CASE STUDY:

Establishment of Indigenous Flora and Fauna in **Revegetated Areas at "The Waterways"**

AUSTRALIAN ECOSYSTEMS

Building sustainable landscapes for the future

INTRODUCTION

'The Waterways' is a 48-hectare restoration project located on Mordialloc Creek in Melbournes south- eastern suburbs which combines a housing estate with large areas of restored habitat set aside for indigenous fauna and flora in open space, lakes and other wetlands (see photograph 1). Restoration of the site commenced in October 2000 and by 2003 over 2 million local provenance, indigenous plants were established. In 2016 The Waterways received the Award for Excellence in Restoration Practice by The Society for Ecological Restoration Australasia (See http://seraustralasia.com/).

All the seeds and cuttings used to propagate these plants came from within 30 kilometres of the site. Of the 223 indigenous vascular plant species established, fourteen are rare or threatened, and these were specifically established in suitable micro-habitats to ensure they would survive and flourish. A total of nine Ecological Vegetation Classes (EVCs, the standard unit of vegetation mapping in Victoria) are being re-established across the site.

The successful establishment of such diverse vegetation has so far attracted 102 species of native birds, and the wetlands on the site are home to 7 species of frogs. So far a total of 19 threatened fauna species have been attracted to the habitats restored at The Waterways, including the nationally endangered Australasian Bittern. When started The Waterways was the largest and most complex ecological restoration project ever undertaken in Victoria.

The high standard of restoration achieved on The Waterways project was due to the project being appropriately funded and because it was managed by staff experienced in planning and implementing ecological restoration. Implementation of restoration works were carried out by Australian Ecosystems Pty. Ltd., which was involved in;

- Initial site investigation and documentation
- Flora species selection, seed collection and propagation
- Weed control works
- Planting
- Spreading propagules to establish cryptogrammic crust
- Maintenance
- Supplementary planting
- Introduction of threatened species
- Ecological Burns
- Vegetation mapping and flora and fauna surveys
- Monitoring

The project was partly funded by Melbourne Water, who are now the managers of the site, and partly by a developer, the Haines Family. This unique relationship and the generosity and willingness to try something innovative by the developer were important factors in the success of the project.

Prior to restoration the land at The Waterways was a property used for grazing horses and supported pasture dominated by exotic species such as Reed Fescue (*Festuca arundinacea*) and Toowoomba Canary Grass (*Phalaris aquatica*), with scattered shrub lands of Gorse (*Ulex europaeus*). Extensive weed control and earthworks were carried out prior to the commencement of revegetation works, and ongoing management of the site has included ecological burning and follow up weed control (see photograph 2).

The habitats which are being restored at The Waterways reflect those which originally occurred in the Carrum Carrum Swamp, a vast wetland complex which, prior to being extensively drained in the 1870's, stretched from Mordialloc to Kananook and as far inland as Keysborough. Local reference ecosystems were selected to act as a benchmark for what was to be achieved in each restored habitat in terms of species diversity and cover. Habitat Hectare assessments, a standard method for assessing the condition of native vegetation in Victoria, have been used to monitor the quality of restored vegetation (see Appendix 1).

The habitats restored at The Waterways include; open water-bodies supporting submerged aquatic macrophytes, mudflats that are exposed as water levels drop in summer, extensive marshes covered by dense emergent vegetation composed of Water Ribbons, sedges and a diversity of aquatic and amphibious herbs, dense Swamp Paperbark Shrub-lands, small seasonal wetlands, open River Red Gum grassy woodland and tussock grassland.

All of these habitats have been extensively cleared in the Gippsland Plain bioregion and are now recognised as endangered, existing as tiny remnant fragments of the original vegetation. Restoration of these habitats provides important additional refuges for locally endangered plants and animals.

Photograph 1 Aerial view of The Waterways from the west

Photograph 2 Management of restored native grasslands at The Waterways has included ecological burning

OPEN WATER, SUBMERGED AQUATIC HERBFIELDS AND EXPOSED MUDFLATS.

