

## **CIPM Research Grants Final Report**

**Title:** The impact of invasive plants on pollinator assemblages and pollinator services: effects of cheatgrass (*Bromus tectorum*) in the Great Basin, U.S.A. (awarded 2006)

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**Proposal -**

The effects of invasive plant species on the habitats they invade are wide ranging, from changes in plant community structure, such as decreased species richness and abundance, to changes in ecosystem processes, including altered nutrient cycling, water availability, and fire regimes (Levine et al. 2003). These invasion-mediated changes likely affect interactions at higher trophic levels, but are largely unexplored in the scientific literature, despite their obvious importance to overall community functioning (Levine et al. 2003). A few revealing conclusions can be drawn from available research. Firstly, a reduction in plant species richness can drive a reduction in insect species richness (Knops et al. 1999). Secondly, invasion of a new plant species into a native community can alter the behavior of resident pollinators, leaving native plants without the pollination services required for successful seed production and natural gene flow. (Chittka and Schurkens 2001). Together, these conclusions hint at the potentially immense negative effect of invasive plant species on pollinator assemblages. Given the important services that pollinators provide to many native plant species, disregarding these effects could greatly hinder restoration efforts.

Perhaps nowhere is this truer than in the Great Basin region, where invasion by exotic plant species and efforts to restore habitat degraded by this invasion is occurring on a massive scale (BLM 2000). Cheatgrass (*Bromus tectorum*), a non-native invasive annual grass, is widely recognized as a key contributor to the rapid degradation of habitat in the Great Basin over the last century (BLM 2000; Booth et al. 2003), dominating over 25% of the approximately 100 million acres of public lands in the Great Basin (BLM 2000). Cheatgrass has numerous documented effects on the plant communities it invades, ranging from reduced species abundance to widespread and nearly wholesale replacement of the Great Basin's native sagebrush and bunchgrass communities (D'Antonio & Vitousek 1992; Levine et al. 2003).

In this project we propose to quantify the effects of cheatgrass invasion on native pollinator communities in the Great Basin. We will complete a survey of pollinator communities and introduce potted flowering plants of native species to determine visitation rates. This will

allow us to 1) quantify the pattern of changes in pollinator assemblages induced by invasive plant species and 2) evaluate the relative effectiveness of pollinator services in communities changed by invasive species. The outcome of this research will improve understanding of invasive species' effects on pollinator assemblages and how these changes may, in turn affect pollinator services. This is of particular importance in the Great Basin, as efforts to restore areas invaded by exotic plant species, including cheatgrass, are increasingly undertaken.

## **Results**

We first identified two equivalent sites, one Non-disturbed and one invaded by *Bromus*, separated by only 4 miles within in the same mountain range (Desatoya Mountains). We initially intended to do parallel experiment in two mountain ranges, but an early drought and flower season restricted our studies to a single range. We quantified the floral composition of the disturbed and Non-disturbed sites using a modified whittaker plot (Stohlgren et al. 1995). The Non-disturbed site, which within the center of the mountain range, and surrounded by relatively Non-disturbed habitat was comprised of 28 species and 0.7% cheat grass. The disturbed site, which was half a mile from the nearest intact habitat, had 13 species and 49% cheat grass (Table 1)

To quantify the insect community within these sites we used pan traps and a protocol developed by the USDA bee lab to survey the flying insect community. From these pan traps we caught 335 individuals and 21 ID groups within the Non-disturbed habitat compared to 38 individuals and 13 ID groups within the disturbed habitat (Table 2). This confirmed that the insect community within an Non-disturbed site, with more plant diversity supported the highest insect community. To investigate how this translated to pollination services we observed visitors to a Native plant (*Penstemon deustus*), and two pollinator-attractive cultivated species (*lavandula sp* and *Digitalis sp*) within each site. Interestingly the lavender was the most attractive to pollinators in both sites. In total we saw 86 pollinator visits at the disturbed sites compared with 417 pollinators at the Non-disturbed sites (Table 3).

## **Discussion –**

The correlation between plant diversity and abundance and diversity and abundance of species in higher trophic levels has been well documented (Naeem, Thompson et al. 1995; Siemann, Tilman et al. 1998; Knops, Tilman et al. 1999; Haddad, Tilman et al. 2001) This is attributed, in part, to the fact that plants are one of the most abundant primary producer of many ecosystems, and therefore follows that a greater diversity of resources should support a greater diversity of consumers. Therefore it is not surprising that we have found a correlation between number of plant species and number and abundance of invertebrate species at our sites. In addition we found that insect species diversity positively associated with insect abundance. Previous studies have found that insect abundance is positively associated with total plant species diversity and with decreasing plant functional group diversity (Siemann, Tilman et al. 1998; Haddad, Tilman et al. 2001). As our disturbed site had fewer plant functional groups (predominately C3 grass) this is contrary to what has been seen in other studies. This discrepancy may in part be due to previous studies focused on herbivores rather than pollinating species, and it is likely that if *Bromus sp* was animal-pollinated it would

support a greater abundance, although not necessarily diversity, of pollinating species (Kimberling and Karra 2001).

