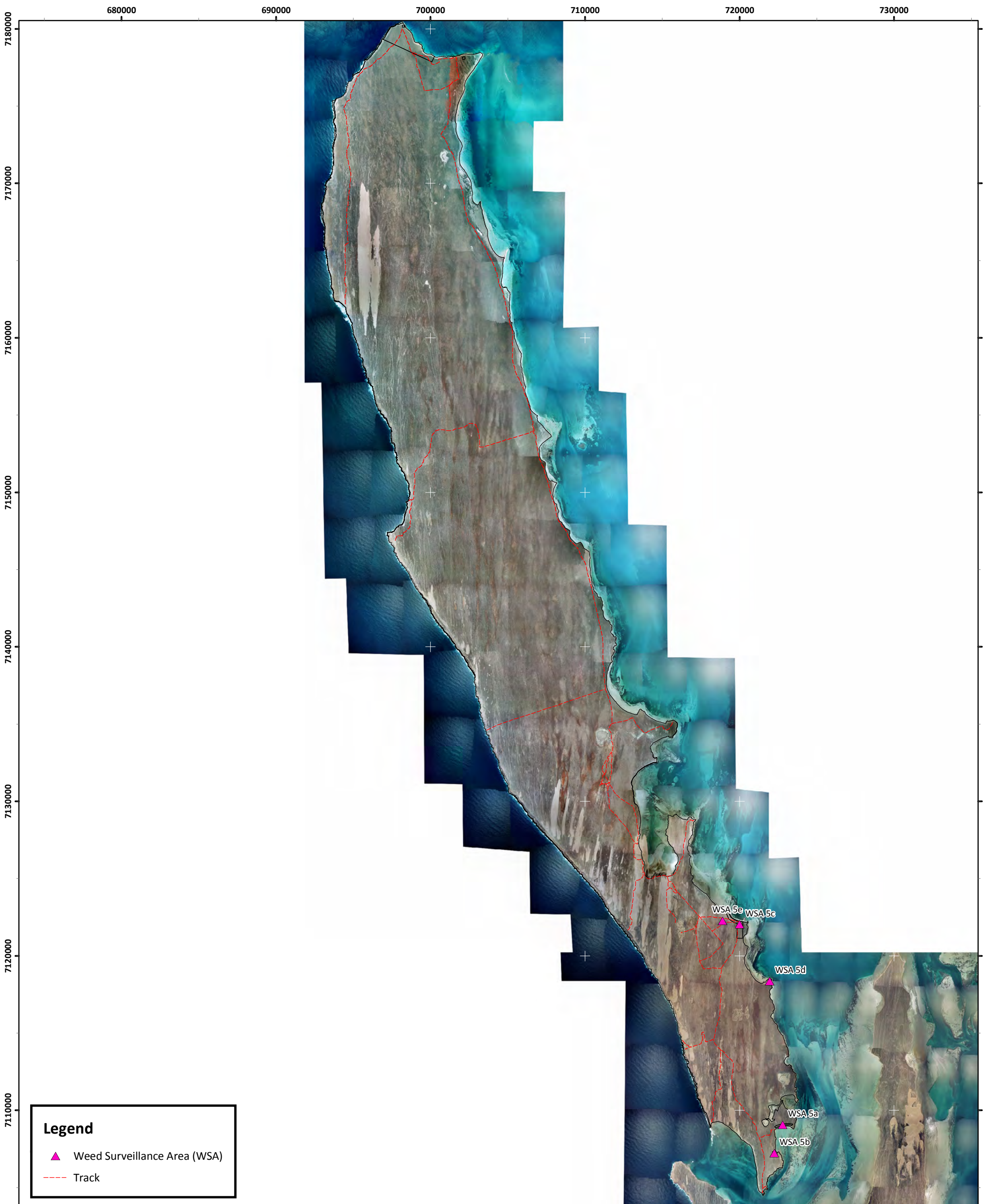


Author: S. Moore	Date: 20-11-2012
Drawn: Y. Hua	15206-12FMV1Rev0_121120_Figure_C34

Datum: GDA 1994
 Projection: MGA Zone 49

0 2,500 5,000 10,000 15,000 Metres

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Figure C.3.5: Weed Surveillance Area 5 – Freehold lease (50 m buffer)