This habitat occurs in the lakes and deep, open areas of the wetlands, covering an area of about 30 hectares. Vegetation growing in this habitat includes submerged herb-fields of Pondweeds, Lake Eel-grass, Lake Water-milfoil and Stoneworts, which were planted over summer 2000/01. At The Waterways open water areas support large populations of Swans, Ducks, Coots, Cormorants, Pelicans and Darters. These birds either feed on fish and invertebrates or the foliage and fruits of water plants.

As water levels recede over summer areas of mudflat are exposed. These flats provide ideal resting areas for water birds as well as feeding habitat for migratory wading birds including the Sharp-tailed Sandpiper, Red-necked Stint and Greenshank. These birds fly from as far away as Alaska and Siberia to spend the summer in Australia, and are protected under special treaties between the Governments of countries through which they travel.

SWAMP PAPERBARK SHRUB-LAND

At The Waterways this habitat covers about 8 hectares. This consists of a remnant area of about 1 hectare that occurred in the south west corner of the site and additional areas that were planted in spring/summer 2001. As this shrub-land habitat matures it is forming a dense canopy. These dense thickets of shrubs, dominated by Swamp Paperbark and including Prickly Moses, Manuka, Woolly Tea-tree, Tree Everlasting and Golden Spray, provide cover and feeding habitat for Ring-tail Possums and bushland birds such as Robins, Thornbills, Wrens, Fantails and Cuckoos (see photograph 3).

Photograph 3 Swamp Scrub at The Waterways. Note the dense layer of mosses in the understory, particularly *Thuidiopsis furfurosa*

MARSHES

Extensive areas of densely vegetated marshes occur where water is less than 1.5 meters deep around the fringes of the lakes and as broad bands across the wetlands. At The Waterways this habitat occupies about 10 hectares. A range of vegetation types have been established in these marshes, the distribution of which is determined by water depth, duration of inundation and local salinity.

These vegetation types include dense swards of large sedges including Tall Spike-rush, Jointed Twig-sedge, Leafy Twig-sedge and River Club-rush, aquatic herb-fields of Water Ribbons, Water-milfoils and Running Marsh-flower and meadows supporting rushes, sedges and amphibious herbs. Localised areas with high salinity (4000 to 12 000 ppm) have been planted with a halophytic (salt tolerant) community including Sea Rush, Australian Salt-grass and Shiny Swamp-mat. Planting began in the marshes at The Waterways in October 2000 and vegetation established very rapidly in most areas (see photograph 4).

Photograph 4 This sequence of photographs, taken over a nine-month period at The Waterways, shows vegetation establishment in a constructed wetland from newly constructed and bare of native species on the top to well vegetated with a high cover of indigenous plants and minimal weeds on the bottom

This vegetation type provides habitat for the locally vulnerable Woolly Water-lily and a diversity of frogs, including the endangered Growling Grass Frog. Small, secretive birds such as Ballions Crake, Little Grassbird and Australian Reed Warbler find suitable refuges in the cover provided by dense vegetation.

Photograph 5 Endangered Growling Grass Frog

In 2007 Magpie Geese took up residence in this habitat at The Waterways (see photograph 6). This species was once extremely abundant in the Carrum Carrum Swamp. However, it was driven to extinction in southern Australia in the early 1900's by hunting and habitat destruction. The Magpie Goose seems to be making a recovery in Victoria, with numbers building up from birds captured in the Northern Territory and released in South Australia that are spreading across to areas where the species formerly occurred.

Photograph 6 Magpie Geese at The Waterways

TUSSOCK GRASSLAND

Native Grasslands and Grassy Woodlands are the most endangered plant communities in Victoria, with less than 1% of there original extent remaining. This habitat covers about four hectares at The Waterways and primarily occurs on the strip of land that runs west of Springvale Road between two major wetland areas. About a third of this habitat was planted in spring 2001, with the remainder in spring 2002. Grassland species were planted out of hikos at a density of 5 to 6 per square meter into areas that had been treated with both knock-down and pre-emergent herbicide. The dominant plants of this habitat are tussock-forming grasses including Wallaby Grasses, Kangaroo Grass and Common Tussock Grass. A diverse array of native wildflowers occurs amongst these grasses.

