

The vegetation and dynamics of coastal dunes at Ramblers Road Foreshore, Portarlinton

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Glossary

Biodiversity	<p>The biological diversity of lifeforms is commonly regarded as comprising three components:</p> <ul style="list-style-type: none"> — Genetic diversity — the variety of genes (or units of heredity) in any population. — Species diversity — the variety of species. — Ecosystem diversity — the variety of communities or ecosystems.
Bioregion (region)	A bioregion defined in a national system of bio-regionalisation based on landscape-based variation in climate, geomorphology, lithology and vegetation.
CMA	<p>Catchment Management Authority (CMA). Victoria is divided into 10 catchment regions, each with a Catchment Management Authority.</p> <p>Under the Water Act 1989, CMAs have management powers over regional waterways, floodplains, drainage and environmental water.</p>
DELWP Advisory listing	Department of Environment, Land, Water and Planning (DELWP) Advisory list of rare or threatened flora and fauna.
Department of Environment, Land, Water and Planning (DELWP)	<p>This department was formerly known as:</p> <ul style="list-style-type: none"> — Department of Environment and Primary Industries (DEPI). — Department of Planning, Local Government, and Property and Land Titles (DTPLI).
Ecological community	An assemblage of species (both flora and fauna, including microorganisms) that are interacting in a unique habitat. The structure, composition and distribution of ecological communities are determined by environmental factors such as climate, geomorphology and lithology.
Ecological Vegetation Class (EVC)	A type of native vegetation classification that is described through a combination of its floristics, life form and ecological characteristics, and through an inferred fidelity to particular environmental attributes. Each EVC includes a collection of floristic communities (i.e. lower level in the classification that is based solely on groups in the same species) that occur across a bio-geographic range, and although differing in species, have similar habitat and ecological processes operating.
Environmental weed	Any plant that is not native to a local area that has invaded native vegetation.
EPBC Act	Commonwealth <i>Environment Protection and Biodiversity Conservation Act 1999</i> .

Exotic	Introduced from another geographic location. Used in the context of this report to refer to species (both flora and fauna) that have been introduced from overseas.
FFG Act	State <i>Flora and Fauna Guarantee Act 1988</i> .
GPS	Global Positioning System developed by the United States government. Provides geolocation and time information to a GPS receiver anywhere on or near the Earth where there is an unobstructed line of sight to four or more GPS satellites.
Habitat	An area or areas occupied (either permanently, periodically or occasionally), by a species, population or ecological community. Includes all biotic and abiotic material components.
Indigenous	Native to the subject site (not exotic).
Introduced	Not native to the area: not indigenous. Refers to both exotic and non-indigenous Australian native species of plants and animals.
Local population	The population that occurs within the site unless the existence of contiguous or proximal occupied habitat and the movement of individuals or exchange of genetic material across the boundary can be demonstrated.
Locality	The area within a ten-kilometre radius of the site.
Matters of National Environmental Significance (MNES)	The following Matters of National Environmental Significance are protected under the <i>Environment Protection and Biodiversity Conservation Act 1999</i> (EPBC Act): listed threatened species and communities, listed Migratory species, Ramsar wetlands of international importance, Commonwealth marine environment, World Heritage Properties, National Heritage Places, the Great Barrier Reef Marine Park and nuclear actions.
Migratory species	Species listed as Migratory under the Commonwealth <i>Environment Protection and Biodiversity Conservation Act 1999</i> relating to international agreements to which Australia is a signatory. These include Japan-Australia Migratory Bird Agreement, China-Australia Migratory Bird Agreement, Republic of Korea-Australia Migratory Bird Agreement and the Bonn Convention on the Conservation of Migratory Species of Wild Animals.
Non-indigenous native	A plant species that is native to Australia that has been introduced to the subject site.
Noxious weed	An introduced species listed under the <i>Catchment and Land Protection Act 1993</i> . Under the Act, noxious weeds have specific control measure and reporting requirements.
Revegetation	Establishment of native vegetation to a minimum standard in formerly cleared areas, outside of a native vegetation patch

Significant	Important; typically used to describe the importance of a species or community at local, regional, state or commonwealth levels.
Significant species	A species listed under the EPBC Act, FFG Act or DELWP Advisory Lists as Migratory, Marine, Extinct, Regionally Extinct, Critically Endangered, Endangered, Vulnerable, Conservation dependent, Threatened, Near threatened or data deficient.
<i>Sp.</i>	Abbreviation of species
<i>Subsp.</i>	Abbreviation of subspecies
Threatened species, populations and ecological communities	Species, populations and ecological communities listed as Vulnerable, Endangered or Critically Endangered (collectively referred to as Threatened) under the DELWP's Advisory listings, the FFG Act, or EPBC Act. Capitalisation of the terms 'Threatened', 'Vulnerable', 'Endangered' or 'Critically Endangered' in this report refers to listing under the relevant state and/or Commonwealth legislation.
Weed	A plant growing where it is not wanted: often (but not necessarily) characterised by high seed production and the ability to colonise an ecosystem quickly and out-compete indigenous flora. Weeds include both exotic and Australian native species of plant naturalised outside of their natural range.

Summary

Ramblers Road Foreshore, Portarlington is subject to dynamic coastal geomorphological processes that constantly change beach profiles due to accretion or loss of sediments. Extensive sand deposits have extended the beach width in the north-east section of the reserve. Primary succession of recently deposited sands is trending towards the formation of Coastal Dune Scrub dominated by Coast Saltbush, *Atriplex cinerea*. Large open expanses of sand have been invaded by Sea Wheat Grass (*Thinopyrum junceiforme*), amongst a range of other species, which will form a continuous grassy sward in the early recruitment process. Beach recreation patterns are impacted by invasion of Sea Wheat Grass and shrub encroachment. The climax condition (end-point vegetation type) is predicted to be a closed shrubland dominated by Coastal Saltbush, which will be progressively become invaded by woody native trees which have been planted in adjacent beach utility areas and residential gardens. Coast tea-tree (*Leptospermum laevigatum*), Boobialla (*Myoporum insulare*), *Melaleuca nesophila*, *M. armillaris* and several exotic woody shrubs and trees will eventually form a tree stratum over the Coastal Dune Scrub. This vegetation prognosis will severely impact beach utilisation patterns and options. Management of vegetation on recently accredited sands is recommended to improve recreational opportunities for beach users of Ramblers Road Foreshore. Beach grooming in combination of control of Sea Wheat Grass using grass-specific herbicide are key management recommendations. Reducing vegetation invasion of the drier sections of the foreshore will improve habitat availability to strand-nesting shorebirds, as well as broadening recreational use options. Construction of a vegetation buffer adjacent to the proposed open beach area will protect residential assets and infrastructure from coastal erosion impacts. Local native species are recommended for a planned revegetation barrier adjacent to the walking track to the south of the beach zone. Beach grooming and revegetation works aimed at restoring beach functionality are estimated at \$27150 (\$8850 for grooming, \$13500 for revegetation, \$4800 for weed control).