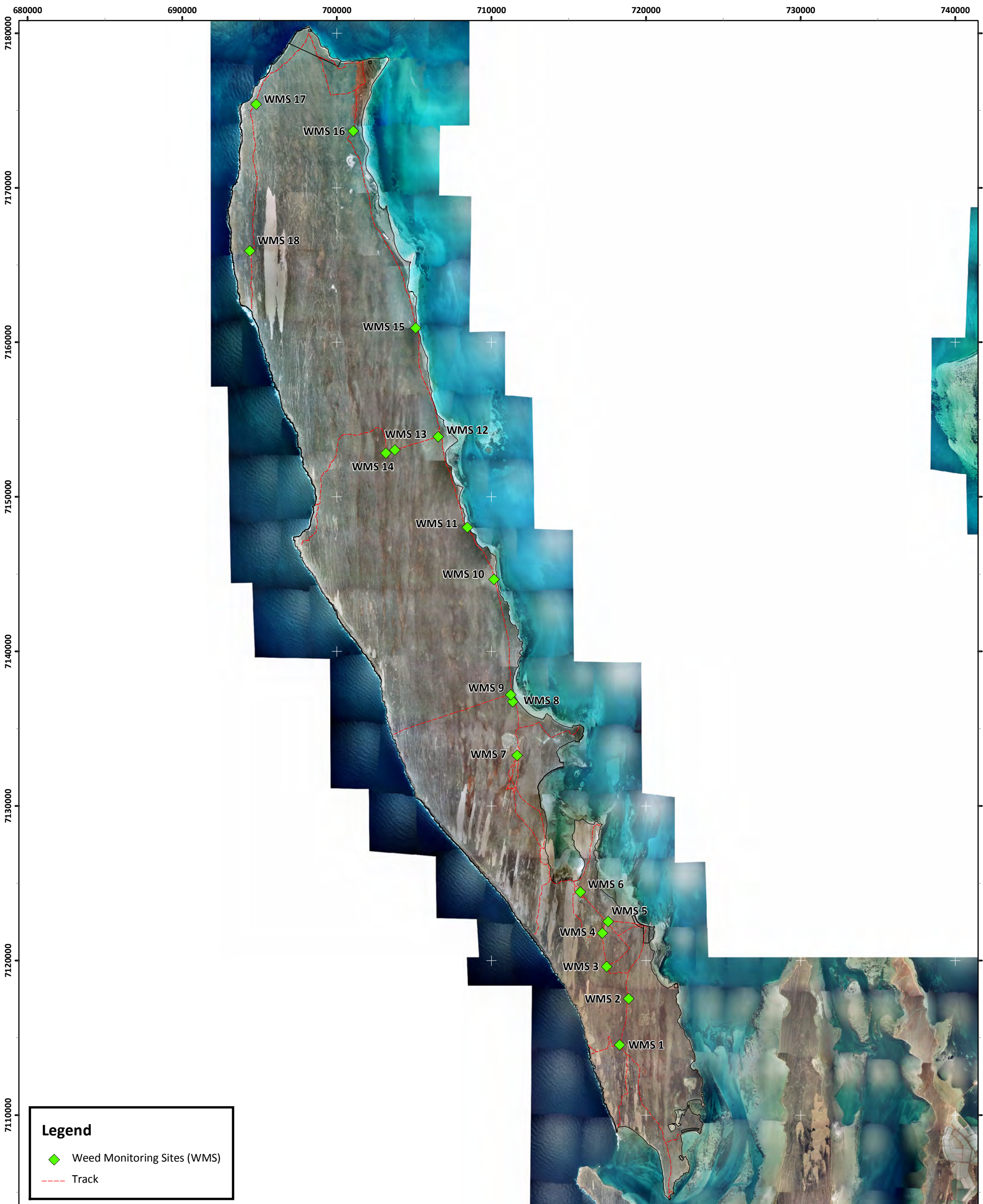


Author: S. Moore	Date: 20-11-2012
Drawn: Y. Hua	15206-12FMV1Rev0_121120_Figure_C35

Datum: GDA 1994
 Projection: MGA Zone 49

0 2,500 5,000 10,000 15,000 Metres

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Figure C.4: Weed Monitoring Sites



Author: S. Moore	Date: 20-11-2012
Drawn: C. Smith	15206-12FMV1Rev0_121120_Figure_C_4

Datum: GDA 1994
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Appendix D: Weed Fact Sheets

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WEED NOTE Mid-West

Birdwood grass (*Cenchrus setiger*)

FAMILY: Poaceae

STATUS: Alien¹, naturalised², invasive³ and serious environmental weed⁴.

TYPE: Erect, perennial grass.

IDENTIFICATION: *Cenchrus setiger* (birdwood grass) can be identified by a ring of short hairs at the base of the leaf blade. As a seedling, the species can also be distinguished from other grasses by a red or purplish colour at the base of the cotyledons (the first two leaves that the seedling sprouts). Birdwood grass can be distinguished from *C. ciliaris* (buffel grass) by its seeds. Buffel grass seeds have long, fine bristles, which birdwood grass seeds lack⁵. This gives birdwood grass seed heads a more 'woody' feel, whereas buffel grass seeds have a softer appearance and feel.

DESCRIPTION: Birdwood grass is an erect, tussocky (appearing as tufts or clumps) perennial that can grow up to 1.5 m tall¹. The seed head are up to 20 cm long and are produced in spring and summer⁶. The flower is erect and spike-like, showing cream to purple flowers from April to May. The flower head starts off as green and matures to straw-coloured or dark purple⁴.

DISTRIBUTION: Birdwood grass is native to Africa and India⁶.

PREFERRED HABITAT: Birdwood grass prefers sand dunes, plains, rangelands, stony hillsides and floodplains¹.

KNOWN LOCATIONS IN WA:

Birdwood grass is has been established as fodder grass in pastoral areas⁶, and has become a serious weed of watercourses from Carnarvon to the Kimberley⁶.

Plate 4: Distinguishing feature



Author: Jesse Kalic

Plate 1: Mature plant



Plate 2: Seed head



Plate 3: Individual seed



THREAT/ IMPACT: Environmental

Birdwood grass competes with native species, reducing biodiversity. It is a particular threat to the tropical savannas in northern Australia⁵.

