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Article *in* The Victorian naturalist · June 2012

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Abstract
A revised list of the butterflies of the La Trobe Wildlife Sanctuary and adjacent nature conservation reserves near Melbourne is presented based on intermittent observations and collections between 1989 and 2011. A total of 31 species is recorded, of which 22 (71%) are considered to be resident. Of the resident species, nine (41%) specialise as larvae on Poaceae. Populations of three resident species that were previously absent have become established via different pathways: *Trapezites symmomus* was translocated deliberately in 1988, *Trapezites phigalioides* appears to have been introduced unintentionally in the late 1990s, while *Toxidia doubledayi* invaded the area naturally during a period of range expansion during the 1990s. The introduction of the hesperiid *Trapezites symmomus* involved several key elements, namely community education in relation to the principles of butterfly conservation, involvement of local science students and park rangers, increasing the extent and integrity of the butterflies' habitat through collection and propagation of the larval food plant, translocation of the larval stage of the butterfly, and long-term monitoring of the species over 20+ years. Ecological restoration and conservation management of the reserves estate over the past two decades appears to have benefited the grass- and *Lomandra*-feeding specialists and other butterflies associated with the understorey ground layer. The success of the *T. symmomus* introduction suggests that other more threatened species in the Melbourne area associated with monocot food plants could potentially be established in conservation reserves through such translocation programs. *(The Victorian Naturalist* **129** (3), 2012, 86–97)

Keywords: butterfly translocation, conservation management, ecological restoration, urban butterfly conservation

Introduction

Butterflies are widely recognised as an important flagship group for promoting the wider concerns and conservation needs of invertebrates, and in recent years consideration of several species in Australia has been instrumental in formulating reserve design for conservation planning, particularly in semi-natural, urban landscapes (Sands and New 2002; New and Sands 2002). About 75 species of butterflies occur in the greater Melbourne region, and they are one of the best known groups of insects in terms of biological and distributional knowledge (Yen 2011). Although a substantial variety of butterflies still exists in the network of small reserves throughout the urban matrix of Melbourne (New and Sands 2002), there is ample evidence to indicate that several species have declined in extent as a result of ongoing urban expansion and the concomitant loss or modification of critical habitats (Braby 1989, 1991; Braby *et al.* 1992; Faithfull 1992; Field 1995; Sands and New 2002; Yen 2011). Threatened species near Melbourne such as the Eltham copper *Paralucia pyrodiscus* and Altona skipper *Hesperilla flavescens* have become pivotal ambassadors for insect conservation through the protection and management of urban populations in dedicated conservation reserves (Field 1995; New and Sands 2002; New *et al.* 2007; Canzano *et al.* 2007; Relf and New 2009; Yen 2011). The perpetuity of this remnant urban butterfly fauna hinges very much on measures to foster site security and habitat protection, together with ongoing conservation management to mitigate threats and maintain or restore natural ecological processes.

La Trobe University lies approximately 13 km north-east of Melbourne, and its urban butterfly fauna was documented in a previous report (Braby 1989) in which 28 species were listed. The species were recorded during the 1980s mainly from three conservation reserves, La Trobe Wildlife Sanctuary, Gresswell Forest Nature Conservation Reserve, and Gresswell Hill Nature Conservation Reserve, which at that time was managed by Mont Park Mental Health Authority. Overall, the butterfly fauna of the reserves estate managed by La Trobe University was considered to have high conservation significance because of its close proximity to Melbourne and inclusion of a prominent hilltop. The reserves preserve samples of remnant indigenous river-red gum woodland and grassland (which have now been substantially enhanced through active conservation management) that support a number of localised and ecologically specialised species of butterflies. These vegetation types have largely disappeared in the lower Yarra Valley and adjacent basalt plains of Melbourne due to extensive urbanisation, and it was considered that the reserves support significant locally adapted populations of butterflies that may be poorly represented in conservation reserves elsewhere in the inner north-eastern region of Melbourne. Gresswell Hill NCR comprises a prominent hilltop with extensive natural vegetation that is used as a landmark for mate-location by many butterflies, including non-resident species which enter the area from nearby bushland areas beyond the 'sea' of residential houses that surround the reserves.