There is some disagreement whether the plant diversity is the factor which determines diversity at higher tropic levels or it is correlated to other factors (Hawkins and Porter 2003). As our sites differed in the levels of disturbance, it is possible that this loss of insect species was associated more with disturbance (Kimberling and Karra 2001; Kimberling, Karra et al. 2001). However as the likelihood of cheatgrass invasion is increased with disturbance it may be difficult to disentangle cause or effect. Although, Kimberling et al (2001a) found that the one group which showed an increase with disturbance was pollinating community, although their definition of disturbance was agricultural and it is possible that these sites were a monoculture of animal pollinating species.

Regardless, the main focus on our study was the effect of disturbance (fire or cattle) and subsequent *Bromus sp* invasion has on pollination services. By combining both pan traps and pollinator observations, we were able to more effectively to demonstrate that the decline in arthropod species translated into a decline in pollinator visits. We found a large difference in visitation in disturbed, cheat-grass dominated site compared to the Non-disturbed site, which was associated with a large difference in abundance and diversity. As this was equally true for a species native to the area and species not native or no historical presence in the area, highlights the decline in pollinator services within a degraded site and the potential pollinator services for restoration of a site.

**Table 1: Summary of Cover and species composition at two sites.**

K-plot summary	Non-	
	disturbed	Disturbed
<b>No of Species</b>		
Forb	14.0	4.0
Grass	4.0	4.0
Shrub	8.0	4.0
Tree	1.0	0.0
Invasive	1.0	1
	28.0	13.0
<b>% Cover</b>		
Cheatgrass	0.7%	48.5%
Rock/Bare Ground	64.1%	49.8%
Shrub or Tree	29.6%	0.8%
Native Grass	2.0%	0.7%
Wildflower	3.7%	0.2%

**Table 2: Summary of Number of ID groups and Abundance of Insects caught in Pan traps**

	Non-Disturbed		Disturbed	
	ID groups	# individuals	ID groups	# individuals
Hymenoptera				

Bees	4	23	2	10
Wasps	5	16	2	3
Ants	3	47	2	5
Diptera	2	2	189	11
Coleoptera	3	3	51	3
Lepidoptera	1	2	3	2
Hemiptera	1	2	6	4
<b>Totals</b>	<b>13</b>	<b>21</b>	<b>335</b>	<b>38</b>

**Table 3: Breakdown of insect visitors to plants in Disturbed and Undisturbed sites.**

	Non-disturbed		Disturbed	
	Count	Percent	Count	Percent
Peponapis	-	-	9	10.5%
tiny dark Bee	1	0.2%	1	1.2%
Small Dark Bees	106	25.4%	51	59.3%
Small Metallic Green Bees	48	11.5%	-	-
Medium Dark Bees	106	25.4%	-	-
Megachilidae	5	1.2%	-	-
Large Dark Bee	63	15.1%	-	-
Large Metallic bee	3	0.7%	1	1.2%
Xylocopa	10	2.4%	-	-
Ants	14	3.4%	-	-
Beetles	49	11.8%	-	-
Flies	2	0.5%	1	1.2%
Butterflies	6	1.4%	19	22.1%
Wasps	4	1.0%	4	4.7%
	417		86	

### Publications

Kramer, AT, Fant JB and Tonietto, R (in prep) The impact of invasive plants on pollinator assemblages and pollinator services: effects of cheatgrass (*Bromus tectorum*) in the Great Basin, U.S.A: Short Communication.

### Literature Cited

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## **Products**

### **Long-Term Goal/s and Continued Progress of Research.**

From this study the student, who has gone on to study for her Master's at Northwestern, has developed a project looking at similar questions with the Chicago region. The project will look at urbanization, including invasive plants, on pollinator communities. She will be applying the same techniques and knowledge learnt from this project for her own work.

**Benefits of Seed Money:** This seed money provided the funds for a student to develop an independent project which was part of a larger study. This study has enabled us to demonstrate the importance of considering the pollination community when restoring a site as well as the negative consequence of plant invasion.

This project has also been used in raising public awareness among members of the Chicago Botanic Garden as to the consequences of disturbance and plant invasion on pollination communities.

**Advancing This Research**

The student is planning a visit to The New York Natural History and the USDA Bee Lab in Logan Utah. There she will be able to identify the ID groups down to species, in addition she will have an opportunity to present and compare our results to similar research down at the Bee Lab. This will strengthen the findings of our research and hopefully lead to future collaborations in this area.

**Website**

[http://www.cbgsience.org/great\\_basin/cipm.htm](http://www.cbgsience.org/great_basin/cipm.htm)

[http://www.cbgsience.org/great\\_basin/pollinators.htm](http://www.cbgsience.org/great_basin/pollinators.htm)

**Budget** – an itemized budget of how the grant monies were spent