References

- 1 Western Australian Herbarium, FloraBase, Department of Environment and Conservation (2012). *Cenchrus setiger*. Accessed from: <<http://florabase.dec.wa.gov.au/browse/profile/29721>>. [18 September 2012].
- 2 Van Vreeswyk, A.M.E., Payne, A.L., Leighton, K.A. and Hennig, P. (2004). Technical Bulletin No. 92: An Inventory and condition survey of the Pilbara region, Western Australia. Department of Agriculture Western Australia, South Perth.
- 3 Department of Environment and Conservation (2009). Invasive Plant Prioritisation Process for DEC - DEC Pilbara Weed Assessment. Accessed from: <<http://www.dec.wa.gov.au/content/view/6295/2358/1/1/>>. [18 September 2012].
- 4 Tropical Forages (2012). *Cenchrus setiger*. Accessed from: <http://www.tropicalforages.info/key/Forages/Media/Html/Cenchrus_setiger.h>. [18 September 2012].
- 5 Cooperative Research Centre for Australian Weed Management (2008). Weed Management Guided - Buffel grass (*Cenchrus ciliaris*). Accessed from: <http://www.dpi.nsw.gov.au/_data/assets/pdf_file/0005/347153/awmg_buffel-grass.pdf>. [19 September 2012].
- 6 Hussey B.M.J, Keighery, G.J., Dodd, J., Lloyd, S.G., Cousens, R.D., (2007). Western Weeds A Guide to the Weeds of Western Australia, (2nd Edition), Weeds Society of Western Australia, Victoria Park, Western Australia.

WEED NOTE Mid-West

Buffel grass (*Cenchrus ciliaris*)

FAMILY: Poaceae

STATUS: Alien¹, serious environmental weed (invasive and presence dramatically alters ecology)².

TYPE: Erect, annual/ perennial grass.

IDENTIFICATION: *Cenchrus ciliaris* (buffel grass) can be identified by a ring of short hairs at the base of the leaf blade³. As a seedling, the species can also be distinguished from other grasses by a red or purplish colour at the base of the cotyledons (the first two leaves that the seedling sprouts).

DESCRIPTION: Buffel grass is a tufted, often tussocking perennial that can grow to 1 m high¹. It can also occur as a small annual, flowering at 3 - 5 cm tall in arid environments (V. Long pers. obs.). Buffel grass is distinguished by purplish or brown (turning white when mature) seedheads in a dense, bristly or fluffy cylindrical spike³. Buffel grass germinates from seed, and can also regenerate new shoots from subsurface rootstock (stolons).

DISTRIBUTION: Buffel grass is native to Africa and India⁴.

PREFERRED HABITAT: Buffel grass is a widespread weed of roadsides, creeklines, river edges, and most vegetation types throughout its range⁴.

KNOWN LOCATIONS IN WA:

This species has become a widespread weed throughout the Mid West Pilbara, Gascoyne and Kimberley regions⁴.



Plate 1: Mature plant



Plate 2: Seed head



Plate 3: Seedling



Plate 4: Distinguishing feature

THREAT/ IMPACT: Environmental

Buffel grass is a major environmental weed in northern Australia as it replaces native understory species and increases the frequency of bushfires^{3,4}. Buffel grass continues to spread throughout the state, both naturally and by deliberate establishment⁴. The tough rootstock of perennial plants allows the plant to remain dormant for many years of drought. Seed persists and remains viable in soil for long periods and the plant is able to grow to a minimum height of 3 cm and flower and seed, all of which makes the species difficult to eradicate (V. Long pers. obs).

References

- 1 Western Australian Herbarium, FloraBase, Department of Environment and Conservation (2012). *Cenchrus ciliaris*. Accessed from: <<http://florabase.dec.wa.gov.au/browse/profile/258>>. [21 August 2012].
- 2 CSIRO (2011). Valuable pasture weed species versus environmental weed. Accessed from: <<http://www.csiro.au/en/Outcomes/Food-and-Agriculture/BufferGrass.aspx>>. [21 August 2012].
- 3 Weeds Australia (2012). Buffel Grass - *Cenchrus ciliaris*. Accessed from: <<http://www.weeds.org.au/cgi-bin/weedident.cgi?tpl=plant.tpl&iibra=all&card=G06>>. [21 August 2012].
- 4 Hussey B.M.J., Keighery, G.J., Dodd, J., Lloyd, S.G., Cousens, R.D., (2007). *Western Weeds A Guide to the Weeds of Western Australia*, (2nd Edition), Weeds Society of Western Australia, Victoria Park, Western Australia.

Author: Jesse Kalic, Reviewer: Vicki Long

WEED NOTE Mid-West

Castor oil plant (*Ricinus communis*)

FAMILY: Euphorbiaceae

STATUS: Alien, invasive (spreads rapidly)².

TYPE: Erect/sprawling, perennial shrub/tree.

IDENTIFICATION: *Ricinus communis* (castor oil plant) has palmate leaves with 5-9 serrated lobes, each containing a prominent mid vein that connects to the point of the central stalk².