Until relatively recently, the reserve estate managed by La Trobe University comprised four discrete areas that totalled around 105 ha: La Trobe Wildlife Sanctuary (c. 29 ha), Gresswell Hill NCR (c. 9 ha), Gresswell Forest NCR (c. 50 ha, including perimeter buffer) and Gresswell Habitat Link NCR (c. 17 ha). The last-mentioned area comprises a broad corridor of land that connects the western end of Gresswell Forest NCR with the northern boundary of La Trobe Wildlife Sanctuary and lies between Gresswell Hill NCR and Strathallan Golf Course; it was established in 1993 and then added to La Trobe University reserve management estate in 1996. However, in 2011 Gresswell Hill NCR, Gresswell Forest NCR and Gresswell Habitat Link NCR were all excised from management by La Trobe University and transferred to the Department of Sustainability and Environment.

Since 1989 I have made intermittent observations and collections of butterflies from La Trobe Wildlife Sanctuary, Gresswell Hill NCR and Gresswell Forest NCR. New records based on these observations are detailed below, together with a summary of the composition and occurrence of each species in these three reserves. Of particular interest is the successful translocation of a local species, the Splendid Ochre *Trapezites symmomus*, that was previously absent from the reserves. This example represents one of very few attempts of intensive habitat restoration targeted for a particular species of invertebrate (Yen 2011).

Observations

Splendid Ochre Trapezites symmomus

This univoltine species was previously absent from La Trobe University, but in late 1988 it was deliberately introduced into Gresswell Forest NCR (Braby 1991). Prior to 1988, the larval food plant, Spiny-headed Mat-rush *Lomandra longifolia* (Fig. 1), occurred naturally in two small remnant patches within the reserve but it did not support a colony of the butterfly, pos-

Fig. 1. Indigenous remnant patch of *Lomandra longifolia* (shown bottom left), the larval food plant of *Trapezites symmomus*, in Gresswell Forest Conservation Nature Reserve growing in *Eucalyptus camaldulensis* dominated grassy woodland. Photo: 2 October 2011.

Fig. 2. Release site ('western patch') for the founding population of *Trapezites symmomus* in Gresswell Forest Conservation Nature Reserve. The site was augmented with a substantial number of tussocks of *Lomandra longifolia* propagated in the La Trobe Wildlife Sanctuary's nursery in 1988-90. The site was burnt to its entirety in March 2003; this figure shows the plants fully regenerated two years after that control burn. Photo: 28 February 2005.

sibly because there were too few plants to support a viable population. One patch, hereafter referred to as the 'western patch' (37.71222°S, 145.07118°E; WGS84), occurred approximately in the centre of Gresswell Forest NCR to the west of Salt Creek (near the intersection of Centre and Antechinus Tracks). The second patch, hereafter referred to as the 'eastern patch' (37.71406°S, 145.07185°E; WGS84), occurred to the east of Salt Creek 200 m SSE of the 'western patch'.

The introduction was achieved firstly by increasing the extent and integrity of the butterflies' habitat of the 'western patch' through collection and propagation of local seed of the larval food plant (Fig. 2) and planting the seedlings in 1988, 1989 and 1990, and secondly by establishing a founding population of the butterfly through translocation of the larval stage with the assistance of secondary environmental science students in 1988 (Fig. 3). Data was not kept on the number of plants propagated or their rate of survival in situ, but it was estimated that approximately 50-100 seedlings were planted. The source areas for the translocation comprised eight sites in the lower Yarra valley within 25 km of La Trobe University, and included Bundoora-Plenty, Smiths Gully, Eltham, Warrandyte, Mitcham, Burwood and Kew in order to maximise diversity of the local gene pool (Table 1). In total, 172 mid to late instar larvae were collected and introduced during October-December 1988, with up to six larvae inside their tubular shelters placed on individual tussocks of the food plant.

Following translocation, sites were monitored intermittently for the presence/absence of the species between 1989 and 2011 in order

Table 1. Source localities from which larvae of *Trapezites symmomus* were collected from the lower Yarra valley and introduced into Gresswell Forest Nature Conservation Reserve.

Location	Number of larvae	Date
Yarra River, Normans Reserve, Warrandyte North	34	02 Oct 1988
Diamond Creek, Eltham North Reserve, Eltham North	21	02 Oct 1988
Diamond Creek, Eltham Lower Park, Eltham	44	10 Nov 1988
Old Caledonia Gully, Peter Franke Reserve, Smiths Gully	17	10 Nov 1988
Mullum Mullum Creek, Yarran Dheran, Mitcham	28	10 Nov 1988
Plenty River Gorge, Bundoora-Plenty	13	12 Nov 1988
Yarra River, Studley Park, Kew	10	28 Dec 1988
Wattle Park, Burwood	5	29 Dec 1988
Total	172	