Seagrass wrack accumulation is an ongoing issue for beach users and boating activity at Point Richards. Recent modification of the Point Richards boat ramp has incorporated a rock groyne designed to deflect sea wrack accumulation, but monitoring is required to determine its effectiveness.

1. Introduction

The vegetation and ecological processes at Ramblers Road Foreshore, Portarlington were investigated at the request of the Friends of Ramblers Road Association. Ramblers Road Foreshore has undergone substantial change since the 1970s, and perhaps earlier, due to erosion and accretion of marine sediments. Changing beach profiles have broad range of impacts affecting natural successional vegetation processes, which directly influence recreational use either directly or indirectly. The marine coastal processes driving beach change may also impact local infrastructure. Boating facilities at Point Richards and Portarlington have been impacted by constantly changing sediment and seagrass wrack accumulation which has required management intervention to protect assets and improve utility.

In this report, the vegetation at Ramblers Road Foreshore and the processes leading to its formation is reported. Weed risk threats are examined and recommendations are provided for threat abatement and habitat improvement. Directions for landscape improvements that consider beach use preferences and faunal habitat considerations are provided. Future trends in vegetation dynamics are broadly predicted. Sea Wheat Grass is a recognised threat to coastal littoral natural assets and is present and spreading at Ramblers Road Foreshore. A review of the literature and anecdotal experiences with Sea Wheat Grass control is presented.

1.1 Objectives

The primary objectives of this report are to:

- Determine and document the vegetation history of the site and construct recommendations on what vegetation communities and species are indigenous and suitable for habitat reconstruction (if relevant) along the littoral zone.
- Review the impact of Sea Wheat Grass on flora and fauna habitat values at Portarlington

2. Materials and methods

2.1 Study site

Ramblers Road Foreshore Reserve is located west of Point Richards Road at Portarlington, approximately 22km east of Geelong on the Bellarine Peninsula. The reserve is bounded by private property on the eastern boundary and the high tide line on the western edge. The reserve is approximately 7.4 ha of low relief coastal dunes and unconsolidated beach sands. A small wetland and associated samphire marsh occur in the south-western section of the reserve.

Ramblers Road Foreshore is freehold land owned and managed by the City of Greater Geelong (CoGG) and is zoned Public Park and Recreation Zone (PPRZ) in the Greater Geelong Planning Scheme. The Parks and Gardens team manage the section from the private property boundary to the NE-SW access track, while the Natural Reserves team manages the larger beach front extending from the walking track to the high tide mark. Parks Victoria (PV) is responsible for the recreational use of the waters of Port Phillip Bay and Department of Environment, Land, Water and Planning (DELWP) is the crown land manager which includes both the seabed (high tide mark) and coastal crown land reserves west and south of Ramblers Road. Bellarine Bayside Foreshore Committee manages the Point Richards boat ramp, carpark and pier and are committee of management for foreshore crown land east of Point Richards Road.

Ramblers Road Foreshore was inspected on 28 July 2022 where background information was provided by the Friends of Rambler Road. On 3 August 2022 vegetation was surveyed by random transects along the length of the reserve. All species were recorded, and the boundary of ecological vegetation communities (EVC) were identified. EVC Benchmark criteria (DELWP 2022) were used to verify vegetation communities. Weed risk scores for all exotic species were obtained from White *et al.* (2018).

The extent of indigenous vegetation cover was estimated visually in each of the EVCs. Stands of vegetation with similar structure and floristics were also surveyed after candidate sites were identified using Goggle Earth satellite imagery. Sites at Spray Farm Lane- Portarlington, McAdams Lane – Portarlington, Beacons Point Road - Clifton Springs, and Point Henry - Geelong were inspected on 3 August 2022.

A literature review for Sea Wheat Grass (SWG) (*Thinopyrum junceiforme*) was undertaken by searching published literature using Google Scholar and ResearchGate data search tools. Supporting literature and anecdotes were provided by The Friends of Ramblers Road, and communication with stakeholders.

3. Results and Discussion

3.1 Vegetation communities and floristics

Three Ecological Vegetation Classes were recognised at Ramblers Road Foreshore and follow those documented by Trengrove (2007). Coastal Dune Scrub (EVC 160) occurs over most of the foreshore in various stages of successional development. A total of 71 species were recorded for Ramblers Road Foreshore with 24 indigenous and 47 exotic species (Table 1).

Coastal Dune Scrub is dominated by the woody chenopod shrub *Atriplex cinerea* (Coast Saltbush) where, in its mature state, forms closed thickets. The EVC is most developed at the SW section of the reserve and extends into abutting crown land on low calcareous dunes towards Clifton Springs (Figure 1). The EVC occurs on recently accreted sands in the eastern areas of the foreshore. A total of fifty-seven species were recorded in Coastal Dune Scrub at Ramblers Road Foreshore with 43 exotic species and 14 native species. There were no significant indigenous species present. Nineteen exotic species with a high invasion risk were recorded, where Sea Wheat Grass was the most prevalent. Most high-risk weeds were in the early stage of invasion. Exotic ruderal and native colonising species form most of the canopy cover. Native canopy cover ranged from 5 to 15%. A wetland complex has developed in association with storm water pondage at SW end of the reserve. Two EVCs are present with Coastal Saltmarsh Mosaic (EVC 9) present as a low halophytic herbfield dominated by *Sarcocornia quinqueflora* (Beaded Glasswort) present around the fringes of the water body (Figure 2, Figure 4). Its distribution is limited by moisture availability and salinity levels. In areas where salinity levels are lower and/or water presence of a more permanent nature, Brackish Wetland (EVC 656) has developed with the *Typha domingensis* (Narrowleaf Cumbungi) and *Ficinia nodosa* (Knobby Club Rush) forming as the dominant species (Figure 5). Species diversity was low in both EVCs with 31 species recorded in the Brackish Wetland (14 native, 17 exotic) and 20 species (11 native, 9 exotic) in the Coastal Saltmarsh. *Atriplex paludosa* (Marsh Saltbush) was present as occasional plants in the wetland complex and is listed as endangered under the Victorian Flora and Fauna Act 1988, primarily due to restricted habitat and distribution.

Table. 1. Census of higher plants found at Ramblers Road Foreshore, July 2022. Species listed for each the three EVC's present.