DESCRIPTION: Castor oil plant grows up to 3 m high and has stout hollow branches that are a dull reddish brown colour⁴. Plants have large leaves that are glossy, dark reddish green when young and a glossy green when mature. Flowers produced are about 2.5 cm across and are covered with soft green or red spines³.

DISTRIBUTION: Castor oil plant is a native of Africa and Eurasia².

PREFERRED HABITAT: Castor oil plant is most commonly found in disturbed areas, road and rail verges, rivers and creeks¹.

KNOWN LOCATIONS IN WA:

Castor oil plant has been recorded over a large area from Esperance to Kununurra¹.



Plate 1: Mature plant



Plate 2: Immature fruit



Plate 3: Flower



Plate 4: Distinguishing feature

THREAT/ IMPACT: Environmental and Agricultural

Castor oil plant seedlings have the potential to grow quickly and establish deep taproot systems that may out-compete native species². Seeds of this plant are extremely poisonous and have been known to kill birds that have been fed contaminated grain¹. Plants also contain milky sap stored in their stems which can cause a nasty rash if it comes in contact with skin².

References

- 1 Hussey B.M.J, Keighery, G.J., Dodd, J., Lloyd, S.G., Cousens, R.D., (2007). Western Weeds A Guide to the Weeds of Western Australia, (2nd Edition), Weeds Society of Western Australia, Victoria Park, Western Australia.
- 2 Department of Agriculture and Food Western Australia (2011). Castor oil plant and its control. Accessed from: <http://www.agric.wa.gov.au/objtwr/imported_assets/content/pw/weed/fn_control_castor_oil_plant.pdf>. [12 October 2012].
- 3 Weeds Australia (2012). *Ricinus communis*. Accessed from: <<http://www.weeds.org.au/cgi-bin/weedident.cgi?tpl=plant.tpl&ibra=all&card=505>>. [3 October 2012].
- 4 Department of Primary Industries - Queensland (2012). *Ricinus communis*. Accessed from: <http://www.daff.qld.gov.au/documents/Biosecurity_EnvironmentalPests/IPA-Castor-Oil-Bush-PP44.pdf>. [3 October 2012].

Author: Nick Wilson

WEED NOTE Mid-West

Common sowthistle (*Sonchus oleraceus*)

FAMILY: Asteraceae

STATUS: Alien¹, invasive (spreads rapidly)².

TYPE: Erect, annual/ perennial herb.

IDENTIFICATION: The leaves of *Sonchus oleraceus* (common sowthistle) are thin and soft, hairless, and dark green with white to purple veins. The leaves are moderately to deeply lobed and the terminal lobe is usually the largest. The bases of the leaves have pointed, ear-shaped lobes on each side of the leaf base where the base of the leaf meets the stem. The leaf margins can be toothed but are not spiny³.

DESCRIPTION: Common sowthistle is an erect annual herb that grows to 1.5 m¹. The stem is hollow and produces a white latex when cut⁴. The flower heads feature yellow ray florets (small flowers, each flower head is composed of many of these) which open in the morning and close in the afternoon⁴.

DISTRIBUTION: Common sowthistle is a native of Eurasia and North Africa⁴.

PREFERRED HABITAT: This species mainly occurs in wastelands, disturbed grounds, and roadsides^{1,4}.

KNOWN LOCATIONS IN WA:

This species is widespread throughout the southern part of Western Australia and up the coast as far north as Karratha. Further records of this species are scattered throughout the Pilbara, Midwest, and Kimberley¹.



Plate 4: Distinguishing feature

Author: Jesse Kalic, Reviewer: Vicki Long



Plate 1: Mature plant



Plate 2: Flower



Plate 3: Seedling

THREAT/ IMPACT: Environmental and Agricultural

A single plant can produce up to 8000 seeds¹. Seed dispersion is aided by a fine pappus on the seeds⁵. In the Pilbara, seedlings appear in late winter and plants rapidly establish and seed before dying off again with the approach of the hot summer. The weed is a problem in cereal production, horticultural crops, vineyards and tree crops⁵.

References

- 1 Western Australian Herbarium, FloraBase, Department of Environment and Conservation (2012). *Sonchus oleraceus*. Accessed from: <<http://florabase.dec.wa.gov.au/browse/profile/8231>>. [21 August 2012].
- 2 Department of Environment and Conservation (2009). Invasive Plant Prioritisation Process for DEC - DEC Pilbara Weed Assessment. Accessed from: <<http://www.dec.wa.gov.au/content/view/full/6295/2358/1/1/>>. [21 August 2012].
- 3 Department of Primary Industries (2011). *Sonchus oleraceus*. Accessed from: <http://vro.dpi.vic.gov.au/dpi/vro/vrosite.nsf/pages/sip_salt_common_sow_thistle>. [3 September 2012].
- 4 Hussey B.M.J, Keighery, G.J., Dodd, J., Lloyd, S.G., Cousens, R.D., (2007). *Western Weeds A Guide to the Weeds of Western Australia*, (2nd Edition), Weeds Society of Western Australia, Victoria Park, Western Australia.
- 5 Department of Agriculture and Food Western Australia (2012). *Common Sowthistle*. Accessed from: <http://www.agric.wa.gov.au/objtwr/imported_assets/content/pw/weed/major/sowthistle.pdf>. [21 August 2012].