Fig. 3. Secondary science students from Bundoora Secondary College (formerly Greenwood High School), together with ranger Laurie Whelan (back row, third from left) and Michael Braby, Gary Forbes and ranger George Paras (front row, left to right), involved with the collection of larvae of *Trapezites symmomus* from Yarran Dheran, Mitcham, a source site used in the experimental translocation of the species into Gresswell Forest Conservation Nature Reserve. Photo: 10 November 1988.

to determine the relative success or failure of the introduction (Table 2). Within the first two years of the introduction, larvae were present at both the founder site ('western patch') and the second remnant indigenous patch of *Lomandra longifolia* ('eastern patch'), indicating that not only had the species survived two seasons (generations), but had expanded to colonise new previously unoccupied habitat. In 1991 and 1994, it was found breeding on planted tussocks of the food plant in the nearby La Trobe Wildlife Sanctuary, indicating that within three years of introduction the butterfly had colonised re-created habitat 2 km SW of the founder site. In March 2003, the food plants at the 'western patch' were burnt in their entirety by fire during a control burn for weed management (G. Paras pers. comm. 2003). A month later, the food plants were starting to regenerate but no early stages of the butterfly were present, except on a few indigenous tussocks 50 m north of the 'western patch' that escaped fire. Two seasons later, adults were recorded at both the 'western' and 'eastern' patches in Gresswell Forest NCR, indicating that the species had survived the control burn and, most likely, had recolonised the 'western patch'. During my last census at Gresswell Forest NCR (2 October 2011), precisely 23 years after the first batch of larvae were introduced into the reserve (2 October 1988), large numbers of late instar larvae were detected at the 'western patch' (Table 2). Larvae were also recorded along Salt Creek near the southern boundary of Gresswell Forest NCR on food plants that had spread via natural recruitment downstream from the 'eastern patch'. In addition to the observations reported in Table 2, G Paras (pers. comm. 2011) has noted that adults of the butterfly have been observed in most years at Gresswell Forest NCR, from 1989 to the present time.

***Montane Ochre* Trapezites phigalioides**

This species was not previously recorded from La Trobe University during earlier field studies. On 29 November 2001, I recorded three males, of which two were collected, hilltopping at the summit of Gresswell Hill NCR. All individuals perched on low grass in a small open (cleared) sunny area.

***Bright Shield-skipper* Signeta flammeata**

This species was previously considered to be a vagrant to La Trobe University, its occurrence based on only two males at Gresswell Hill NCR in February and March 1988 (Braby 1989). On 20 January 1993, several males (c. 5) were observed hilltopping at the summit of Gresswell Hill NCR during late afternoon; all individuals were either 'dog-fighting' or perched on the outer foliage of a Golden Wattle *Acacia pycnantha* tree 6–7 m above ground level. The occurrence of this species throughout the broad flight period during late summer (Jan–Mar) and presence of multiple hilltopping individuals in mid-January suggests the species is probably resident in the area.

***Lilac Grass-skipper* Toxidia doubledayi**

This species was not previously recorded from La Trobe University during earlier field studies. On 25 December 1994, I made an extensive search for the species in Gresswell Forest NCR but failed to detect it, despite the fact that adults were abundant further east at Eltham at the same time. However, several years later, on 29 November 2001, I recorded the species in the La Trobe Wildlife Sanctuary (1 male collected at the nursery), at Gresswell Forest NCR (1 male collected from near southern entrance), and at Gresswell Hill NCR (2 males collected) where adults were particularly abundant, especially on the eastern slope around patches of introduced blackberry, but also at the summit. On blackberry, males showed a distinct tendency to perch on the large white flower petals and less frequently on the green leaves of this noxious weed.

***Greenish Grass-dart* Ocybadistes walkeri**

A final instar larva was collected on a blade of a large tussock of *Lomandra longifolia* at Gresswell Forest NCR on 2 October 2011; the larva pupated a few days later and a female emerged on 16 October 2011. Clumps of *Ehrharta erecta* grew amongst the *L. longifolia* and this introduced grass may have been the larval food plant; that is, the larva may have left the grass to pupate amongst the broad leaves of the *L. longifolia* tussock.

Table 2. Summary of field observations on *Trapezites symmomus* at Gresswell Forest Nature Conservation Reserve (GFNCR) and La Trobe Wildlife Sanctuary (LTUWS) during 1988-2011. Searches for the early stages on each occasion were approximately 30 mins unless otherwise stated. LFP = larval food plant *Lomandra longifolia*.

