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**Journal of Insect Conservation**

An international journal devoted to  
the conservation of insects and related  
invertebrates

ISSN 1366-638X

J Insect Conserv  
DOI 10.1007/s10841-015-9761-x



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# Beauty with benefits: butterfly conservation in Washington State, USA, wine grape vineyards

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Received: 20 June 2014 / Accepted: 7 February 2015  
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**Abstract** The butterfly fauna of south central Washington State, USA is characterized by shrub-steppe specialists adapted to hot, dry summers and cold winters. However, the shrub-steppe ecosystem has diminished at an alarming rate due to extensive agricultural development fostered by access to an abundant water supply from the Cascade Mountains. This has resulted in loss and fragmentation of habitat for ~50 species of butterflies which are now in decline. Viticulture is a major agricultural industry in south central Washington and has transitioned in recent years to a sustainable, low pesticide-input enterprise. Current viticultural pest management research is focused on restoration of shrub-steppe habitat and native plants to enhance and sustain beneficial arthropod populations (predators and parasitoids) for pest control. Butterfly populations were surveyed during 2012–13 in a pair of vineyards (habitat-enhanced, conventional) in each of four viticultural regions [Columbia gorge (CG), Walla Walla valley (WWV), Yakima valley (YV), Wahluke slope (WS)] in south-central Washington. The habitat-enhanced sites supported a significantly greater number of flowering plant species (mostly native) than conventional vineyard sites. Twenty nine butterfly species were recorded from the habitat-enhanced vineyards with only nine of these recorded from the conventional vineyards. Overall, there were double the number of species in habitat-enhanced vineyards [mean ( $\pm$ SE)  $5.62 \pm 0.85$ ] compared to conventional vineyards ( $2.75 \pm 0.75$ ) although this was not statistically significant. A significantly greater number of species occurred in the

CG and WWV habitat-enhanced vineyards ( $10.5 \pm 0.5$ ) compared to the conventional vineyards ( $3.5 \pm 0.0$ ) in these regions. Smaller numbers of butterfly species occurred in YV and WS vineyards with no significant differences between habitat-enhanced and conventional sites. Butterfly abundance was significantly greater in habitat-enhanced vineyards ( $20.37 \pm 5.34$  individuals/visit) compared to conventional vineyards ( $5.5 \pm 0.9$ ) with greatest differences in the CG and WWV vineyards. The pest management strategy of restoring native plants and habitats in a low pesticide-input crop like wine grapes in central Washington may have substantial benefits for butterfly abundance, diversity and conservation. Many of the flowering native perennials important in attracting and sustaining endemic biological control agents, are also larval hosts and/or nectar sources for threatened shrub-steppe butterflies.

**Keywords** Shrub-steppe · Viticulture · Pest management · Habitat restoration · Butterfly conservation

## Introduction

South central Washington State in the Pacific Northwest of the United States is characterized climatically by low annual rainfall, hot, sunny summers and cold wet winters (Daubenmire 1956). It is largely a basin or low plateau punctuated by dry ranges and scored by deep coulees and channeled scablands. The Columbia River runs through the region fed by other rivers like the Snake and the Yakima (Benito and O'Connor 2003). This largely treeless area is dominated by a rich and diverse shrub-steppe ecosystem that has sagebrush (*Artemisia tridentata*) and bunchgrass prairie as the primary vegetation types (Wooten 2003).

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Surprisingly perhaps, this region supports a large and diverse fauna of butterflies; about half of the ~160 species known from the Pacific Northwest occur in south-central Washington (Pyle 2002; James and Nunnallee 2011). South central Washington is also a major agricultural production area supported by irrigation derived from annual snowpack in the nearby Cascade Mountains. More than 100 crops are grown in the region including apples, wheat, corn, potatoes, hops and grapes. Agricultural development over the past 40–50 years has severely eroded the shrub-steppe especially in the valleys and many of the region's butterflies have suffered significant declines as habitats have been lost (Pyle 1974, 2002; James and Nunnallee 2011).