WEED NOTE Mid-West

Couch (*Cynodon dactylon*)

FAMILY: Poaceae

STATUS: Alien¹, serious environmental weed (invasive and presence dramatically alters ecology)², native to parts of Australia^{3,4}.

TYPE: Rhizomatous, perennial herb.

IDENTIFICATION: *Cynodon dactylon* (couch) can be identified primarily by its dense mat forming stoloniferous habit and by its seed heads. These occur on an erect stalk up to 30 cm tall and have 2 - 7 finger-like spikes⁵, which resemble wheel spokes⁶. The spikes are approximately 3 - 5 cm long and purplish in colour⁶.

DESCRIPTION: Couch is a low, creeping grass that spreads by runners which can form their own roots³. The leaves are bluish-green and may or may not be hairy^{4,6}. The leaf blades are linear-triangular in shape and 2 - 5 cm long and 2 - 4 mm wide⁵.

DISTRIBUTION: Couch has been described separately as being native to Australia³, native to the Kimberley and the tropics worldwide⁴, and native to southern Africa and south-east Asia⁵. It is possible that there are both native and non-native forms of couch in Australia.

PREFERRED HABITAT: Couch has been widely planted as a lawn grass, but has invaded wetlands and river edges in southwest Western Australia⁴.

KNOWN LOCATIONS IN WA:

Couch occurs throughout Western Australia, but is more concentrated in the Perth region and the Kimberley¹.



Plate 4: Distinguishing feature



Plate 1: Mature plant



Plate 2: Flower head



Plate 3: Runner

THREAT/ IMPACT: Environmental and Agricultural

Couch spreads rapidly by seed and runners which root readily and is highly invasive of wetlands and rivers⁴. Toxicity in grazing animals has been recorded but is rare⁵.

References

1 Western Australian Herbarium, FloraBase, Department of Environment and Conservation (2012). *Cynodon dactylon*. Accessed from: <<http://florabase.dec.wa.gov.au/browse/profile/283>>. [10 September 2012].

2 Northern Land Manager (2011). Managing weeds for wildlife conservation - Couch Grass, *Cynodon dactylon*. Accessed from: <<http://www.landmanager.org.au/managing-weeds-wildlife-conservation-couch-grass-cynodon-dactylon>>. [12 October 2012].

3 Weeds Australia, (2012). Couch Grass - *Cynodon dactylon*. Accessed from: <<http://www.weeds.org.au/cgi-bin/weedident.cgi?tpl=plant.tpl&iibra=all&card=E14>>. [10 September 2012].

4 Hussey B.M.J, Keighery, G.J., Dodd, J., Lloyd, S.G., Cousens, R.D., (2007). Western Weeds A Guide to the Weeds of Western Australia, (2nd Edition), Weeds Society of Western Australia, Victoria Park, Western Australia.

5 Department of Agriculture and Food Western Australia (2012). Couch grass (*Cynodon dactylon*). Accessed from: <http://www.agric.wa.gov.au/objtwr/imported_assets/content/past/couch%20grass.pdf>. [10 September 2012].

6 Mangrove Mountain Computer Club (2008). Couch grass (*Cynodon dactylon*). Accessed from: <<http://www.weeds.mangrovemountain.net/ruminants.html>>. [10 September 2012].

Author: Jesse Kalic, Reviewer: Tom Atkinson

WEED NOTE *Mid-West*

False sowthistle (*Reichardia tingitana*)

FAMILY: Asteraceae

STATUS: Alien, invasive (spreads rapidly)².

TYPE: Erect, annual/perennial herb.

IDENTIFICATION: *Reichardia tingitana* (false sowthistle) has fleshy, hairless leaves that have prickly margins. The leaves are lance shaped with the narrow end connected to the stem³.

DESCRIPTION: False sowthistle is an erect annual/perennial herb that grows to 50cm tall³. Dandelion like flowers² are produced from August to October¹ and are yellow with a purplish base and the outer petals are red-striped³.

DISTRIBUTION: False sowthistle is a native to the Mediterranean region³.

PREFERRED HABITAT: False sowthistle can be found growing within coastal dunes, alluvial river flats¹, townsites and roadsides².

KNOWN LOCATIONS IN WA:

False sowthistle has been recorded from Shark Bay to to Jurien Bay and is commonly recorded around Geraldton².

Plate 1: Mature plant



Plate 2: Leaves



Plate 3: Seed head



Plate 4: Distinguishing feature



THREAT/ IMPACT: Environmental and Agricultural

False sowthistle is considered a minor environmental weed in Western Australia. Seeds are light and fluffy so can be spread over a long distance by wind⁴.

References

1 Western Australian Herbarium, FloraBase, Department of Environment and Conservation (2012). *Reichardia tingitana*. Accessed from: <<http://florabase.dec.wa.gov.au/browse/profile/8197>>. [3 October 2012].

2 Hussey B.M.J, Keighery, G.J., Dodd, J., Lloyd, S.G., Cousens, R.D., (2007). *Western Weeds A Guide to the Weeds of Western Australia*, (2nd Edition), Weeds Society of Western Australia, Victoria Park, Western Australia.