Status	Species	Common Name	FFG Act ¹	Weed rank ²	Risk class	CALP Act ³	Coastal Dune Scrub EVC 160	Brackish wetland EVC 656	Saltmarsh Mosaic EVC 9
	<i>Acacia sophorae</i>	Coast Sallow Wattle					✓		
*	<i>Agapanthus praecox</i>	Agapanthus		32.2	very high		✓		
*	<i>Aizoon pubescens</i>	Galenia		21.1	high		✓		
*	<i>Arctotheca calendula</i>	Cape Weed		12.3	medium		✓		
*	<i>Asparagus asparagoides</i>	Bridal Creeper		23.3	high	*	✓		
	<i>Atriplex cinerea</i>	Coast Saltbush					✓	✓	✓
	<i>Atriplex paludosa</i>	Marsh Saltbush	E					✓	✓

	<i>Austrostipa sp.</i>	Spear Grass				✓		
*	<i>Berkheya rigida</i>	African Thistle	32.1	very high		✓	✓	✓
*	<i>Bromus hordeaceus</i>	Soft Brome	12.3	medium		✓		
		American Sea						
*	<i>Cakile edentula</i>	Rocket	12.1	medium		✓	✓	✓
*	<i>Carpobrotus aequilaterus</i>	Angled Pigface	32.2	very high		✓		
*	<i>Cenchrus clandestinus</i>	Kikuyu	32.2	very high		✓	✓	
				Moderately				
*	<i>Cirsium vulgare</i>	Spear Thistle	13.3	high	*	✓	✓	✓
*	<i>Coprosma repens</i>	Mirror Bush	33.1	very high		✓	✓	
*	<i>Cortaderia selloana</i>	Pampas Grass	23.1	high			✓	✓
*	<i>Cotyledon orbiculata</i>	Pig's Ear	32.1	high		✓		
	<i>Crassula sp.</i>	Crassula				✓		
				moderately				
*	<i>Cynodon dactylon</i>	Couch Grass	21.2	high		✓	✓	
*	<i>Delairea odorata</i>	Cape Ivy	32.2	very high		✓		
	<i>Dianella brevicaulis</i>	Flax-lily				✓		
		Trailing African						
*	<i>Dimorphanthe frutescens</i>	Daisy	31.2	high		✓		
*	<i>Diplotaxis tenuifolia</i>	Sand Rocket	11.2	medium	*	✓		
	<i>Disphyma crassifolium</i> subsp. <i>clavellatum</i>	Rounded Noon-flower					✓	✓
	<i>Distichlis distichophylla</i>	Australian Salt-grass				✓	✓	✓
*	<i>Ehrharta erecta</i>	Veldt Grass	32.2	very high		✓		
				moderately				
*	<i>Erigeron sp.</i>	Fleabane	13.3	high		✓		
*	<i>Euphorbia paralias</i>	Sea Spurge	23.1	high		✓		
	<i>Ficinia nodosa</i>	Knobbly Club-rush				✓	✓	✓
*	<i>Fumaria capreolata</i>	White Fumitory	22.2	high		✓		
*	<i>Fumaria muralis</i>	Pink Fumitory	22.2	high		✓		
*	<i>Gazania linearis</i>	Gazania	32.3	very high		✓	✓	✓
		Yellow Horned						
*	<i>Glaucium flavum</i>	Poppy	13.1	Medium		✓		
				Moderately				
*	<i>Hypochoeris radicata</i>	Cat's-ear	13.3	high		✓		
*	<i>Juncus acutus</i>	Spiny Rush		high	*		✓	
	<i>Juncus kraussii</i> subsp. <i>australiensis</i>	Sea Rush	13.1				✓	✓
	<i>Lachnagrostis billardieri</i> subsp. <i>billardieri</i>							
		Coast Blown-grass				✓		
	<i>Lagunaria patersonii</i> subsp. <i>patersonii</i>			moderately				
*	<i>Lagurus ovatus</i>	Pyramid Tree	21.2	high			✓	
*	<i>Laphangium luteoalbum</i>	Hares-tail Grass	13.1	medium		✓		
	<i>Leptospermum laevigatum</i>	Jersey Cudweed				✓		
	<i>Lilaeopsis polyantha</i>	Coast Tea-tree				✓		
		Australian Lilaeopsis					✓	✓
*	<i>Lolium ?perenne</i>	Rye Grass	12.2	medium		✓		
*	<i>Lomandra hystrix</i>	Creek Mat-rush	N/A			✓		
*	<i>Lycium ferocissimum</i>	Boxthorn	23.3	high	*	✓		
				moderately				
*	<i>Lysimachia arvensis</i>	Pimpernell	13.3	high		✓		
*	<i>Lythrum hyssopifolia</i>	Lesser Loosestrife	12	medium		✓		
*	<i>Medicago sp.</i>	Medic	13	medium		✓	✓	✓
				moderately				
*	<i>Melaleuca armillaris</i>	Giant Honey Myrtle	21.2	high		✓		
		Showy Honey		moderately				
*	<i>Melaleuca nesophila</i>	Myrtle	21.1	high		✓		
	<i>Myoporum insulare</i>	Boobialla				✓	✓	
*	<i>Oxalis pes-caprae</i>	Soursob	31.3	very high	*	✓	✓	
		Cape Leeuwin						
*	<i>Paraserianthes lophantha</i>	Wattle	22.2	high		✓		
*	<i>Phoenix canariensis</i>	Canary Island Palm	32.2	very high		✓		
	<i>Phragmites australis</i>	Australian Reed					✓	
*	<i>Plantago coronopus</i> subsp. <i>coronopus</i>	Buck's-horn Plantain	12	medium		✓	✓	✓
	<i>Rhagodia candolleana</i>	Seaberry Saltbush				✓		
*	<i>Rumex sp.</i>	Dock	23.1	high			✓	
		Creeping						
	<i>Samolus repens</i>	Brookweed					✓	✓

	<i>Sarcocornia quinqueflora</i>	Beaded Glasswort			✓	✓
	<i>Schoenus sp.</i>	Bog Rush			✓	✓
	<i>Senecio glomeratus</i>	Annual Fireweed			✓	
*	<i>Sonchus oleraceus</i>	Milk Thistle	13.3	moderately high	✓	✓
	<i>Suaeda australis</i>	Austral Sea-blite				✓
*	<i>Symphytotrichum subulatum</i>	Aster-weed	13.2	moderately high	✓	✓
	<i>Tetragonia implexicoma</i>	Bower Spinach			✓	
*	<i>Thinopyrum junceiforme</i>	Sea Wheat Grass	33.1	very high	✓	✓
	<i>Typha domingensis</i>	Narrowleaf Cumbungi				✓
*	<i>Vulpia sp.</i>	Fescue	12	medium	✓	
*	<i>Watsonia iversfeldii</i>	Watsonia	31.2	high	✓	
*	<i>Yucca gloriosa</i>	Yucca	0	lower	✓	

1. Flora and Fauna Guarantee Act, E= endangered. 2. Weed Rank score as determined in Advisory List of Environmental Weeds (White *et al.* 2018), 3. Species listed under the Catchment and Land Protection Act.
2. Flora and Fauna Guarantee Act, E= endangered. 2. Weed Rank score as determined in Advisory List of Environmental Weeds (White *et al.* 2018), 3. Species listed under the Catchment and Land Protection Act.



Figure 1. Pale yellow outlines extend of Coastal Dune Scrub. The blue broken line is the approximate position of a former primary dune. The blackline outlines the Saltmarsh and wetland complex with more detail in insert.