Date	Reserve	Observations
Oct-Dec 1988	GFNCR	172 larvae released on LFP at founder site ('western patch').
15 Dec 1989	GFNCR	8 late instar larvae recorded on planted tussocks of LFP at 'western patch'; 3 larvae on an indigenous tussock of LFP 100 m E of 'western patch'; 4 larvae on LFP at 'eastern patch'.
10 Jul 1990	GFNCR	4 early instar larvae recorded on LFP at 'western patch'.
25 Jul 1991	GFNCR	1 early instar larva, numerous unoccupied larval shelters, and pupal shelters containing wasp parasites recorded on LFP at 'western patch'.
25 Jul 1991	LTUWS	1 unoccupied larval shelter (including remnant head capsule) recorded on planted tussock of LFP around edge of main lake near Ring Road.
27 Feb 1993	GFNCR	8 unoccupied larval shelters (including remnant head capsules) recorded on LFP at both 'western' and 'eastern' patches.
25 Dec 1994	GFNCR	3 late instar larvae and numerous unoccupied larval shelters recorded at both 'western' and 'eastern' patches.
25 Dec 1994	LTUWS	2 late instar larvae and numerous unoccupied shelters (including larval feeding damage) recorded on planted tussocks of LFP around edge of main lake near Ring Road.
29 Nov 2001	GFNCR	1 late instar larva and numerous unoccupied shelters recorded at 'western patch'.
29 Nov 2001	LTUWS	1 late instar larva and numerous unoccupied shelters recorded on LFP near main lake.
12 Apr 2003	GFNCR	0 early stages recorded on regenerating tussocks at 'western patch' following control burn previous month in March 2003; 1 freshly laid egg collected from dead leaf of LFP (egg hatched 19 d later on 1 May 2003) and several unoccupied larval shelters (including remnant head capsules) recorded on unburnt indigenous tussocks of LFP 50 m N of 'western patch'.
28 Feb 2005	GFNCR	several adults recorded at both 'western' and 'eastern' patches; LFP fully regenerated following control burn 2 years earlier.
2 Oct 2011	GFNCR	40 larvae (2 instar III, 32 instar IV, 6 instar V) recorded at 'western' patch during 1 h search; larvae present at 'eastern patch', as well on plants regenerating along Salt Creek c. 100 m S of 'eastern patch'; LFP in good condition following La-Niña drought breaking rains.
4 Oct 2011	LTUWS	9 mid instar larvae recorded on several tussocks of LFP near main lake.

***Imperial Jezebel* Delias harpalyce**
This species was previously recorded infrequently (at Gresswell Hill NCR and university campus) and it was suggested to be a visitor to La Trobe University (Braby 1989). However, four empty pupal shells on a remnant larval web were recorded on Creeping Mistletoe *Muellerina eucalyptoides* parasitising a River Red Gum *Eucalyptus camaldulensis* host tree at Gresswell Forest NCR on 15 December 1989. On 10 July 1990, several empty pupal shells of *D. harpalyce* were located on a clump of *M. eucalyptoides* parasitising *E. camaldulensis* growing near the car park entrance (Greenwood Drive) of Gresswell Forest NCR. D Britton (pers. comm.) also reared adults from the latter location in late 1989. These observations suggest that a breeding population of the species is established and that the species is resident in the area.

***Lesser Wanderer* Danaus petilia**
This migratory species was previously known only from single sightings on La Trobe Wildlife Sanctuary and nearby areas (Braby 1989). On 3 January 1993, an individual was observed at 1530 h in a grassy area near the northern entrance of Gresswell Forest NCR.

***Shouldered Brown* Heteronympha penelope**
This species was previously considered to be a vagrant to La Trobe University, with only one male recorded at Gresswell Hill NCR on 19 March 1988 (Braby 1989). However, on 14 March 1993 a female was observed along the central track of Gresswell Forest NCR. Subsequently, adults of both sexes were found to be common in the reserve on 2 March 2004, although they were restricted to better quality grassy woodland. The following season, the species was noted to be very abundant at Gresswell Forest NCR on 28 February 2005, with many freshly emerged adults observed along and near the central creek system. Of particular note was the capture, on 2 March 2004, of an albinic male in which the orange ground colour was replaced with pale creamish-brown.

***Ringed Xenica* Geitoneura acantha**
Only small numbers of this species were previously recorded from La Trobe University, mostly from Gresswell Forest NCR where it was very localised along Salt Creek (Braby and New 1989). In 1986, the maximum number of adults recorded in this reserve during counts over a 2 km transect conducted throughout the entire flight season was only six (Braby and New 1989). However, on 28 February 2005 adults were noted to be particularly abundant (>30 observed over 1 h observation period) over a wide area along Salt Creek in the southern half of Gresswell Forest NCR. I also recorded two males in a dense grassy shaded area on the upper slopes of Gresswell Hill NCR on 20 January 1993.