3 Department of Primary Industries - Victoria (2012). *False Sow-thistle*. Accessed from: <http://vro.dpi.vic.gov.au/dpi/vrosite.nsf/pages/sip_salt_false_sow_thistle>. [3 October 2012].

4 Department of Primary Industries - Queensland (2012). *Reichardia tingitana*. Accessed from: <http://keyserver.lucidcentral.org/weeds/data/03030800-0b07-490a-8d04-0605030c0f01/media/Html/Reichardia_tingitana.htm>. [3 October 2012].

Author: Nick Wilson

WEED NOTE ^{Mid-West}

Fourleaf allseed

(*Polycarpon tetraphyllum*)

FAMILY: Caryophyllaceae

STATUS: Alien¹.

TYPE: Prostrate, annual herb.

IDENTIFICATION: *Polycarpon tetraphyllum* (fourleaf allseed) can be distinguished by its flowers, which are tiny and occur in clusters at the ends of stems. The petals are mostly hidden within the calyx (a whorl of leaf-like appendages that surround the flower)³.

DESCRIPTION: Fourleaf allseed is a small, erect, spreading, or prostrate annual herb to 15 cm tall¹. The leaves are dark green and oval-shaped and occur in whorls (a ring-like arrangement) of four surrounding the stem². The leaves in each whorl are often two different sizes, with each opposite pair being the same size. The stem, leaves, and calyx can be green to pink.

DISTRIBUTION: Fourleaf allseed is native to Europe³.

PREFERRED HABITAT: Fourleaf allseed is widespread weed of gardens, limestone areas, and Tuart woodlands from Exmouth to Bunbury³.

KNOWN LOCATIONS IN WA:

Fourleaf allseed occurs along the coastline and a few hundred km inland from Israelite Bay to Onslow¹.



Plate 1: Mature plant



Plate 2: Leaves



Plate 3: Seedlings



Plate 4: Distinguishing feature

THREAT/ IMPACT: Environmental

Fourleaf allseed is a prolific seeder⁴. Its ecological impact has been rated by the Department of Environment and Conservation as low⁵.

References

¹ Western Australian Herbarium, FloraBase, Department of Environment and Conservation (2012). *Polycarpon tetraphyllum*. Accessed from: <<http://florabase.dec.wa.gov.au/browse/profile/2905>>. [19 September 2012].

² The University of Queensland (2012). *Polycarpon tetraphyllum*. Accessed from: <http://keys.lucidcentral.org/keys/v3/UQCenentary/key/UQ_Cenentary/Media/Html/polycarpontetraphyllum.htm>. [19 September 2012].

³ Hussey B.M.J., Keighery, G.J., Dodd, J., Lloyd, S.G., Cousens, R.D., (2007). *Western Weeds A Guide to the Weeds of Western Australia*, (2nd Edition), Weeds Society of Western Australia, Victoria Park, Western Australia.

⁴ International Environmental Weed Foundation (2007). *Polycarpon tetraphyllum*. Accessed: <http://www.iewf.org/weedid/Polycarpon_tetraphyllum.htm>. [19 September 2012].

⁵ Department of Environment and Conservation (2009). *Invasive Plant Prioritisation Process for DEC - DEC Pilbara Weed Assessment*. Accessed from: <<http://www.dec.wa.gov.au/content/view/6295/2358/1/1/>>. [19 September 2012].

Author: Jesse Kalic

WEED NOTE Mid-West

Ice plant

(*Mesembryanthemum crystallinum*)

FAMILY: Aizoaceae

STATUS: Alien, invasive (spreads rapidly)².

TYPE: Spreading, annual/biannual herb.

IDENTIFICATION: *Mesembryanthemum crystallinum* (ice plant) leaves are ovate and covered by large bladder cells that give them a distinctive glistening appearance³.

DESCRIPTION: Ice plant is grows like a mat along the ground up to 1 metre across and is covered in large³. Plants usually produce small white flowers during spring².

DISTRIBUTION: Ice plant is a native to South Africa².

PREFERRED HABITAT: Ice plant is generally a weed of saline farmland soils, granite rocks in arid areas, salt lake margins² and sand dunes³.

KNOWN LOCATIONS IN WA:

Ice plant has been recorded over widespread areas from Carnarvon to Eucla².

Plate 4: Distinguishing feature



THREAT/ IMPACT: Environmental and Agricultural

Ice plant can form dense mats that prevent the germination of other plants and since plants accumulate salt, when the plant dies the salt leaches into the soil surrounding the individual, preventing less salt tolerant species from establishing³. Seed can persist in the soil for 20+ years¹.

Plate 1: Mature plant



Plate 2: Leaf



Plate 3: Leaves



Author: Nick Wilson

References

- 1 Western Australian Herbarium, FloraBase, Department of Environment and Conservation (2012). *mesembryanthemum crystallinum*. Accessed from: <<http://florabase.dec.wa.gov.au/browse/profile/2813>>. [3 October 2012].
- 2 Hussey B.M.J, Keighery, G.J., Dodd, J., Lloyd, S.G., Cousens, R.D., (2007). *Western Weeds A Guide to the Weeds of Western Australia*, (2nd Edition), Weeds Society of Western Australia, Victoria Park, Western Australia.
- 3 CSIRO (2012). *Mesembryanthemum crystallinum*. Accessed from: <<http://www.anbg.gov.au/cpbr/WfHC/Mesembryanthemum/index.html>>. [3 October 2012].