The area planted to wine grapes in south central Washington has grown from a few hundred hectares in the mid 1970s to more than 13,000 hectares in 2014 and production is now only second to California in the US (Perdue 2013). The vast majority of these new vineyards have been planted on former shrub-steppe lands. Pest management in Washington viticulture was dominated by the widespread use of broad-spectrum insecticides up until about 2000 (Cone et al. 1990; James 2014). Thereafter, there has been a consistent decline in the use of insecticides in Washington wine grapes resulting in biologically-based integrated pest management today (James 2013, 2014). Few insecticides are now applied in Washington grapes and those that are, are generally narrow-spectrum and have reduced or no impact on non-target organisms. Current research on pest management in Washington wine grapes is centered on increasing the efficacy and sustainability of conservation biological control of pests by restoring native plants and habitats within and around vineyards (<http://www.wavineyardbeautywithbenefits.com/>). The establishment of native shrub-steppe flora on agricultural land not subjected to frequent pesticide applications opens up opportunities not only for native plant conservation but also for the conservation of insects like butterflies that are associated with these plants (James et al. 2013). The potential for Washington State wine grape vineyards to become butterfly conservation areas is explored in this field study.

## Methods

### Vineyard sites

A pair of vineyards (habitat-enhanced, conventional) was selected in each of four viticultural regions [Columbia gorge (CG), Walla Walla valley (WWV), Yakima valley (YV), Wahluke slope (WS)] in south-central Washington, which differ enough climatically and geologically to warrant individual appellation status (Gregutt 2007). In each region the pair of sites was separated by 0.5–32 km.

Habitat-enhanced vineyards had a history of allowing plants, mostly natives, to colonize the site and/or some attempt had been made to establish native plants. The CG and WS sites had been restoring native plants for 15–20 years. The YV and WWV vineyards had only been restoring native plants for about 5 years. An inventory was taken of all broad-leaved plant species occurring at each vineyard site during the survey period. Insecticides were never (CG, WS) or only rarely used (YV, WWV). All insecticides were 'soft' and narrow-spectrum in their action, unlikely to have major deleterious effects on butterfly populations. The conventional vineyard sites had made no attempt to encourage native plants and frequently used herbicides within vine rows. Native plants were also not encouraged in areas outside the grapevine block. Insecticides were occasionally used in the conventional vineyards (1–2 sprays/season) but all were narrow spectrum.

### Butterfly surveys

Butterfly surveys were conducted at each vineyard during May to September in 2012 and 2013. Vineyards were visited every 2 weeks and the number and species of butterflies seen during a 30–40 min period between 1000 and 1500 h were recorded. In most instances butterflies were identified in the field and verified by photographs. Some species were netted to confirm identity. Surveying was conducted in the vineyard and the immediately surrounding area up to 25 m from the grapes. Weather on most occasions was sunny and warm (15–38 °C) and conducive to butterfly activity.

### Data analysis

Data on numbers of plant and butterfly species occurring in habitat-enhanced and conventional vineyards were compared using paired Student's *t* tests.

## Results

The habitat-enhanced vineyard sites supported a significantly greater number of plant species [mean ( $\pm$  SE) 47.0  $\pm$  6.3, range 32–61] than conventional vineyard sites (mean 8.7  $\pm$  4.1, range 4–21,  $t = 4.532$ , 3 df,  $P = 0.020$ ) (Tables 1, 2). Similarly, a mean of 30.2  $\pm$  3.3 native plant species were present in habitat-enhanced vineyards compared to 5.0  $\pm$  1.7 in conventional vineyards ( $t = 6.733$ , df = 3,  $P = 0.007$ ). Habitat-enhanced vineyards had a significantly greater number of plants known to be visited by butterflies for nectar (42  $\pm$  4.1) compared to 8.0  $\pm$  4.0 plants in conventional vineyards ( $t = 5.097$ , df = 3,  $P = 0.015$ ). Habitat-enhanced vineyards supported a

**Table 1** Plant species present in the habitat-enhanced (H) and conventional (C) vineyards in the Columbia gorge (CG), Walla Walla valley (WWV), Yakima valley (YV) and Wahluke slope (WS) appellations