***Marbled Xenica* Geitoneura klugii**
This species was previously recorded from early December to mid April at Gresswell Forest NCR (Braby and New 1989). On 29 November 2001, I recorded two males hilltopping at Gresswell Hill NCR, which represents an early season record. Kearney *et al.* (2010) found in males of the satyrine *Heteronympha merope* a significant correlation between adult emergence and year, which was correlated with global temperature rise, in the Melbourne area during the twentieth century. Whether males of *G. klugii* are also now emerging earlier remains an open question, but is likely given the decade of warm, dry conditions experienced during the 2000s.

***Dark Purple Azure* Ogyris abrota**
This species was previously recorded breeding at Gresswell Hill NCR and university campus (Braby 1989). On 15 December 1989, numerous hatched eggs, eight early instar larvae, and two empty pupal shells were recorded at Gresswell Forest NCR, the early stages being found under loose bark of a sapling of the host tree *Eucalyptus camaldulensis* which supported a clump of the larval food plant *Muellerina eucalyptoides*. The following season, numerous empty egg shells and three empty pupal shells were recorded on the same mistletoe clump on 10 July 1990. On this occasion the eggs had been deposited mostly on the adventitious roots and branches of the mistletoe, but one was found on a leaf and others were deposited on the host tree close to the food plant.

***Two-spotted Line-blue* Nacaduba biocellata**
This species was found breeding at Gresswell Hill NCR where two late instar larvae were collected from the flower buds of Lightwood *Acacia implexa* on 20 January 1993; both larvae proved to be parasitised (Braby 1998).

***Saltbush Blue* Theclinesthes serpentatus**
Very few adults of this species were previously recorded from La Trobe University, with only two records in March and April (Braby 1989). On 11 May 2007, several adults (c. 5) were observed around midday during unseasonably warm and sunny conditions in the nursery of La Trobe Wildlife Sanctuary; several adults were freshly emerged and frequently alighted on potted plants, suggesting the species was breeding locally, most likely on chenopods being propagated in the nursery.

Discussion
The new observations reported here, together with existing data (Braby 1989), bring the total list of butterflies recorded for La Trobe Wildlife Sanctuary and adjacent nature conservation reserves to 31 species (Table 3). The three additional species, all hesperiids, appear to be resident, but populations of each have become established via different pathways. *Trapezites symmomus* was introduced deliberately in 1988, whereas *Trapezites phigalioides* appears to have been introduced unintentionally in the late 1990s. In contrast, *Toxidia doubledayi* established itself naturally during a period of range expansion in the Melbourne area during the 1990s.

In the case of *Trapezites symmomus*, the goals of this experimental introduction were threefold: (1) to introduce secondary science students to practical butterfly conservation; (2) to assess the feasibility of establishing a 'new' butterfly population of a species in a conservation reserve from which it was previously absent or was no longer extant; and (3) to enhance the local biodiversity of the La Trobe University reserves estate (Braby 1991). The fact that *T. symmomus* has now persisted at Gresswell Forest NCR for 23 years and that it colonised the La Trobe Wildlife Sanctuary where it has been established for at least 20 years since the species was first introduced into Gresswell Forest NCR in 1988 indicates that these goals have been achieved. Moreover, in the late 1990s and early 2000s, a decade after initial habitat enrichment of *T. symmomus* at Gresswell Forest NCR, the two patches of *Lomandra longifolia* along Salt Creek, which are separated by a distance of 200 m, were starting to expand via natural recruitment as a result of ongoing habitat restoration, including weed control and judicious fire management (G Paras pers. comm. 2011). The 'eastern patch', in particular, is now more than twice its area of occupancy compared with its extent in the 1980s, and propagules have also started to colonise areas further downstream along Salt Creek. Thus, there is the potential for the two breeding habitat patches to expand further and eventually connect with one another.

Trapezites phigalioides is a distinctive and conspicuous skipper, and it is unlikely that it was previously overlooked but, equally, it is unlikely that it had naturally colonised the area given its specialised habitat requirements with larvae dependent on Wattle Mat-rush *Lomandra filiformis* and its restricted distribution in the Melbourne area. It is possible that the species was accidentally introduced to the conservation reserves. Former ranger B. Smith (pers. comm. 2003) noted that a number of the larval food plants of the butterfly were translocated from Eltham (from sites to be developed for housing, including Progress Road) to the La Trobe Wildlife Sanctuary in the late 1990s. *Trapezites phigalioides* is resident in the Eltham area and presumably the translocated food plants contained sufficient numbers of the early stages (either as eggs, larvae or pupae) of this species so that a breeding colony was inadvertently established in the reserves.