3.2 Dynamic processes

Ramblers Road Foreshore is geomorphologically dynamic with accretion and erosion of marine sediments occurring which has occurred over several decades at least and continues to occur as an extant process. Sand accumulation at Ramblers Road Foreshore is annotated from historical aerial and satellite images and demonstrates significant beach extension over most of the beach frontage along Ramblers Road, particularly

in the NE section (Rijkenberg *et al.* 2020). The remains of a previous beach fringe now consisting as low irregular sandy hummocks are evident in the central region of Ramblers Road Foreshore. Unconsolidated marine sediments in the NE section of Ramblers Road Foreshore are currently sparsely vegetated and subject to primary colonisation by both native and exotic species. Coastal Dune Scrub has developed in the SW section of the reserve and progressively becomes sparser towards the NE. Recruitment and development of the shrub canopy, primarily *Atriplex cinerea*, is evident along the shoreline and along the eastern margin adjacent to the walking track, where landscape planting may have occurred. Recruitment of seedlings is evident of the drier open expanse of sediments (beach) between the walking track and the shoreline. This open area is undergoing primary colonisation by *T. junceiforme* (Sea Wheat Grass) and a range other exotic species. Few native species are present, but *F. nodosa* (Knobby Club Rush) is the dominant species and is expected to expand over time. The spit vegetation at Point Henry (Geelong) is an example of the community that is likely to form in the mid-late successional process at Ramblers Road Foreshore (Figure 3). Several high-risk weeds were detected in the open beach area including *Agapanthus*, *Asparagus*, *Carpobrotus*, *Cenchrus*, *Euphorbia*, *Gazania* and *Oxalis*, which are all expected to expand without management intervention. Nearly all are currently at low densities and canopy cover. Although *Leptospermum laevigatum* (Coast Tea-tree) is within its natural range, the foreshore is not considered its natural niche, and the species should be regarded as invasive (Figure 7). Numerous seedlings of *L. laevigatum* occur over the open beach area indicating active recruitment, presumably from mature trees scattered adjacent to the walking track. Similarly, the non-indigenous native trees *M. armillaris* and *M. nesophila* have active recruitment. In the absence of management, the open beach area is expected to under-go succession to closed Coastal Dune Scrub dominated by *A. cinerea*. The herbaceous layer will consist primarily of *T. junceiforme* and a complex of exotic herbs, grasses and annuals. Few native species are expected to predominate, but disturbance tolerant species capable of vegetative propagation will survive and expand. This group will include *F. nodosa*, *Dianella brevicaulis*, and *Distichlis disticophylla*. Native trees notably *L. laevigatum* and *Melaleuca* are expected to expand and over several decades will eventually form a woody canopy over the Coastal Dune Scrub, which could lead to disintegration of the scrub community. The “beach” area will contract to the near shoreline which will be fringed by *A. cinerea*.

The successional processes and outcomes of the Brackish Wetland and Saltmarsh Mosaic are difficult to predict. The wetland receives storm water runoff which is expected to continue with current drainage profiles. Sediment accumulation will occur in the wetland and alter its configuration over time. Deep areas will become shallower and emergent aquatics, particularly *T. domingensis* are expected to expand. The water body fringe line is also expected to change.

3.3 Weed threats

The prevalence of bare-ground caused by high levels of human foot traffic and combined with recent accumulation of sediments by marine-driven accretion processes have favoured the establishment of exotic plants. The flora of Ramblers Road Foreshore is dominated by exotic species (66%), although most species occur as few individuals or are in the early stages of invasion. Few species are expansive and form a dominant component of the canopy cover, except for *T. junceiforme* (Sea Wheat Grass), which is widespread over the foreshore reserve (Figure 9).

Key weed threats are identified (Table 2) which includes 23 species with very high to high invasion risk. All high-risk species require management to prevent further establishment. In most cases, the low densities and limited extent provide good prospects for control. Management options are included in Table 2. The occurrence of infestations on DELWP and privately managed land to the SW of Ramblers Road Foreshore increase the risk of reinvasion of Ramblers Road Reserve, necessitating an on-going, low intensity, weed management program.

Sea Wheat Grass is a key threat to native biodiversity and recreational use at Ramblers Road Foreshore. The entire Coastal Dune Scrub and much of the Brackish Wetland vegetations is susceptible to invasion. In the absence of management, Sea Wheat Grass will dominate the exposed sandy sediments and form a closed grassland in the early stages of succession towards a shrubland dominated by *A. cinerea*. The closed canopy will restrict recreational activities of the beach and eliminate habitat for open-sand nesting birds such as Hooded Plover and Red-capped Dotterel. A literature review of Sea Wheat Grass was under completed for



Figures 3-8. Figure 3, Coastal Dune Scrub at Point Henry, note closed canopy of *Atriplex*. Figure 4, Saltmarsh Mosaic at Ramblers Road Foreshore. Figure 5, Brackish wetlands shortly West of Ramblers Road Foreshore. Figure 6, Excavator with sand grooming head. Figure 7, Invasion of *Leptospermum laevigatum* (Coast Tea-tree) at Ramblers Road Foreshore. Figure 8, Seagrass wrack accumulating at high tide mark against accentuated dune created by Sea Wheat Grass establishment.

this study and information relevant to its management are presented (Appendix 1). In summary, only applications of the grass-specific herbicide haloxyfop under label conditions can be used to control Sea Wheat Grass at Ramblers Road Foreshore. The herbicide needs to be applied while the plant is actively growing (Autumn-Spring) and all plants require treatment with follow-up maintenance over 18-24 months. Native grasses receiving haloxyfop will also be susceptible, but apart from *Distichlis distichophylla* (Sea Couch), few species are present and could be avoided with careful herbicide application.

Table 2. Key high-risk weed control targets at Ramblers Road Foreshore

Species	Common Name	Density/ extent ¹	Method of control	Potential for control/ notes
<i>Agapanthus praecox</i>	Agapanthus	F	Manual	High. Difficult to control with herbicides.
<i>Aizoon pubescens</i>	Galenia	O	Spot-spray	High. Aggressive and capable to dominating beach area
<i>Asparagus asparagoides</i>	Bridal Creeper	F	Manual or Spot-spray	High. Can manually remove tubers
<i>Berkheya rigida</i>	African Thistle	O	Spot-spray	High. Use liquid or granule application.
<i>Carpobrotus aequilaterus</i>	Angled Pigface	N	Spot-spray	Moderate. Need to kill all pieces.
<i>Cenchrus clandestinus</i>	Kikuyu	N	Spot-spray	Moderate
<i>Coprosma repens</i>	Mirror Bush	F	Manual	High. Will form dominant canopy over time.
<i>Cortaderia selloana</i>	Pampas Grass	F	Manual	High. Small plants only at site
<i>Cotyledon orbiculata</i>	Pig's Ear	F	Manual	High. Remove all pieces
<i>Delairea odorata</i>	Cape Ivy	O	Spot-spray	Moderate. Follow-up always required.
<i>Dimorphotheca frutescens</i>	Trailing African Daisy	F	Spot-spray	High. All pieces need to be removed. Herbicides may be more effective
<i>Euphorbia paralias</i>	Sea Spurge	O	Manual or spot-spray	Manual or spot-spray
<i>Gazania linearis</i>	Gazania	F	Spot-spray	High. Very high risk weed. Treat while in early stages
<i>Juncus acutus</i>	Spiny Rush	O	Spot-spray	High. Herbicide choice is important.
<i>Leptospermum laevigatum</i>	Coast Tea-tree	O	Manual	High.
<i>Lycium ferocissimum</i>	Boxthorn	F	Cut and paint	High