Plant	Nectar	Host	CG-H	CG-C	WWV-H	WWV-C	YV-H	YV-C	WS-H	WS-C
<i>Achillea millefolium</i>	X		X	X	X		X	X	X	
<i>Agoseris retrorsa</i>	X			X	X		X		X	
<i>Agrostemma githago</i> (A)	X		X							
<i>Alcea rosea</i> (A)	X	X	X							
<i>Amaranthus retroflexus</i> (A)	X	X			X					
<i>Ambrosia artemisiifolia</i> (A)	X				X					
<i>Ambrosia acanthicarpa</i> (A)	X						X		X	
<i>Amsinckia lycopsoides</i>	X		X		X		X		X	
<i>Apocynum cannabinum</i>	X						X		X	
<i>Artemisia ludoviciana</i>	X				X	X				
<i>Artemisia tridentata</i>	X				X				X	
<i>Asclepias fascicularis</i>	X	X	X							
<i>Astragalus caricinus</i>	X	X					X		X	
<i>Astragalus sclerocarpus</i>	X	X					X		X	
<i>Balsamorhiza careyana</i>	X		X						X	
<i>Bassia hissipifolia</i> (A)					X					
<i>Calendula</i> sp. (A)	X				X					
<i>Calochortus macrocarpus</i>									X	
<i>Capsella bursa-pastoris</i> (A)	X			X	X					
<i>Carduus nutans</i> (A)	X	X			X					
<i>Castilleja</i> sp.	X	X	X							
<i>Castilleja thompsoni</i>	X	X							X	
<i>Ceanothus integerrimus</i>	X	X	X	X						
<i>Centaurea cyanus</i> (A)	X		X	X						
<i>Centaurea solstitialis</i> (A)	X				X	X	X		X	
<i>Chaenactis douglassii</i>	X								X	
<i>Chamaebatiaria millefolium</i>					X					
<i>Chenopodium album</i> (A)	X	X							X	
<i>Chondrilla juncea</i> (A)	X				X					
<i>Chorispora tenella</i> (A)	X								X	
<i>Cirsium arvense</i> (A)	X	X			X		X			
<i>Clarkia amoena</i>	X	X	X							
<i>Clematis ligusticifolia</i>	X				X					
<i>Collomia grandiflora</i>	X		X	X						
<i>Convolvulus arvensis</i> (A)	X			X					X	
<i>Conyza canadensis</i>	X				X		X		X	
<i>Coreopsis tinctoria</i>	X				X					
<i>Crepis</i> sp.	X								X	
<i>Cynoglossum grande</i>	X		X							
<i>Dalea purpurea</i>	X				X					
<i>Dichelostemma congestum</i>	X		X							
<i>Daucus pusillus</i>	X	X	X							
<i>Epilobium</i> sp.	X						X		X	
<i>Ericameria nauseosus</i>	X	X							X	X
<i>Erigeron filifolius</i>	X	X					X		X	
<i>Erigeron linearis</i>	X	X							X	
<i>Erigeron pumilus</i>	X	X							X	

Table 1 continued

Plant	Nectar	Host	CG-H	CG-C	WWV-H	WWV-C	YV-H	YV-C	WS-H	WS-C
<i>Erigeron speciosus</i>	X	X			X					
<i>Eriogonum niveum</i>	X	X							X	
<i>Eriogonum thymoides</i>	X	X							X	
<i>Erodium cicutarium</i>	X		X	X	X	X	X		X	
<i>Eschscholzia californica</i>	X		X							
<i>Euthamia occidentalis</i>	X								X	
<i>Fallugia paradoxa</i>	X				X					
<i>Frasera albicaulis</i>	X		X							
<i>Gaillardia aristatata</i>	X				X		X		X	
<i>Galium aparine</i>			X							
<i>Geranium carolinianum</i>	X				X					
<i>Helianthus annuus</i>	X				X					
<i>Hieracium scouleri</i>	X		X							
<i>Hymenoxys acaulis</i>	X				X					
<i>Hypericum perforatum</i> (A)	X		X							
<i>Hypochaeris radicata</i> (A)	X		X		X		X		X	
<i>Lactuca serriola</i> (A)	X				X		X		X	
<i>Lavandula angustifolia</i> (A)	X		X							
<i>Lepidium perfoliatum</i>	X	X							X	
<i>Linanthus pungens</i>	X								X	
<i>Linum lewisii</i>	X				X		X		X	X
<i>Logfia arvensis</i> (A)					X					
<i>Lomatium triternatum</i>	X	X	X							
<i>Lomatium nudicaule</i>	X	X	X	X						
<i>Lotus corniculatus</i> (A)	X	X			X					
<i>Lotus nevadensis</i>	X	X	X	X						
<i>Lotus micranthus</i>	X	X	X							
<i>Lupinus</i> sp.	X	X	X	X						
<i>Lupinus polycarpus</i>	X	X	X		X		X		X	
<i>Machaeranthera canescens</i>	X	X			X		X	X	X	X
<i>Madia exigua</i>	X		X							
<i>Malva neglecta</i> (A)	X	X		X	X				X	
<i>Matricaria discoidea</i>	X			X	X				X	
<i>Medicago falcate</i> (A)	X	X			X					
<i>Medicago lupulina</i> (A)	X	X			X					
<i>Medicago sativa</i> (A)	X	X	X	X	X				X	
<i>Melilotus officinalis</i> (A)	X	X			X		X		X	
<i>Oenothera pallida</i>	X				X		X		X	
<i>Onopordum acanthium</i> (A)	X	X			X					
<i>Parthenocissu vitaceae</i>					X					
<i>Penstemon</i> sp.	X	X			X		X		X	
<i>Penstemon eatonii</i>	X	X			X					
<i>Penstemon palmeri</i>	X	X			X					
<i>Phacelia hastata</i>	X								X	
<i>Philadelphus lewisii</i>	X		X							
<i>Plagiobothrys</i> sp.	X		X							
<i>Plantago patagonica</i>	X	X			X		X		X	