In 1993, *Toxidia doubledayi* was recorded in abundance for the first time from several sites at Eltham where I had not seen it previously, and other entomologists/naturalists also observed it from new locations in the lower Yarra Valley, including East Malvern, Janefield (Plenty River Gorge), Cottlesbridge and Warrandyte during the 1993-94 flight season (Braby 1994). On the basis of these observations it was concluded that the skipper was expanding its range locally in the Melbourne area, possibly in response to unseasonably cool and wet conditions that prevailed during 1992-1994. In 1995, I found the species breeding at Eltham on Weeping Grass *Microlaena stipoides*, and a decade later (5 November 2006) at Greensborough (Yandell Reserve) I recorded a final instar larva within a rolled leaf shelter of Thatch Saw-sedge *Gahnia radula* [presumably the sedge was being used as a pupation site and did not represent the larval

food plant]. The observations made at La Trobe University suggest that this univoltine species is now established in the Wildlife Sanctuary and adjacent conservation reserves, and most likely it colonised the area naturally sometime between 1995 and 2000.

Of the species recorded from the conservation reserves and university campus, 22 (71%) are now considered to be resident based on presence of the immature stages or availability of larval food resources and adult population structure (Table 3). That is, these species breed regularly with some stage of the life cycle present at all times of the year. Of the remaining nine species, four are considered to be visitors (specimens regularly enter the area but do not breed or very rarely breed), two are vagrants (specimens occasionally enter the area but do not breed), and three are immigrants (populations of migratory species which enter the area on a seasonal basis but do not breed) (Table 3). Interestingly, of the resident species a high proportion of these (9/22 or 41%) specialise as larvae on Poaceae (Table 3). These grass-feeding butterflies belong to two taxonomic groups: the Hesperiidae and Nymphalidae: Satyrinae. The actual species of grass used in the conservation reserves have not been determined, but are likely to include several of the moist, shade-loving species such as *Microlaena stipoides, Poa morrisii, P. labillardieri* and *P. ensiformis*, all of which occur in the reserves and most are known larval food plants for these butterflies elsewhere (Braby 2000). Larval food plants for the other resident species include *Acacia* spp. (3 butterfly spp.), *Lomandra* spp. (2 butterfly spp.), various legumes (2 butterfly spp.) and the mistletoe *Muellerina eucalyptoides* (2 butterfly spp.) which chiefly parasitises *Eucalyptus camaldulensis*.

The key elements in successful urban butterfly conservation include habitat protection and site security, management of threatening processes, habitat restoration and enrichment (which may include translocation), and monitoring, together with education and scientific knowledge of the ecological requirements of the focal species (New and Sands 2002; New *et al.* 2007). Butterfly populations in urban landscapes typically occur in small, fragmented and isolated sites, which frequently require intensive management and ecological restoration from a variety of threats (Yen 2011). The major threatening processes facing urban butterflies in conservation reserves are invasion of exotic weeds, human pressures (e.g. recreation activities, rubbish dumping, vegetation trampling, domestic and street run-off), altered fire regime including inappropriate fuel reduction burns, and vegetation succession (New and Sands 2002).

With respect to the La Trobe Wildlife Sanctuary, Gresswell Forest NCR and Gresswell Hill NCR, conservation management and ecological restoration of these three conservation reserves over the past two decades appears to have benefited butterflies associated with the understorey ground layer, in particular the *Lomandra*-feeding and several of the grass-feeding specialists. Previously, populations of *Trapezites symmomus, T. phigalioides, Signeta flammeata, Toxidia doubledayi, Geitoneura acantha* and *Heteronympha penelope* were either absent or occurred in very low abundance and two of these species (*S. flammeata, H. penelope*) were thought to be non-resident. However, extensive management and restoration of riparian habitats, especially revegetation of the indigenous flora and weed control/eradication over the past 20 years (G Paras and B Smith pers. comm. 2005), has led to dramatic changes in the structure and composition of the vegetation in Gresswell Forest NCR. In particular, the extensive plantings of indigenous trees and shrubs along Salt Creek has increased the extent of the shaded understorey, with a concomitant increase in the extent of native shade-tolerant grasses such as *Microlaena stipoides*. It would appear that this change in microhabitat has been beneficial to sedentary species such as *G. acantha* and *H. penelope*. In the case of *H. penelope*, it is possible that this species always existed in Gresswell Forest NCR, but it was rarely detected in the 1980s due to its small population size. It is now resident in the reserve and appears to be abundant.