The plants in this habitat had to contend with extreme conditions over the 2002/03 summer drought. However, a high percentage survived to produce seed which germinated with the reasonable amount of autumn rain that fell, as the pre-emergent herbicide had worn off by this time. The control of weeds in this habitat zone will be critical in allowing wildflower species to become properly established. Rare plant species that have been established in this habitat zone include Grey Billy-buttons, Matted Flax-lily and Pale Swamp Everlasting (see photograph 7).

Photograph 7 Abundant Billy-buttons (*Craspedia paludicola* and *C. canens*) in restored tussock grassland at The Waterways

This grassland provides an ideal hunting ground for a number of birds of prey, including the Brown Falcon, Black-shouldered Kite and Australian Kestrel. It also provides cover and feeding habitat for insect and seed-eating birds such as the Brown Quail. A flock of about 20 Blue-winged Parrots have been regularly seen in this habitat. These parrots are usually quite uncommon in the Melbourne area. Moist grasslands beside the wetland have been colonised by the vulnerable Glossy Grass Skink (*Pseudemoia rawlinsoni*) (see photograph 8).

Photograph 8 The vulnerable Glossy Grass Skink (*Pseudemoia rawlinsoni*) at The Waterways

RIVER RED GUM GRASSY WOODLAND

This habitat type occurs in mosaic with Tussock grassland. It is essentially very similar in the composition of the field-layer, the main difference being the presence of trees and clumps of shrubs. River Red Gum and Swamp Gum have been planted so that they will eventually form an open woodland structure (see photograph 9). Other tree and tall shrub species planted in this habitat include Drooping Sheoke, Blackwood and the tree form of Silver Banksia, which is now very uncommon in the local area. As these woodlands mature they are providing structural habitat diversity and accommodating woodland birds such as Robins, Cuckoos and Pardalotes.

It will take many years for the River Red Gums to reach a majestic size and stature, and to provide tree hollows which are essential for many species of native fauna. A limited number of tree hollows are provided in the dead trees (stags) that were placed in The Waterways wetlands.

Photograph 9 Open River Red Gum grassy woodland with scattered seasonal wetlands at The Waterways

SEASONAL WETLANDS

Small seasonal wetlands, affectionately known as 'frog hollows', occur within Tussock Grassland (see photograph 10). Although this habitat covers less than half a hectare it provides very important habitat to a diversity of flora and fauna. These wetlands are important breeding areas for frogs including the Banjo Frog, Striped Marsh Frog and Spotted Grass Frog and a range of invertebrates that do not occur in the larger, more permanent storm water treatment wetlands such as Shield Shrimp. Birds which utilise these wetlands for feeding include the White-faced Heron and Latham's Snipe.

Rare plant species that have been established in this habitat zone include Swamp Billy-buttons, Woolly Water-lily, Grey Spike-rush, Giant River Buttercup and Swamp Everlasting.

Photograph 10 Seasonal rain-filled wetland at The Waterways

RE-ESTABLISHING CRYPTOGRAMMIC CRUST

A diversity of cryptograms including *Thuidiopsis furfurosa*, *Hypnum cuppressiforme*, *Triqutrella papilata* and some Bryum and lichen species were collected in the field from nearby remnants of native vegetation threatened with imminent loss by freeway construction and new housing estates. These were placed in a blender and made into a 2 litre, thick slurry and the slurry was then diluted into a 20 litre a firefighting backpack. The diluted slurry was then applied to bare soils in the revegetated areas at The Waterways in August 2002 and; some areas were left untreated as a control.

It was not until the wet winter of 2016 that it became apparent how successful this technique had been. There are now quite large areas with a good cover of cryptograms, particularly in the restored grassland and swamp scrub areas. There are some cryptograms in the untreated areas but the species richness and cover are much lower. Cryptogrammic crust cover appears to suppress weed germination, reducing the need for herbicide application, yet provides recruitment opportunities for native forbs (see photograph 11).