**Table 1** continued

Plant	Nectar	Host	CG-H	CG-C	WWV-H	WWV-C	YV-H	YV-C	WS-H	WS-C
<i>Plantago lanceolata</i> (A)		X	X	X						
<i>Polygonum convolvulus</i> (A)					X					
<i>Purshia tridentata</i>	X	X							X	
<i>Ratibida columnifera</i>	X				X					
<i>Rosa woodsii</i>	X				X		X		X	
<i>Salix exigua</i>	X	X			X		X			
<i>Salsola kali</i> (A)	X	X			X	X		X	X	
<i>Salvia dorrii</i>	X								X	
<i>Sisymbrium altissimum</i> (A)	X	X		X	X	X	X	X	X	
<i>Solidago occidentalis</i>	X				X		X			
<i>Sphaeralcea munroana</i>	X				X		X		X	X
<i>Tamarix ramosissima</i> (A)	X						X		X	
<i>Taraxacum officinale</i> (A)	X			X	X		X		X	
<i>Toxicodendron diversilobum</i>			X							
<i>Tragopogon dubius</i> (A)	X		X	X	X		X		X	
<i>Tribulus terrestris</i> (A)	X				X		X	X	X	
<i>Trifolium repens</i> (A)	X	X	X	X	X					
<i>Trifolium pretense</i> (A)	X	X			X					
<i>Trifolium arvense</i> (A)	X	X	X		X					
<i>Trifolium campestre</i> (A)	X	X	X							
<i>Triteleia grandiflora</i>	X		X							
<i>Vicia sativa</i> (A)	X	X	X	X						
<i>Vicia villosa</i> (A)	X	X	X	X						
<i>Zauschneria latifolia</i>	X				X					
<i>Zigadenus venenosus</i>	X		X							
Total 119 (A 42)	110	50	42	21	61	5	32	5	53	4

Species recognized as butterfly host plants and nectar plants are indicated. All species native except those marked (A) (alien)

significantly greater number of known butterfly larval host plants ( $17.0 \pm 2.2$ ) than conventional vineyards ( $3.5 \pm 2.5$ ,  $t = 4.902$ ,  $df = 3$ ,  $P = 0.016$ ).

Twenty nine butterfly species were recorded from habitat-enhanced vineyards with only nine of these recorded from conventional vineyards (Table 3). Of the nine species found in conventional vineyards, two are widespread, mobile, wide-ranging species that may not have been resident in the vineyards. Twenty five of the 29 species recorded in habitat-restored vineyards are likely to be resident in the vineyard or adjacent areas (Table 3). During the 2 years, there were double the number of species in habitat-enhanced vineyards ( $5.62 \pm 0.85$ ) compared to conventional vineyards ( $2.75 \pm 0.75$ ) although this was not statistically significant ( $t = 2.091$ ,  $df = 3$ ,  $P = 0.128$ ). A significantly greater number of species occurred in the CG and WWV habitat-enhanced vineyards ( $10.5 \pm 0.5$ ) compared to the conventional vineyards ( $3.5 \pm 0.0$ ,  $t = 14$ ,  $df = 1$ ,  $P = 0.045$ ) in these regions. Smaller numbers of butterfly species (3–6) occurred in YV and WS vineyards and although there was no difference in numbers between

habitat-enhanced (3) and conventional sites (3) at WS, twice as many (6) species occurred at the YV habitat-enhanced site than in the conventional vineyard (3).