The introduction of *Trapezites symmomus* in 1988 and its long-term persistence in Gresswell Forest NCR and La Trobe Wildlife Sanctuary for over two decades represents one of few documented attempts to translocate a native species of butterfly successfully into a conservation reserve in Australia. Mjadwesch and Nally

Table 3. List of butterflies recorded from La Trobe Wildlife Sanctuary (LTUWS), Gresswell Hill Nature Conservation Reserve (GHNCR) and Gresswell Forest Nature Conservation Reserve (GFNCR) and their ecological status. Larval food plants are given for resident species: these are listed to species level where they have been recorded within the reserves, or to family level where they have not been not recorded within the reserves, the taxa listed being based on published records elsewhere for the Melbourne region. + = species recorded from area; o = evidence of species breeding in area. *recorded from university campus only.

Species	LTUWS	GHNCR	GFNCR	Ecological status	Larval food plant
Trapezites symmomus	+, o		+, o	resident	*Lomandra longifolia*
Trapezites phigalioides		+		resident	Asparagaceae
Dispar compacta	+	+	+	resident	Poaceae
Toxidia doubledayi	+	+	+	resident	Poaceae
Signeta flammeata		+		resident	Poaceae
Taractrocera papyria	+	+	+	resident	Poaceae
Ocybadistes walkeri	+	+	+, o	resident	Poaceae
Papilio anactus	+	+	+	visitor	
Eurema smilax	+			immigrant	
Belenois java	+	+	+	immigrant	
Delias aganippe		+		visitor	
Delias harpalyce	+	+	+, o	resident	*Muellerina eucalyptoides*
Pieris rapae	+	+	+	resident	Brassicaceae
Danaus petilia	+		+	immigrant	
Danaus plexippus			+	vagrant	
Vanessa itea	+	+	+	visitor	
Vanessa kershawi	+	+	+	resident	Asteraceae
Junonia villida	+	+	+	resident	Plantaginaceae, Scrophulariaceae
*Charaxes sempronius**				vagrant	
Heteronympha merope	+	+	+	resident	Poaceae
Heteronympha penelope		+	+	resident	Poaceae
Geitoneura acantha	+	+	+	resident	Poaceae
Geitoneura klugii	+	+	+	resident	Poaceae
Hypochrysops delicia	+, o	+, o	+, o	resident	*Acacia mearnsii, A. pycnantha*
Ogyris abrota		+, o	+, o	resident	*Muellerina eucalyptoides*
Ogyris olane		+		visitor	
Jalmenus evagoras	+, o	+	+, o	resident	*Acacia mearnsii, A. melanoxylon, A. pycnantha, A. dealbata*
Nacaduba biocellata	+	+, o	+	resident	*Acacia implexa*
Theclinesthes serpentatus	+			resident	Amaranthaceae
Lampides boeticus	+	+	+	resident	Fabaceae
Zizina otis	+	+	+	resident	Fabaceae

(2008) reported the successful salvage of the endangered Purple Copper *Paralucia spinifera* in the central tablelands of southern New South Wales in which 1260 larvae were removed from their food plants from a site (about to be developed for road realignment) and transferred to an adjacent area. Other initiatives to augment and enhance breeding habitats within urban reserves or establish new habitats (see New and Sands 2002 for review) have relied on natural dispersal of the relevant butterfly species to colonise new sites. For example, conservation management of *Hesperilla flavescens* in Victoria over the last decade has involved several approaches aimed primarily at increasing the extent of its larval food plant, the Chaffy Saw-Sedge *Gahnia filum*, through a revegetation program, including propagation and planting from seed, natural recruitment through aided seed dispersal, mosaic burning to stimulate regeneration, and translocation of individual tussocks to create new habitat (Savage 2002 in Relf

and New 2009). A preliminary census undertaken at a site at Point Cook near Melbourne in the 2006-2007 flight season demonstrated that areas comprising new habitat at which *G. filum* had been transplanted 7-10 years earlier were occupied by the early stages of *H. flavescens*, indicating that the new habitat had been successfully colonised (Relf and New 2009). Belvedere *et al.* (1998) reported attempts with the Sword-grass Brown *Tisiphone abeona* in The Basin-Boronia area, a fragmented suburban landscape east of Melbourne, in which the breeding habitat of the butterfly was restored or enriched by propagating stands of the larval food plant, Red-fruit Saw-sedge *Gahnia sieberiana*, in six reserves between two bushland sites known to support populations of *Tisiphone abeona* (Belvedere *et al.* 1998). It is envisaged that the new habitats will eventually be colonised by the butterfly through natural dispersal of gravid females.