Photograph 11 Cryptogrammic crust in inter-tussock space in restored grassland at The Waterways. these spaces provide recruitment opportunities for herbaceous species such as *Wahlenbergia multicaulis* and *Brachyscome parvula*

THE FUTURE

The habitats that have been created at The Waterways are about 16 years old, yet they have already attracted a vast array of native fauna. There is incredible potential for the area to provide vitally important habitat for an even greater diversity of rare plants and animals as these habitats mature.

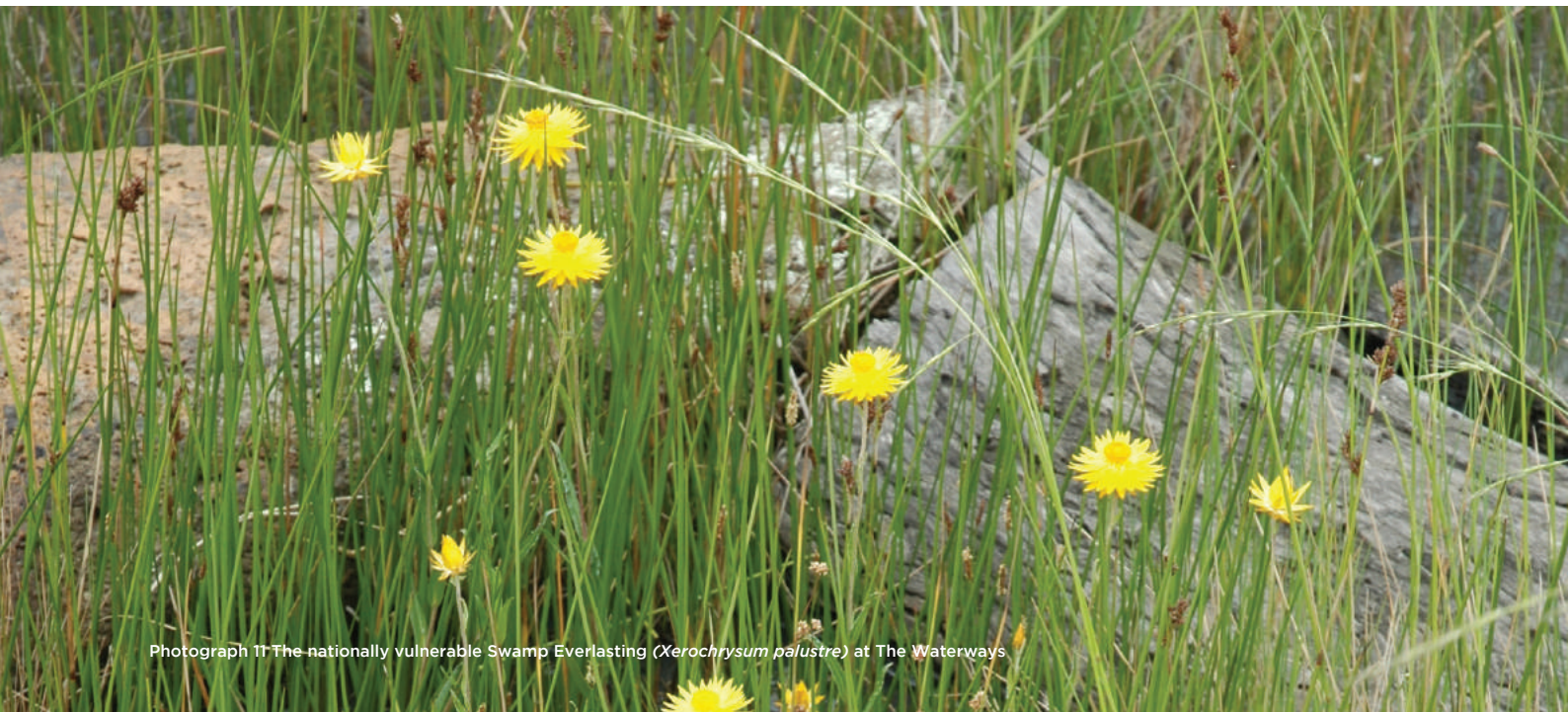
If the area is to reach its full potential, careful management of weeds and pest animals is required. Ongoing monitoring of flora and fauna is also necessary. These are both areas in which the local community is becoming involved.