WEED NOTE Mid-West

Japanese pepper

(*Schinus terebinthifolius*)

FAMILY: Anacardiaceae

STATUS: Alien, serious environmental weed (invasive and presence dramatically alters ecology)².

TYPE: Erect/sprawling, perennial shrub/tree.

IDENTIFICATION: *Schinus terebinthifolius* (Japanese pepper) can be distinguished by branchlets not hanging, leaves and also the bright red fruits smell peppery when they are crushed¹.

DESCRIPTION: Japanese pepper is an erect tree or sprawling shrub that can grow up to 15 metres tall, but more commonly to 6 metres. Male trees produce small cream flowers in late summer, whilst the female trees produce the bright red fruit that is 1-seeded³.

DISTRIBUTION: Japanese pepper originates from Brazil³.

PREFERRED HABITAT: Japanese pepper has escaped from cultivation and can be found in areas that are disturbed³, but can invade a number of natural environments¹.

KNOWN LOCATIONS IN WA:

Japanese pepper has been recorded around Geraldton, Perth and in the Goldfields³.



Plate 1: Seedling



Plate 2: Leaves



Plate 3: Flowers



Plate 4: Distinguishing feature

THREAT/ IMPACT: Environmental

Japanese pepper can dominate ecosystems preventing growth of native species¹. Berries are most likely spread by birds so they can be transported over long distances³.

References

¹ Weeds Australia (2012). *Schinus terebinthifolius*. Accessed from: <<http://www.weeds.org.au/cgi-bin/weedident.cgi?tpl=plant.tpl&ibra=all&card=T41>>. [3 October 2012].

² PlantNet - New South Wales Flora Online (2012). *Schinus terebinthifolius*. Accessed from: <[http://plantnet.rbgsyd.nsw.gov.au/cgi-bin/NSWfl.pl?page=nswfl&lvl=sp&name=Schinus terebinthifolius](http://plantnet.rbgsyd.nsw.gov.au/cgi-bin/NSWfl.pl?page=nswfl&lvl=sp&name=Schinus%20terebinthifolius)>. [3 October 2012].

³ Hussey B.M.J, Keighery, G.J., Dodd, J., Lloyd, S.G., Cousens, R.D., (2007). *Western Weeds A Guide to the Weeds of Western Australia*, (2nd Edition), Weeds Society of Western Australia, Victoria Park, Western Australia.

Author: Nick Wilson

WEED NOTE Mid-West

Mediterranean turnip (*Brassica tournefortii*)

FAMILY: Brassicaceae

STATUS: Alien, invasive (spreads rapidly)².

TYPE: Erect/branched, annual herb.

IDENTIFICATION: *Brassica tournefortii* (Mediterranean turnip) can be identified by pinnate leaves that contain sharp lobes pointing backwards towards the leaf base. The inflorescence is densely hairy although the hairs become more sparse towards the top³.

DESCRIPTION: Mediterranean turnip grows from 10 cm to 60 cm tall. Flowers are produced from June to November and contain petals that are yellow to cream in colour⁴. Fruit produced is 3 mm to 7 mm long and 2 mm to 3 mm wide, constricted inbetween each seed⁴.

DISTRIBUTION: Mediterranean turnip is a native to southern Europe, northern Africa, western Asia, the Arabian Peninsula and Pakistan².

PREFERRED HABITAT: Mediterranean turnip is commonly found growing in areas of wasteland, roadsides, grazed woodlands, shrublands, islands and a wide spread agricultural weed³.

KNOWN LOCATIONS IN WA:

Mediterranean turnip is a widespread weed recorded in the areas from Carnarvon to Eucla³.

Plate 4: Distinguishing feature



Plate 1: Basal rosette of leaves



Plate 2: Mature plant



Plate 3: Flowers



THREAT/ IMPACT: Environmental and Agricultural

Mediterranean turnip is an aggressive weed of sandy and disturbed soils in Western Australia and can displace native vegetation. Seeds can poison stock if too many are injected¹.

References

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WEED NOTE ^{Mid-West}

Pimpernel (*Lysimachia arvensis*)

FAMILY: Primulaceae

STATUS: Alien, invasive (spreads rapidly)².

TYPE: Sprawling, annual herb.

IDENTIFICATION: *Lysimachia arvensis* (pimpernel) has bright green oval sessile leaves that grow in opposite pairs. The petal margins on the flowers are somewhat crenate and have small glandular hairs¹.

DESCRIPTION: Pimpernel grows to about 50 cm long and produces small orange, red or blue flowers in the leaf axis and are usually produced from spring to autumn¹.

DISTRIBUTION: Pimpernel is a native to the Mediterranean region¹.

PREFERRED HABITAT: Pimpernel is generally a weed of light soils¹.

KNOWN LOCATIONS IN WA:

Records are widespread in areas from Carnarvon to Eucla¹.

THREAT/ IMPACT: Environmental and Agricultural

This plant has been linked to the poisoning death of cattle in Uruguay and sheep in Australia².