<i>Melaleuca armillaris</i>	Giant Honey Myrtle	F	Spot-spray	High
<i>Melaleuca nesophila</i>	Showy Honey Myrtle	F	Spot-spray	High
<i>Oxalis pes-caprae</i>	Soursob	N	Spot-spray	Moderate. Well established infestations will require multiple applications over several seasons
<i>Paraserianthes lophantha</i>	Cape Leeuwin Wattle	S	Manual	High
<i>Phoenix canariensis</i>	Canary Island Palm	F	Spot-spray	High
<i>Thinopyrum junceiforme</i>	Sea Wheat Grass	N	Spot or boom spray	Moderate. An aggressive species that will require persistence but with declining input over time. Limited selective herbicide options. See Appendix.
<i>Watsonia ?versfeldii</i>	Watsonia	F	Manual	High

1. S = single plant, F = few plants, O = occasional and scattered, N = numerous

Although a weed management plan would be useful for Ramblers Road Foreshore, threat abatement could be achieved by simply undertaking regular (1-2month) surveillance using parallel transects along the foreshore and treating all high-risk species. The City of Greater Geelong have responsibility for weed management of the Ramblers Road Foreshore and have been active with Sea Wheat Grass control, however time allocation from CoGG is sometimes limited. There are opportunities for contractor services or volunteer effort to undertake priority tasks that CoGG are unable to complete.

3.4 Fauna

The Victorian Biodiversity Atlas contains 62 bird records, 1 mammal record and 1 plant records for the Ramblers Road Foreshore, however none was listed as significant fauna or flora (August 2022). In the federal Protected Matters database, which searches over a broader area than the designated study site (10 km radius), four threatened ecological communities, 63 threatened species, 44 migratory species and 54 marine species are listed. The majority of these either do not occur or are highly unlikely to occur at the Foreshore Reserve. Thirty-eight species consisting of 33 birds, 2 mammals, 1 frog and 2 fish have a very low probability of presence at the Ramblers Road Foreshore (Table 3). No species of national conservation status have been sighted at Ramblers Road Foreshore.

3.5 Management of Seagrass wrack

Accumulation of seagrass wrack on the western beaches of Port Phillip Bay is a natural process and has many positive ecological functions including protection of shorelines from erosion, nutrient cycling, habitat for invertebrates, indirect food source for birds and predatory insects. Seagrass wrack deposits vary considerably temporally and are influenced by tidal patterns and levels of leaf stem and leaf shed in nearby seagrass

meadows. Multiple factors are likely to have contributed to high levels of seagrass wrack deposits in recent years at Ramblers Road Foreshore. Climatic conditions that have a direct effect on seagrass ecology and the disruption of natural tidal movements by boating infrastructure e.g., Point Richards boat ramp have contributed to massive seagrass wrack deposits on Ramblers Road Foreshore in recent times. High abundance of seagrass wrack can impede recreational activities and prolonged accumulation requires management where recreational activities are prevented. The City of Greater Geelong have responsibility for beach maintenance, but seagrass wrack management is discretionary. The conflict between beach users and seagrass management policy within CoGG requires resolution. A decision-making matrix that uses quantitative criteria, triggers for management action and stakeholder participants would help resolve tensions associated with seagrass wrack deposition. Monitoring of seagrass wrack deposits would assist in evaluation of the impact of the new Point Richards rock groyne which has been designed to deflect seagrass wrack from shallow waters around the ramp and into deeper waters. A monitoring protocol would be desirable.

3.6 Beach grooming

Vegetation colonisation of beach deposits at the NW end of Ramblers Road Foreshore is a natural process but interferes with traditional beach use activities. The climax vegetation (as discussed above) will be Coast Dune Scrub degenerating to a disclimax of tall coastal scrub dominated by Coast Tea-tree and other non-native trees. It is expected there will be very limited open sandy areas. The understorey will be scattered shrubs and high levels of Sea Wheat Grass, at least in earlier stages of colonisation.

Beach grooming involves mechanical shifting of sand to remove coarse material such as rocks, seaweed, plastics and other rubbish, and vegetation. Beach grooming is utilised by Bellarine Bayside to maintain a sandy foreshore for recreational activities. The process involves raking sand with an excavator fitted with a slotted bucket (Figure 6). Similarly, a Bobcat can be used with a sand-sifting front mounted bucket for smaller areas. The process is undertaken under contract at around \$1650 per day plus \$600 transport costs (PJ & T McMahon Excavations, pers. comm. September 2022). Approximately 5 days of contractor time would be required to groom the proposed beach zone. A single treatment is expected to be effective, but monitoring is required to determine the need for follow-up needs.

The beach grooming process is ideal for clearing coastal sands of unwanted vegetation and is recommended for application at Ramblers Road Foreshore in designated areas that is compatible with nature conservation objectives and recreational uses. The shifting process will remove subterranean stems of Sea Wheat Grass and contribute to its suppression but should only be undertaken after plants have been killed by a program of herbicide application. Beach grooming will maintain an open area of clean sand that will allow recreational use and, if large enough, provide habitat for nesting Red-capped Plovers. Remaining areas can be landscaped to accelerate restoration of Coastal Dune Scrub, providing erosion control and biodiversity values. Proposed

beach grooming and revegetation zones are provided (Figure 9). A sequential grooming process is suggested with only part of the beach groomed in the initial phase to allow for monitoring and assessment of methods before proceeding to larger areas.

A removal of native vegetation permit from DELWP is not required to undertake beach grooming in the designated area of NW Ramblers Road Foreshore as cover by native species is less than 25% and technically is not considered native vegetation under the guidelines (DELWP 2017).

Table 3. Selection species identified in Protected Matters Database present or likely to be present in and nearby (10km radius) of the Ramblers Beach Foreshore. Unlikely species have been deleted.