THE WATERWAYS VITAL STATISTICS:

Date restoration works began	October 2000
Total area of restoration	40 ha of wetland and 8 ha of terrestrial revegetation
Condition prior to revegetation works	Pasture dominated by exotic species such as Reed Fescue *(Festuca arundinacea)* and Toowoomba Canary Grass *(Phalaris aquatica)* grazed by horses with scattered shrub lands of Gorse *(Ulex europaeus)*.
Restoration activities conducted by Australian Ecosystems	• Initial site investigation and documentation • Earthworks to create wetlands • Flora species selection, seed collection and propagation • Weed control works • Planting • Spreading propagules to establish cryptogrammic crust • Maintenance • Supplementary planting • Introduction of threatened species • Ecological Burns • Vegetation mapping and flora and fauna surveys • Monitoring
No. of indigenous plants planted	Over 2 million
No. of indigenous flora species re-established	23 species, the diversity and combination of which have been selected to reflect the original Carrum Carrum Swamp habitats
No. of exotic flora species (weeds) recorded in restoration areas	37
No. of rare or threatened flora species re-established **Status under the Federal EPBC Act (1999) :** E = endangered Australian wide V = vulnerable Australia wide **Status under the State Flora and Fauna Guarantee Act (1988):** L = listed as Threatened in Victoria Status on the DSE advisory list : e = endangered in Victoria v = vulnerable in Victoria r = rare in Victoria k = conservation status poorly understood	*Fourteen, as listed below:* • Matted Flax-lily *(Dianella amoena)* – Ee • Swamp Everlasting *(Xerochrysum palustre)* - VLv • Graceful Swamp Wallaby-grass *(Amphibromus fluitans)* - Vk • Purple Blown-grass *(Lachnagrostis punicea subsp. filifolia)* - Lr • Grey Billy-buttons *(Craspedia canens)* – e • Plains Yam-daisy *(Microseris scapigera)* - v • Woolly Water-lily *(Philydrum lanuginosum)* - v • Pale Swamp Everlasting *(Coronidium gunnianum) (Lowland Swamps))* - v • Pale-flower Cranesbill *(Geranium sp. 3)* - r • Leafy Twig-sedge *(Cladium procerum)* - r • Feather-leaf Buttercup *(Ranunculus amplus)* - r • Southern Bristle-sedge *(Chorizandra australis)* - k • Grey Spike-sedge *(Eleocharis macbarronii)* - k • Large River Buttercup *(Ranunculus papulentus)* – k
No. of Ecological Vegetation Classes re-established and their status in Gippsland Plains Bioregion E = endangered	• Swamp Scrub (EVC 53 – E) • Plains Grassy Wetland (EVC 125 – E) • Plains Grassland (EVC 132 - E)/Plains Grassy Woodland (EVC 55 – E) • Aquatic Sedgeland (EVC 308 - status not determined) • Brackish Herbfield (EVC 538 - status not determined) • Plains Sedgy Wetland (EVC 647 - E) • Aquatic Herbland (EVC 653 – E) • Submerged Aquatic Herbland (EVC 918 - status not determined) • Wet Verge Sedgeland (EVC 932 – status not determined)

THE WATERWAYS VITAL STATISTICS (cont.):