Plate 1: Leaf



Plate 2: Mature plant



Plate 3: Flowers



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References

¹ Atlas of Living Australia (2012). Scarlet pimpernel. Accessed from: <<http://bie.ala.org.au/species/Lysimachia+arvensis>>. [3 October 2012].

² Kelly JC, McCowan CI, Roche MJ., (2012). Suspected poisoning of cattle by scarlet pimpernel (*Lysimachia arvensis* L.), Australian Veterinary Association, Warrnambool, Victoria.

WEED NOTE *Mid-West*

Red brome

(*Bromus rubens/madritensis*)

FAMILY: Poaceae

STATUS: Alien, invasive (spreads rapidly)².

TYPE: Slender to tufted, annual grass.

IDENTIFICATION: *Bromus rubens/madritensis* (red brome) can be identified by its flat, hairy or glabrous leaves³ that are 20 cm long and 5 mm wide, containing plump purpleish to red-brown spikelets 12 - 20 mm long².

DESCRIPTION: Red brome is a tufted annual grass like herb that grows from 10 - 40 cm high with erect or bent stems¹. The inner flowering bracts is 10 - 14 mm long and has a long straight awn or bristle, 8 - 12 mm long⁴.

DISTRIBUTION: Red brome is native of the Mediterranean region³.

PREFERRED HABITAT: Red brome is a common weed of disturbed areas, firebreaks³, open areas¹, sandy soils, dry lake beds and river flats⁴.

KNOWN LOCATIONS IN WA:

Red brome has been recorded in a wide range of habitats from Eyre to Shark Bay¹.

Plate 4: Distinguishing feature



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Plate 1: Mature plants



Plate 2: Emerging flower-head



Plate 3: Young flower-heads



THREAT/ IMPACT: Environmental and Agricultural

Red brome produces a large amount of seed and biomass that can create a fire hazard once it dies off and dries. This species starts off slowly but can invade an area and displace native grasses¹.

References

- 1 Western Australian Herbarium, FloraBase, Department of Environment and Conservation (2012). *Bromus rubens*. Accessed from: <<http://florabase.dec.wa.gov.au/browse/profile/253>>. [3 October 2012].
- 2 PlantNet - New South Wales Flora Online (2012). *Bromus rubens*. Accessed from: <[http://plantnet.rbgsyd.nsw.gov.au/cgi-bin/NSWfl.pl?page=nswfl&lvl=sp&name=Bromus rubens](http://plantnet.rbgsyd.nsw.gov.au/cgi-bin/NSWfl.pl?page=nswfl&lvl=sp&name=Bromus%20rubens)>. [3 October 2012].
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WEED NOTE Mid-West

Rough cat's tail (*Rostraria pumila*)

FAMILY: Poaceae

STATUS: Alien, invasive (spreads rapidly)².

TYPE: Tufted, annual grass.

IDENTIFICATION: *Rostraria pumila* (rough cat's tail) can be identified by bright green leaf blades that are 3 - 7 cm long and 1 - 3 mm wide. The surface of these is glabrous or indumented⁴.

DESCRIPTION: Rough cat's tail is a tufted annual grass that grows from 5 cm to 30 cm tall⁴. The inflorescence is a dense panicle, flowering in spring³.

DISTRIBUTION: Rough cat's tail is native of the Mediterranean¹.

PREFERRED HABITAT: Rough cat's tail can be found growing on roadsides, sand dunes, cliff slopes¹ and disturbed habitats⁴.

KNOWN LOCATIONS IN WA:

Rough cat's tail has been recorded throughout the southern half of Western Australia from Esperance to Shark Bay and can be found on offshore islands³.

THREAT/ IMPACT: Environmental

Rough cat's tail is an introduced grass that out competes other grass. It is a common weed of grazed semi-arid woodland and shrublands³ where it can dominate parts of the understory.

Plate 1: Mature plant

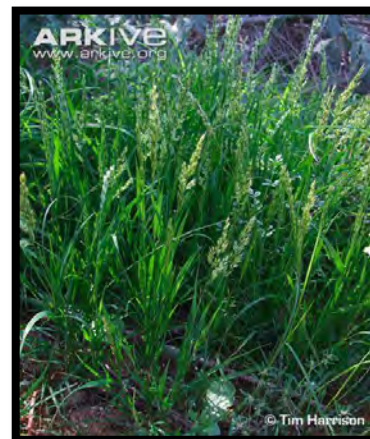


Plate 2: Flower head



References

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- 2 PlantNet - New South Wales Flora Online (2012). *Rostraria cristata*. Accessed from: <<http://plantnet.rbgsyd.nsw.gov.au/cgi-bin/NSWfl.pl?page=nswfl&lvl=sp&name=Rostraria~pumila>>. [15 October 2012].
- 3 Hussey B.M.J, Keighery, G.J., Dodd, J., Lloyd, S.G., Cousens, R.D., (2007). *Western Weeds A Guide to the Weeds of Western Australia*, (2nd Edition), Weeds Society of Western Australia, Victoria Park, Western Australia.
- 4 AusGrass2, (2011). *Rostraria pumila*, <http://ausgrass2.myspecies.info/content/rostraria-pumila>. [15 October 2012]

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