Species ID	Scientific Name	Common Name	Simple Presence	Presence Text	Threatened Category	Migratory Status	Migratory Category	Marine Status
856	<i>Calidris ferruginea</i>	Curlew Sandpiper	Known	Species or species habitat known to occur within area	Critically Endangered	Migratory	Migratory Wetlands Species	Listed - overfly marine area
847	<i>Numenius madagascariensis</i>	Eastern Curlew, Far Eastern Curlew	Likely	Species or species habitat likely to occur within area	Critically Endangered	Migratory	Migratory Wetlands Species	Listed
82338	<i>Anthochaera phrygia</i>	Regent Honeyeater	Likely	Species or species habitat likely to occur within area	Critically Endangered			
744	<i>Lathamus discolor</i>	Swift Parrot	Likely	Species or species habitat likely to occur within area	Critically Endangered			Listed - overfly marine area
747	<i>Neophema chrysogaster</i>	Orange-bellied Parrot	Likely	Migration route likely to occur within area	Critically Endangered			Listed - overfly marine area
77037	<i>Rostratula australis</i>	Australian Painted Snipe	Likely	Species or species habitat likely to occur within area	Endangered			Listed - overfly marine area (as <i>Rostratula benghalensis</i> (sensu lato))
66491	<i>Thalassarche chrysostoma</i>	Grey-headed Albatross	May	Species or species habitat may occur within area	Endangered	Migratory	Migratory Marine Birds	Listed
1060	<i>Macronectes giganteus</i>	Southern Giant-Petrel, Southern Giant Petrel	May	Species or species habitat may occur within area	Endangered	Migratory	Migratory Marine Birds	Listed

89224	<i>Thalassarche cauta</i>	Shy Albatross	Likely	Foraging, feeding or related behaviour likely to occur within area	Endangered	Migratory	Migratory Marine Birds	Listed
26033	<i>Pterodroma leucoptera</i>	Gould's Petrel, Australian Gould's Petrel	May	Species or species habitat may occur within area	Endangered			
1001	<i>Botaurus poiciloptilus</i>	Australasian Bittern	Likely	Species or species habitat likely to occur within area	Endangered			
64456	<i>Diomedea sanfordi</i>	Northern Royal Albatross	Likely	Foraging, feeding or related behaviour likely to occur within area	Endangered	Migratory	Migratory Marine Birds	Listed
855	<i>Calidris canutus</i>	Red Knot, Knot	Known	Species or species habitat known to occur within area	Endangered	Migratory	Migratory Wetlands Species	Listed - overfly marine area
90381	<i>Thinornis cucullatus</i>	Eastern Hooded Plover, Eastern Hooded Plover	May	Species or species habitat may occur within area	Vulnerable			Listed - overfly marine area (as <i>Thinornis rubricollis rubricollis</i>)
26179	<i>Prototroctes maraena</i>	Australian Grayling	Likely	Species or species habitat likely to occur within area	Vulnerable			
1075	<i>Phoebastria fusca</i>	Sooty Albatross	Likely	Species or species habitat likely to occur within area	Vulnerable	Migratory	Migratory Marine Birds	Listed
64445	<i>Pachyptila turtur subantarctica</i>	Fairy Prion (southern)	Known	Species or species habitat known to occur within area	Vulnerable			
26177	<i>Nannoperca obscura</i>	Yarra Pygmy Perch	May	Species or species habitat may occur within area	Vulnerable			
929	<i>Falco hypoleucos</i>	Grey Falcon	Likely	Species or species habitat likely to occur within area	Vulnerable			

89221	<i>Diomedea epomophora</i>	Southern Royal Albatross	Likely	Foraging, feeding or related behaviour likely to occur within area	Vulnerable	Migratory	Migratory Marine Birds	Listed
1828	<i>Litoria raniformis</i>	Growling Grass Frog, Southern Bell Frog, Green and Golden Frog, Warty Swamp Frog, Golden Bell Frog	Known	Species or species habitat known to occur within area	Vulnerable			
1061	<i>Macronectes halli</i>	Northern Giant Petrel	Likely	Foraging, feeding or related behaviour likely to occur within area	Vulnerable	Migratory	Migratory Marine Birds	Listed
66472	<i>Thalassarche melanophris</i>	Black-browed Albatross	Likely	Foraging, feeding or related behaviour likely to occur within area	Vulnerable	Migratory	Migratory Marine Birds	Listed
682	<i>Hirundapus caudacutus</i>	White-throated Needletail	Known	Species or species habitat known to occur within area	Vulnerable	Migratory	Migratory Terrestrial Species	Listed - overfly marine area
64464	<i>Thalassarche carteri</i>	Indian Yellow-nosed Albatross	Likely	Species or species habitat likely to occur within area	Vulnerable	Migratory	Migratory Marine Birds	Listed
877	<i>Charadrius leschenaultii</i>	Greater Sand Plover, Large Sand Plover	Likely	Species or species habitat likely to occur within area	Vulnerable	Migratory	Migratory Wetlands Species	Listed
86380	<i>Limosa lapponica baueri</i>	Nunivak Bar-tailed Godwit, Western Alaskan Bar-tailed Godwit	Likely	Species or species habitat likely to occur within area	Vulnerable			
82273	<i>Thalassarche bulleri platei</i>	Northern Buller's Albatross, Pacific Albatross	May	Species or species habitat may occur within area	Vulnerable			Listed (as <i>Thalassarche</i> sp. nov.)

64463	<i>Thalassarche salvini</i>	Salvin's Albatross	Likely	Foraging, feeding or related behaviour likely to occur within area	Vulnerable	Migratory	Migratory Marine Birds	Listed
64462	<i>Thalassarche steadi</i>	White-capped Albatross	Known	Foraging, feeding or related behaviour known to occur within area	Vulnerable	Migratory	Migratory Marine Birds	Listed
64460	<i>Thalassarche bulleri</i>	Buller's Albatross, Pacific Albatross	May	Species or species habitat may occur within area	Vulnerable	Migratory	Migratory Marine Birds	Listed
89223	<i>Diomedea exulans</i>	Wandering Albatross	Likely	Foraging, feeding or related behaviour likely to occur within area	Vulnerable	Migratory	Migratory Marine Birds	Listed
186	<i>Pteropus poliocephalus</i>	Grey-headed Flying-fox	Likely	Foraging, feeding or related behaviour likely to occur within area	Vulnerable			
83086	<i>Antechinus minimus maritimus</i>	Swamp Antechinus (mainland)	May	Species or species habitat may occur within area	Vulnerable			
470	<i>Grantiella picta</i>	Painted Honeyeater	May	Species or species habitat may occur within area	Vulnerable			
64459	<i>Thalassarche impavida</i>	Campbell Albatross, Campbell Black-browed Albatross	Likely	Foraging, feeding or related behaviour likely to occur within area	Vulnerable	Migratory	Migratory Marine Birds	Listed
64458	<i>Diomedea antipodensis</i>	Antipodean Albatross	Likely	Foraging, feeding or related behaviour likely to occur within area	Vulnerable	Migratory	Migratory Marine Birds	Listed
82950	<i>Sternula nereis</i>	Australian Fairy Tern	Likely	Foraging, feeding or related behaviour likely to occur within area	Vulnerable			

3.7 Revegetation

4.7.1 Coastal Dune Scrub

The area surrounding the proposed beach groom zone should be restored to Coastal Dune scrub as quickly as possible to reduce the opportunities for weed invasion. Key EVC benchmark species should be used but also include other that are native to the community. A planting list is provided (Table 4). Planting densities should be high to allow for rapid vegetative cover and a high level of attrition due to the harsh conditions at the site (dry sandy soils). The design outline should blend into the beach zone to create a natural appearance, and this could be aided by irregular placement of low open graminoids, particularly *F. nodosa*, *D. distichophylla*, *Austrostipa*, *Poa poliformis* along the beach/revegetation zone interface. Approximately 4500 plants would be required for the proposed revegetation zone at a cost of \$2.20 per plant (including GST). Plants cost approximately \$1.00 to plant. No guards or stakes are suggested. Weed control prior to planting would entail 2-3 days of preparation works at around \$1600 per day for two contractors (excluding materials). Seagrass wrack could be used to mulch planting zones and help define the revegetation area as well as providing ameliorated conditions for growth.