No. of fauna species recorded inhabiting and visiting Waterways	102 indigenous bird species (17 of which have nested at Waterways), eight mammals, seven species of frogs, and four reptiles
No. of rare or threatened fauna species recorded inhabiting and visiting Waterways **Federal Environment Protection and Biodiversity Conservation Act (1999) status:** E = endangered Australian wide **State Flora and Fauna Guarantee Act (1988) status:** L = listed as Threatened in Victoria N = nominated for FFG Act listing DSE advisory status: e = endangered in Victoria v = vulnerable in Victoria nt = near threatened JAMBA = Japan Migratory Bird Agreements with Australia CAMBA = China Migratory Bird Agreements with Australia	Nineteen threatened species and an additional four are listed on international bird migratory agreements, as listed below: • Growling Grass Frog *(Litoria reniformis)* – Ee • Glossy Grass Skink *(Pseudemoia rawlinsoni)* - v • Eastern Great Egret *(Ardea modesta)* – Lv • Intermediate Egret *(Ardea intermedia)* -Le • Hardhead *(Aythya australis)* - v • Australasian Shoveler *(Anas rhynchotis)* - v • Musk Duck *(Biziura lobata)* - v • Blue-billed Duck *(Oxyura australis)* - Le • Australasian Bittern *(Botaurus poiciloptilus)* - LEe • Baillon's Crake *(Porzana pusilla palustris)* - v • Terek Sandpiper *(Xenus cinereus)* – e and JAMBA and CAMBA • Caspian Tern *(Sterna caspia)* – Lnt • Whiskered Tern *(Chlidonias hybridus javanicus)* - nt • Magpie Goose *(Anseranas semipalmata)* - Nv • Royal Spoonbill *(Platalea regia)* - nt • Latham's Snipe *(Gallinago hardwickii)* – nt and JAMBA and CAMBA • Pied Cormorant *(Phalacrocorax varius)* - nt • Spotted Harrier *(Circus assimilis)* - nt • Pacific Gull *(Larus pacificus)* - nt • Green Shank *(Tringa nebularia)* - JAMBA and CAMBA • Sharp-tailed Sandpiper *(Calidris ruficollis)* - JAMBA and CAMBA • Curlew Sandpiper *(Calidris ferruginea)* - JAMBA and CAMBA • Pectoral Sandpiper *(Calidris melanotos)* - JAMBA and CAMBA
Overall Conservation Significance according to the Native Vegetation Management Framework	Very High Conservation Significance
Water treatment and quality	EPA testing has shown that The Waterways wetlands are removing 90% of the nitrogen and 50% of the phosphorus from the Mordralloc Creek water



Photograph 11 The nationally vulnerable Swamp Everlasting *(Xerochrysum palustre)* at The Waterways

Habitat Hectare results for four quadrats at The Waterways, 2006

Habitat Zone			**Q1**	**Q7**	**Q8**	**Q10**
EVC Number			132_62	125	53	653
		Max. score	Treeless	Treeless	Scrub	Treeless
Site Condition	Large Old Trees	10	NA	NA	NA	NA
	Tree Canopy Cover	5	NA	NA	0^	NA
	Understorey	25	15	15	15	20
	Lack of Weeds	15	15	15	11	13
	Recruitment+	10	6	10	0^	6
	Organic Matter	5	2	5	3	5
	Logs	5	NA	NA	NA	NA
	*Site Condition Total**		51.83	61.38	36.25	60.02
Landscape	Patch Size	10	8	8	8	8
	Neighbourhood	10	2	2	2	2
	Distance to Core	5	1	1	1	1
	subtotal		11	11	11	11
Total Habitat Score		**100**	**63**	**72**	**47**	**71**
Bioregion			Gippsland Plain			
EVC Conservation Status			Endangered			
Conservation	Conservation Status x Habitat score		Very High			
	Threatened Species Rating		Very High		Low	Very High
	Other Site Attribute Rating		Low			
	Overall Conservation Significance (highest)		**Very High**			
No. of Large Old trees			0	0	0	12

* *Modified approach to habitat scoring* for treeless or scrub vegetation, (Site condition component multiplied by an index of 1.36 (treeless) or 1.25 (scrub) to account for lack of tree and log components)

Habitat hectares = habitat score/100 X area to be removed in zone (ha)

^ Attributes of established vegetation