Butterfly abundance was significantly greater in habitat-enhanced vineyards ( $20.37 \pm 5.34$  individuals/visit compared to conventional vineyards ( $5.5 \pm 0.9$ ,  $t = 3.315$ ,  $df = 3$ ,  $P = 0.018$ ) (Fig. 1). Differences were greatest at the CG and WWV vineyards ( $t = 48$ ,  $df = 1$ ,  $P = 0.013$ ) and least at the YV and WS vineyards ( $t = 0.909$ ,  $df = 1$ ,  $P = 0.530$ ) (Fig. 1).

## Discussion

Butterfly populations have rarely been studied in vineyards. Schmitt et al. (2008) working in Germany reported that butterfly abundance and diversity were much lower in vineyards than in nearby fallow land, ascribing this to a lack of nectar and host plant resources in vineyards as well as negative effects from pesticide applications. Low butterfly abundance and diversity was also reported from

**Table 2** Plant species characteristics for the habitat-enhanced and conventional vineyards used in this study located in four eastern Washington viticultural appellations

Site	Number of plant species	Number (%) native plant species	Number (%) alien plant species	Number (%) nectar providers	Number (%) host plant species
Wahluke slope habitat-enhanced	53	38 (71.7)	15 (28.3)	46 (86.8)	17 (32.1)
Wahluke slope conventional	4	4 (100)	0 (0.0)	4 (100.0)	1 (25.0)
Columbia gorge habitat-enhanced	42	29 (69.0)	13 (31.0)	39 (92.9)	19 (45.2)
Columbia gorge conventional	21	9 (42.9)	12 (57.1)	20 (95.2)	11 (52.4)
Yakima valley habitat-enhanced	32	22 (68.8)	10 (31.2)	32 (100.0)	11 (34.4)
Yakima valley conventional	5	3 (60.0)	2 (40.0)	5 (100.0)	1 (20.0)
Walla Walla habitat-enhanced	61	32 (52.4)	29 (47.6)	51 (83.6)	21 (34.4)
Walla Walla conventional	5	3 (60.0)	2 (40.0)	3 (60.0)	1 (20.0)
All habitat-enhanced sites	119	77 (64.7)	42 (35.3)	103 (86.6)	45 (37.8)
All conventional sites	29	16 (55.2)	13 (44.8)	26 (89.6)	12 (41.4)

**Table 3** Butterfly species recorded in the habitat-enhanced and conventional vineyards used in this study located in four eastern Washington viticultural appellations (YV Yakima valley, WWV Walla Walla valley, WS Wahluke slope, CG Columbia gorge)