Access tracks to the beach through the proposed revegetation zone need to be incorporated into the revegetation plan. These are not shown in Figure 3.

4.7.2 Brackish wetland and saltmarsh mosaic

No revegetation is recommended for these communities as natural recruitment will occur over time. As the wetlands are small and sensitive to disturbance by human traffic, the construction of boardwalks is not recommended. A viewing platform with access from the main walking track would be compatible with conservation values.

4.7.3 Windbreaks

A range of exotic trees and shrubs are utilised in windbreak strips or barriers on the grassy zone between the walking track and the private property boundary. Many are highly invasive trees such as *Coprosma repens* (Mirror Bush), *L. laevigatum* (Coast Tea-tree) and *Melaleuca armillaris* (Giant Honey Myrtle). The windbreaks serve as a source of propagules for invasion into the beach zone and ideally should be removed and replaced with indigenous non-invasive species. Windbreaks are more effective if designed with several species and include a tree layer with a denser shrub canopy. Few species are suitable for this purpose and are listed (Table 4).



Figure 3. Proposed beach grooming zone (pale white) and revegetation zone (yellow) for NW Ramblers Road Foreshore. The proposed revegetation zone is approximately 5000m², and the proposed groom zone is approximately 6500m²

Table 4. Proposed revegetation species for Coastal Dune Scrub at Ramblers Road Foreshore. The list is mindful that residents oppose establishment of trees that will block sea views.

Species	Common Name	Plants/100m ²
<i>Atriplex cinerea</i>	Coast Saltbush	30
<i>Allocasuarina verticillata</i>	She-oak	0.5
<i>Apium prostratum</i>	Sea Celery	5
<i>Carpobrotus rossii</i>	Karkalla	5
<i>Clematis microphylla</i>	Small-leaf Clematis	5
<i>Dianella brevicaulis</i>	Coastal Flax-lily	5
<i>Distichlis distichophylla</i>	Australian Salt-grass	10
<i>Ficinia nodosa</i>	Kobby Club Rush	10
<i>Geranium potenilloides</i>	Cranesbill	5
<i>Leucopogon parviflorus</i>	Coast Beard-heath	5
<i>Lomandra longifolia</i>	Spiny-headed Mat-rush	5
<i>Poa poiformis</i>	Tussock Grass	5

<i>Rhagodia candolleana</i>	Seaberry Saltbush	5
<i>Senecio spathulatus</i>	Dune Groundsel	5
<i>Suaeda australis</i>	Australe Seablite	5
<i>Tetragonia implexicoma</i>	Bower Spinach	10
<i>Threlkeldia diffusa</i>	Coastal Bonefruit	5
Windbreak species		
<i>Myoporum insulare</i>	Boobialla	
<i>Melaleuca pubescens</i>	Moonah	
<i>Melaleuca halmatutorum</i>	Salt Paperbark	
<i>Allocasuarina verticillata</i>	She-oak	

5 Acknowledgements

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6 References

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Appendix 1.

The biology and ecology of Sea Wheat Grass *Thinopyrum junceiforme*: a review of information relevant to its management at Ramblers Road Foreshore

The published paper of L.M. Hanlon and M.B. Mesgaran (2014) was a key reference in the preparation of this review.

Taxonomy

The genus *Thinopyrum* comprise tetraploid plants ($2n = 4x = 28$) (Löve 1980, Jauhar and Peterson 2001). There are three species complexes within the genus *Thinopyrum*: *T. elongatum* (Tall Wheat Grass) (Host) D.R. Dewey, *T. inter-medium* (Intermediate Wheat Grass) (Host) Barkworth & Dewey and *T. junceum* (Russian Wheat Grass) (L.) Á. Löve. *Thinopyrum junceiforme* (Sea Wheat Grass) falls within the complex of *T. junceum* and is found around the Atlantic and Baltic coasts (Nieto-Lopez *et al.* 2003). The nomenclature (naming) of this group is complicated, with the complex *T. junceum* also being denominated as *Agropyron junceum* (L.) P. Beauv., *A. junceum* ssp. *mediterraneum* Simonet & Guin., *Elytrigia juncea* (L.) Nevski, and *Elymus farctus* (Viv.) Runemark ex Melderis (Nieto-Lopez *et al.* 2003).

Distribution

Sea Wheat Grass was first recorded in Australian herbarium records in 1933, with a specimen collected from Ricketts Point, Victoria (MEL 0626849A). It may well have arrived much earlier, in ballast or cargo from the Windjammers, or sailing vessels, which plied between Europe and southern Australia from the 1830s through to 1950 (South Australia Maritime Museum n.d.). It was tested as an aid for dune stability in Port Fairy, Victoria in the 1950s and 1960s. Sea Wheat Grass mostly grows between the strand line and the foredune of beaches or along the sandy banks of estuaries. It favours sites with brackish groundwater and can tolerate occasional sea water inundation (Heyligers 1985). Sea Wheat Grass is now widely naturalised in the coastal districts of south-eastern Australia (south-eastern South Australia, Victoria and Tasmania). The species is also naturalised in New Zealand and the USA. Sea Wheat Grass is Indigenous to south-western Europe, extending to north-west France.

As with many coastal species, the grass occupies a niche of high temperatures, high salinity, desiccation and abrasion from winds, and extremes of soil moisture content (Hesp 1991, Levinsh 2006, Maun 2009). Additional factors in this dynamic niche include high light intensity and nutritional deficiencies (Hesp 1991, Martinez *et al.* 2001). In Australia, the plant grows lower on the beach, and closer to the swash than any native species (Hilton *et al.* 2006); this could be because no other plants can survive repeated seawater inundation unless they are halophytes.

