Forty years of change in the sunflower bee community in the southwest United States

Introduction

The ecological and economic importance of pollinators is a matter of recent public concern as well as scientific interest [Potts et al. 2010; Vanbergen et al. 2013]. A diverse pollinator assemblage confers resilience to environmental changes, including climate change, and stabilizes pollination service in natural and agro-ecosystems [Hooper et al. 2005]. Bees are the largest contributors to pollination and in recent decades have experienced declines and local extirpations [NRC 2007]. The reasons for some declines are well known; others remain unexplained. Declines are not equally distributed across all functional groups. For example, specialist bees (which collect resources from one or a few plant species) should be highly competitive due to close spatial and temporal synchronization with their hosts. Yet there is evidence that specialists are declining more rapidly than generalists (which collect from a wide variety of plants) [Biesmeijer et al. 2006].

Objectives

The applicant's academic and career goal is to contribute to efforts to sustain and promote pollinator diversity, and help ensure that these efforts use the best available science. The objective of the present study is to examine how pollinator communities have changed over time in the southwest U.S., an area of historically high pollinator diversity. Questions include: Which pollinators (specialists vs. generalists) show indications of decline, increase or extinction? Which environmental variables are most closely correlated with pollinator community changes? To answer these questions I am conducting a historical ecology study of bees pollinating native sunflower (*Helianthus annuus*). Historical comparisons can provide valuable information on pollinator status, but until now there has been no such study in the southwest U.S.

I hypothesize that sunflower bee species diversity will be lower now than in the past, with specialists showing indications of decline and generalists stable or increasing. Areas of high human impact (i.e., greater increases in population, development, and/or agricultural use) are expected to show sharper declines in bee abundance and diversity than low-impact areas. I also expect that species previously associated with low-elevation areas will show signs of shifting to higher elevations in response to climate change. Information from this study will inform further research, with the goals of understanding how important pollinator diversity is to pollination, and which measures may be most effective in supporting diverse pollinator populations.

Methods

This study replicates surveys conducted in the 1970s by Smithsonian Institute and UC Berkeley entomologists Paul D. Hurd and E. Gorton Linsley. Hurd & Linsley surveyed 12 sites in the southwest and California[1] to identify sunflower bees. I will resample these sites to find out whether and how sunflower bee community composition may have changed over the past four decades. My study duplicates the sampling times, sampling effort, and methods (net- and hand-trapping) of the previous study and will allow me to compare the species observed to Hurd & Linsley's record. I intend to resample all sites annually for up to three years (2015–2017).

Relevance

Sunflower is uniquely useful for studying pollination because it is a wild plant that is also cultivated as a crop. It thus provides resources for pollinators in an array of settings from natural areas to urban and agricultural sites. Sunflowers rely on insect pollination for reproduction and produce pollen and nectar throughout their long growing season [Hurd et al. 1980]. These factors attract a great diversity of bees, from generalists to species that specialize largely or exclusively

[1] NM: Silver City, Animas, Rodeo; AZ: Benson; CA: Indio, Corcoran, Merced, Madera (3 sites), Escalon, Bishop.

on sunflower. This makes sunflower ideal for testing the hypothesis that specialists are at greater risk of extinction in a context of anthropogenic influence. Hurd & Linsley's study sites have undergone various changes since the 1970s: human population growth, development, and agricultural intensification have occurred at some sites while at other locations human population has remained static or declined. The sites provide a gradient of impacts that can be examined for correlation with changes in the bee community. Information on how such changes may decrease pollinator populations or alter species distributions has been identified as a key knowledge need by pollination biologists and agricultural producers [Dicks et al. 2013; Mayer et al. 2011].

Benefits

This study will provide information to other pollination researchers as well as end-users of research (food and farming industry representatives, conservation practitioners, government and corporate sustainability planners). Results may be presented at Entomological or Ecological Society conferences or gatherings of researchers, policy-makers, and others engaged in pollinator conservation. The applicant's connection to the University of New Mexico will help position UNM as a participant in the global discussion on pollinator conservation strategy. The applicant and UNM would benefit from joining in efforts to bring scientific knowledge to discussions with stakeholders, to increase public awareness about the importance of pollinators and pollination.

Budget

An itemized project budget follows. Applicant received funding from UNM's Graduate and Professional Students Association to cover travel and lodging for year one (2015) and has sampled seven sites and collected over 3,000 bees so far. The five remaining 2015 sample locations are expected to produce an additional 3,000–4,000 bees. Applicant is requesting GRAC funding to purchase pinning and storage materials for these additional specimens.

Literature Cited

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Note: This project / applicant has NOT received previous GRAC research funding.

Itemized Project Budget, year 1 (2015)

Item	Description	debit	credit	balance
GRANT	Source: GPSA New Mexico Research Grant (Spring 2015)		2,963.00	2,963.00
Car mattress	For sleeping in car on travel days	103.88		2,859.12
12v plug-in travel cooler	For preserving insect specimens during travel	120.09		2,739.03
Gloves, gators	Field protective gear	30.22		2,708.81
Trip 1 lodging (3 nights)	Preliminary assessment of all CA sampling sites	198.09		2,510.72
Trip 1 gas		322.70		2,188.02
Trip 2 lodging (6 nights)	Sites: Escalon, Madera West, CA	366.76		1,821.26
Trip 2 gas		331.18		1,490.08
GRANT	Source: GPSA Professional Development Grant (Summer 2015)		500.00	1,990.08
Trip 3 lodging (8 nights)	Sites: Silver City, Animas, Rodeo NM; Benson, AZ; Bishop, CA	615.49		1,374.59
Trip 3 gas		304.97		1,069.62
Trip 4 lodging (12 nights) estimate*	Sites: Indio, Madera West, Madera East, Merced, Corcoran, CA	840.00		229.62
Trip 4 gas estimate **		300.00		-70.38
Insect storage boxes (1 dozen)	For storage and protection of insect specimens	51.95		-122.33
Insect pins (100 per pack x 40 packs)	For pinning specimens	184.00		-306.33
Insect storage drawer kit (6 drawers)	For long-term specimen storage and preservation	158.75		-465.08
	Total cost for insect pinning & storage supplies	**394.70**		

* Average lodging cost = $70/night

** Based on gas cost for prior trips

Funding Sources	**Amount**	**Status**
Travel and lodging		
UNM Graduate and Professional Student Association New Mexico Research Grant, Spring 2015	$ 2963	funded
UNM Graduate and Professional Student Association Professional Development Grant, Summer 2015	$ 500	funded
Insect pinning and storage supplies (highlighted in table above)		
UNM BGSA Graduate Research Allocation Committee	$ 394	applied for here

Additional funding to be pursued during the current funding period: New Mexico Game and Fish “Share with Wildlife” grant, to be submitted by September 25, 2015. Proposal for funding to support New Mexico sites during year two of project (2016).