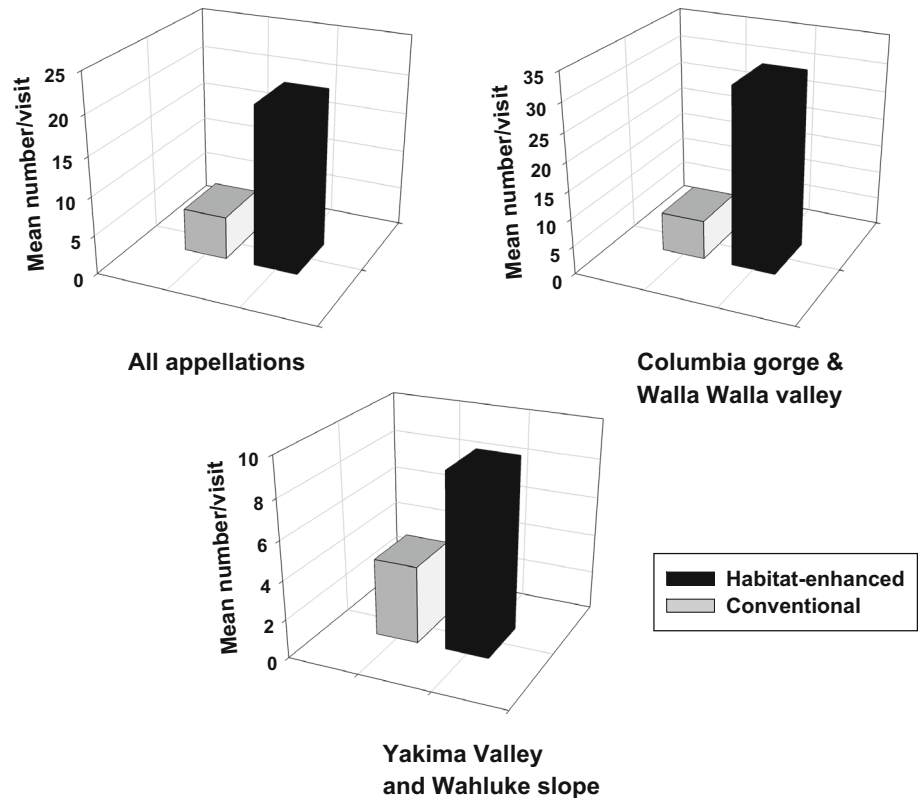
Butterfly species	Habitat-enhanced vineyards	Conventional vineyards
<i>Papilio zelicaon</i>	CG, WWV	CG
<i>Papilio eurymedon</i>	CG	
<i>Papilio rutulus</i>	CG	
<i>Pontia beckerii</i>	CG, WWV, YV, WS	CG, WWV, YV, WS
<i>Pieris rapae</i> *	CG, WWV, YV	CG, WWV, YV, WS
<i>Colias philodice</i> *	CG, WWV, YV	
<i>Colias eurytheme</i> *	CG, WWV, YV,	CG, WWV, YV
<i>Lycaena helloides</i>	CG, WWV	
<i>Callophrys augustinus</i>	CG	
<i>Satyrium californica</i>	CG	
<i>Plebejus icarioides</i>	CG	
<i>Plebejus lupini/acmon</i>	CG, WWV, YV	
<i>Glaucopsyche lygdamus</i>	CG	CG
<i>Celastrina echo</i>	CG	CG
<i>Strymon melinus</i>	WWV, WS	WS
<i>Phyciodes mylitta</i>	CG, WWV	
<i>Nymphalis antiopa</i>	YV, WS	
<i>Vanessa cardui</i> *	WWV	
<i>Polygonia satyrus</i>	WWV	
<i>Cercyonis pegala</i>	CG	
<i>Coenonympha tullia</i>	CG	
<i>Hesperia colorado</i>	CG	
<i>Hesperia juba</i>	WWV	
<i>Ochlodes sylvanoides</i>	CG, WWV	CG
<i>Atalopedes campestris</i>	CG	
<i>Erynnis propertius</i>	CG	
<i>Pyrgus communis</i>	WWV	
<i>Pholisora catullus</i>	WWV	WWV
<i>Heliopetes ericetorum</i>	WWV	

Species marked \* are migratory or highly dispersive

vineyards in New Zealand but this was largely a consequence of the small number of butterflies (23 spp.) resident in New Zealand (Gillespie and Wratten 2012). However,

native plants established in New Zealand vineyards were not associated with increased abundance and/or diversity of butterflies (Gillespie and Wratten 2012).

**Fig. 1** Mean number of individual butterflies seen per visit at habitat-enhanced and conventional vineyards in four central Washington appellations during 2012–2013



In contrast, our study suggests that the pest management enhancement strategy of restoring native plants and habitats in a low pesticide-input crop like wine grapes in central Washington, may have substantial benefits for butterfly abundance, diversity and conservation. Many flowering native plants attractive to natural enemies of pest insects in central Washington are also important nectar sources or larval host plants for butterflies. For example, 10 species of native flowering buckwheats (*Eriogonum* spp.) were shown to be attractive to a wide range of beneficial insects in central Washington (James et al. 2014). These plants are also larval hosts to at least 11 lycaenid butterflies (James and Nunnallee 2011).