Plant associations

Both native and exotic plants grow in association with Sea Wheat Grass on incipient dunes and foredunes in Victoria. On the incipient dunes, such plants may include native hairy spinifex, and the exotics *Cakile* spp. (Sea Rockets) and *Euphorbia paralias* L. (Sea Spurge). On the fore-dunes, the vegetation is more varied and includes the native plants *Atriplex cinerea*, (Coast Saltbush), and *Ficinia nodosa* (Knobby Club Rush), with *Lepidosperma gladiatum* (Coast Sword-sedge) growing in the swale of incipient dunes. On open sites on the foredunes, hardy succulents such as native and naturalized *Carpobrotus* spp. (Pigface), and native plants *Rhagodia baccata* (Seaberry Saltbush) and *Tetragonia tetragonioides* (Sea Spinach), manage the inhospitable environment remarkably well, as does the native

Geranium solanderi var. *solanderi* (Native Geranium). Exotic weed species such as *Fumaria* spp. (Fumitory), *Oxalis* spp. (Soursob) and *Allium triquetrum* L. (Angled Onion) are just a few of the smaller flowering plants also found in association with Sea Wheat Grass on the foredunes.

Morphology and physiology

Sea Wheat Grass is a rhizomatous, perennial grass growing to approximately 50cm in height, but under favourable conditions it can grow as tall as 80 cm. Plants can grow from a single node and produce as many as 20–100 tillers. The blue-green leaves of Sea Wheat Grass are glabrous below and finely pubescent above, usually 30 cm in length, but they can grow up to 50 cm, with the widest part of the blade varying from 3 mm to 8 mm (average 5mm). Populations from South Australia have wider leaves than those of Victoria or Tasmanian. Sea Wheat Grass is a C3 cool-season grass, but other data describing its physiology or biochemistry are lacking.

Temporary burial is a common occurrence in plants of sandy environments, and many plants such as Sea Wheat Grass survive such burial, with the short-term suspension of physiological activity such as photosynthetic capacity, which is quickly reinstated once uncovered (Harris and Davy 1988, Perumal and Maun 2006). This is due to newly emerged leaves from previously buried plants having an increased chlorophyll content, and a higher energy content in subterranean organs (Yuan *et al.* 1993, Perumal and Maun 2006). Young plants of Sea Wheat Grass lack the axillary meristems and energy reserves required to grow new shoots when buried, and they re-allocate their resources from non-photosynthetic organs to maintain the photosynthetic ones, until the plant is uncovered by winds or storms (Harris and Davy 1988). It has been shown that multi-node rhizome fragments have more success in emergence, and from greater depths, than do single-node fragments (Harris and Davy 1986b).

Reproduction/Floral biology

Sea Wheat Grass can reproduce both sexually and asexually (Löve 1984), but production of flowering tillers in Britain (Harris and Davy 1986a) and mature seeds in Australia is low. Flowering occurs over December and January, but the brittle seed heads do not persist for long on the plant. In Australia, the main route of propagation is by rhizome growth and fragmentation. Dispersal of propagules by water, is the most likely vector for the dispersal of Sea Wheat Grass caryopses along the coastline of southern Australia. In Australia, reproduction is largely vegetative from new shoots off nodes along the highly meristematic rhizomes, which are produced in great lengths. On land, single-node Sea Wheat Grass rhizome fragments can emerge from depths of up to 17 cm. Multi-node fragments can emerge from greater depths (>17 cm), producing more emergent shoots and more quickly than single-node shoots, especially in late winter to early spring (Harris and Davy 1986b).

Importance

Detrimental

No native plants or plant communities are currently recognised as under threat because of Sea Wheat Grass, but potentially *Carex pumila* and *Atriplex billardiarei* are expected to be affected in the future. Several threatened shore bird species are potentially at risk from encroachment by Sea Wheat Grass. Beach nesting birds at risk include: Little Tern (*Sterna albifrons sinensis*), Fairy Tern (*Sterna nereis nereis*), Caspian Tern (*Sterna caspia*), Hooded Plover (*Thinornis rubricollis*), Red capped Plover (*Charadrius ruficapillus*) and the Pied Oystercatcher (*Haematopus longirostris*).

In Victoria, anecdotal evidence suggests that Sea Wheat Grass impacts on the rookery of *Eudyptula minor* (Fairy Penguin) on Phillip Island's Summerlands beach, by creating steep-fronted incipient dunes that are too

high for the birds to climb to access their burrows. Furthermore, on Phillip Island and beaches in Victoria such as those on the Barwon Coast and Geelong, the endangered *Thinornis rubricollis* (Hooded Plover), which prefers a nest scrape with little vegetation on which to lay its eggs, is likely to have its nesting sites encroached by Sea Wheat Grass (Cousens *et al.* 2012). Sea Wheat Grass traps and stabilises sands where native vegetation does not generally occur, thereby altering the natural beach landforms and preventing the movement of sand. It builds low wide foredunes in low wind situations or areas of prograding shoreline while hummocky dune fields develop in high wind environments (Heyligers 1985). Steep-fronted incipient dunes that are thickly vegetated with Sea Wheat Grass are also found along the South Australian coast such as at Normanville. Hilton *et al.* (2006) proposed that the sand-binding ability of Sea Wheat Grass makes it more resilient to erosive processes in comparison to native flora. Sea Wheat Grass is noted by Heyligers (1985) as being more efficient than native species at trapping sand and building dunes where otherwise dunes would not have formed. Such dunes have the potential to limit sediment movement, thereby changing the ecosystems and geomorphology of the coastlines on which they appear. Therefore, it is of concern that Sea Wheat Grass can rapidly colonize the swash and incipient dunes after propagules are washed ashore following storms.

Beneficial

Sea Wheat Grass is a potential gene source for salt tolerance in wheat (Wang *et al.* 2003), which has been investigated in Triticeae in general, as well as in *T. bessarabicum* (Gorham *et al.* 1985, Gorham *et al.* 1986). Sea Wheat Grass has also been investigated as a potential gene source for scab resistance in wheat (Jauhar and Peterson 2001).

Weed management

Phillip Island Nature Parks (PINP) in Victoria, has used Verdict™ 520 (Haloxypfop), Fusilade™, Starane™, glyphosate and metsulphuron-methyl at the recommended rate for similar plants, as well as lower rates. Staff at PINP report that the lower rates of herbicides were more efficient than the recommended rate, as it is believed that lower rates allow for trans-location of the herbicide throughout the plant, rather than killing the aerial parts alone via one larger application. The Barwon Coast Foreshore Committee of Management, Victoria, has also used Verdict™ 520. The application rate was 50 mL of Verdict 520 per 100 L of water, plus 500 mL of Uptake™ spray oil added to the product as an adjuvant to improve the spreading and wetting qualities of the herbicide. It has been reported that this treatment is making an impact on Sea Wheat Grass with minor off-target damage to native grasses. Additionally, it has been found that two applications, 2–4 weeks apart, as suggested by the manufacturer of Verdict™ 520 for use on other invasive grasses, were not required for the suppression of Sea Wheat Grass (W.Chapman personal communication 2014).

There are no specific herbicide recommendations for Sea Wheat Grass on any Australian herbicide label registered on PubCris (Interrogated 11/8/22).

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