The success of the introduction of *Trapezites symmomus* suggests that other local, sedentary and ecologically specialised butterflies could potentially be translocated to the La Trobe Wildlife Sanctuary and adjacent nature conservation reserves following habitat restoration and enrichment. For example, populations of the Varied Sedge-skipper *Hesperilla donnysa* (with larvae specialising on *Gahnia radula*) and Varied Dusky-blue *Candalides hyacinthinus* (with larvae specialising on Downy Dodder-laurel *Cassytha pubescens* and Coarse Dodder-laurel *C. melantha*) occur nearby in the Plenty River gorge, but are currently not established at La Trobe University, and attempts are currently underway to establish or augment their larval food plants and ecological requirements (G. Paras pers. comm. 2011).

Moreover, the *Trapezites symmomus* experiment suggests that other more threatened species in the Melbourne area could potentially be established in conservation reserves through such ambitious translocation programs. Notable amongst these is the threatened *Hesperilla flavescens*, the core population of which is restricted to small remnant habitat patches comprising coastal sedgelands dominated by *Gahnia filum* between Altona and Point Cook south-west of Melbourne (New and Sands 2002; New *et al.* 2007; Relf and New 2009). This vulnerable species is now extinct near Adelaide, and the remaining sites near Melbourne are threatened by urbanisation, particularly the loss and degradation of its breeding habitat through drainage of swamps and weed invasion, as well as a variety of human pressures (Relf and New 2009). The extant sites are also fragmented and isolated from each other. As noted above, attempts are already underway to expand the breeding habitat at these sites, but there is no reason why a new population of the butterfly could not be founded at a new unoccupied site, if indeed suitable areas still exist for such a translocation program.

Acknowledgements

I am grateful to George Paras, Bruce Smith, Laurie Whelan, David Britton, Gerard Closs and Valerie Himmelreich for comments and information, or assistance with field work. Tim New and George Paras kindly read a draft of the manuscript.

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Compiled by KN Bell

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Received 4 November 2011; accepted 23 February 2012

A seagrass shading experiment to determine the effects of a dredge plume

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Abstract
The environmental effect on seagrass of sediment plumes from dredging is often questioned in Environmental Impact Statements. Seagrass in southern Port Phillip Bay, Victoria, Australia, was shaded in winter and spring to the same level as the worst scenario of shading by an expected dredge plume. After 90 days of shading, *Heterozostera nigricaulis* shoot numbers reduced by 61%. After 134 days of shading, the shoot density reduced by 84%. Some of the shades were removed after 71 days of shading, but shoot density continued to decline for a further 40 days in these plots, and no recovery was observed throughout this time. In these plots, where shades had been removed, shoot densities then stabilised and no further loss was reported at day 134. A minimum light requirement of 12.5%–25.6% appears to be suitable for sustaining *H. nigricaulis* beds. (*The Victorian Naturalist* **129** (3), 2012, 97–108)

Keywords: *Heterozostera nigricaulis*, shading, dredging, shoot density, light requirement

Introduction

One of the major impacts of dredging is an increase in turbidity and suspended sediments in the water column and the subsequent decrease in light availability to benthic plants. This research describes site and seagrass specific shading experiments to determine the potential effect of a dredge plume.

Much research has been carried out on the susceptibility of seagrasses to shading (Bulthuis and Woelkerling 1983; Goldsborough and Kemp 1988; Peralta *et al.* 2002; Gacia *et al.* 2005). Little of this research has been applied to understanding the effects of reduced light conditions on seagrass under a dredge plume. In an excellent review of the environmental impacts of dredging on seagrasses, Erftemeijer and Lewis (2006) looked at 45 case studies globally, accounting for the loss of about 21 000 ha of seagrass. They recommend site specific evaluations of the effects of dredging plumes. Recently, Mackey *et al.* (2007) studied many parameters of *Amphibolis griffithii* biology under shade conditions, in areas adjacent to harbour dredging programs in their region. Although a wide range of morphological and physiological variables responded to reduced light availability, the majority of variables showed substantial recovery after 42 days. This was one of the first experiments in the peer reviewed literature to match site specific dredging activities with response by seagrass to those activities. Previous work usually appeared in environmental effects and impact statements and internal government or corporate reports. Previously accepted methods used in research on seagrass, with the modelled reduction in light caused by a dredging plume are brought together and the way that site-specific evaluations can be made is shown.