The aim of this study was to compare butterfly abundance and diversity in wine grape vineyards that actively encourage or restore native plants and vineyards that follow a conventional approach of minimizing and discouraging establishment and growth of plants other than grapevines. There were 2–13 X as many plant species at habitat-enhanced sites as at conventional sites with most of these plants known nectar resources for butterflies. More than a third of plant species at habitat-enhanced sites are known to host larvae of Washington butterflies. Butterfly diversity and abundance was demonstrably greater in habitat-enhanced vineyards in three of the four areas. The greatest differences occurred in the CG and WWV appellations. The habitat-enhanced vineyard in the CG has been under the current

management since 1994 and had the greatest butterfly diversity with 21 species. The WWV vineyard has a shorter history of habitat enhancement (~5 years) but has an aggressive program of establishing flowering native plant species. Sixteen butterfly species were recorded at this site. The YV habitat-enhanced vineyard has only recently begun establishing native plants and only six butterfly species were recorded. The WS habitat-enhanced vineyard has been encouraging native plants for 20 years but is in a hotter and drier appellation which may explain the low apparent butterfly diversity (three species). Curiously, at least three common and widespread species seen in the other habitat-enhanced vineyards (*Pyrgus communis*, *Pholisora catullus*, *Heliopetes ericetorum*) were not recorded at the WS vineyard, despite the presence of their host plants (*Malva* spp., *Chenopodium*).

Four of the 29 butterfly species recorded in the vineyards in this study are considered migratory or highly dispersive and can turn up almost anywhere in eastern Washington (Table 3). However, for the majority of butterfly species we found in vineyards, larval host plants were also present. For example larval host plants for 18 of the 21 species recorded in the CG habitat-enhanced vineyard, were also present in or very near to the vineyard. Similarly, 14 of the 16 species recorded at the WWV habitat-enhanced vineyard also had larval host plants present. Thus, there is a good possibility that breeding populations of

these butterflies are present in these habitat-enhanced vineyards.

Our research on beneficial insect attraction to native plants in Washington has identified many other plant species apart from *Eriogonum* spp. (James et al. 2014) that have potential for enhancing pest management in wine grape vineyards and are also butterfly host and/or nectar plants (James et al. in prep.). The importance of stinging nettles (*Urtica dioica*) as larval hosts for a range of nymphalid butterflies in the Pacific Northwest is well known (James and Nunnallee 2011), but their great value in harboring predatory bugs and parasitic wasps is less well known (James et al. in press). In the future Washington wine grape growers should be able to select plants for establishment in vineyards based on their value to pest management and to butterfly conservation. This should enable vineyards to play an important role in butterfly conservation by creating habitat for vulnerable shrub-steppe species, as an additional benefit of minimizing pest management concerns and costs. Vineyards in different viticultural regions of Washington should be able to tailor their native vegetation mix to suit both their local pest pressures and local opportunities for butterfly conservation. For example, many new vineyards in the YV appellation, particularly around the Tri-Cities in south central Washington, occupy sites that formerly hosted populations of *Plebejus icarioides* (Boisduval's blue) and *Chlosyne acastus* (Sagebrush checkerspot) (James unpubl. obs). In most cases, populations of these butterflies still exist within a few kilometers of vineyards and by simply restoring nectar sources and the larval host plants of these species [lupines (*Lupinus* spp., rabbitbrush) (*Ericameria nauseosus*)], it should be possible to re-extend the range of these species to again include the vineyards.

Successful butterfly conservation within agricultural lands primarily depends on the availability of nectar and larval hosts as well the absence or near-absence of agricultural chemicals. Achieving the latter, until recently, has been difficult if not impossible in most crops and agricultural regions. However, significant advances have been made in non-chemical pest management and crops like wine grapes in Washington can be produced with no or very little pesticide input (James 2013, 2014). In addition, many contemporary pesticides have apparently little or no impact on non-target organisms, although the sub-lethal impacts of these remain to be determined in many cases (Desneux et al. 2007). The situation we report here of butterflies co-existing with viticultural production in Washington is a scenario which is likely to become increasingly common in agricultural areas worldwide during the next few decades. Washington State grapegrowers are now being encouraged to cultivate native plants with the twin aims of enhancing sustainable biologically-based pest management and butterfly conservation (James et al. 2013).

**Acknowledgments** We gratefully acknowledge the cooperation of the wine grape growers who participated in this study and allowed us access to their properties. Funding was provided by Western Sustainable Agriculture Research and Education (WSARE), the Northwest Center for Small Fruits Research (NCSFR) and the Washington Association of Wine Grape Growers (WAWGG).

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