Assessing the potential for regenerating conifer forests to provide habitat for bees

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Introduction

Animal pollinators represent upwards of 300,000 species worldwide (Kearns et al. 1998) and play indispensable roles by fertilizing nearly 90% of the world's wild flowering plants (Ollerton et al. 2011) and 35% of agricultural crops (Klein et al. 2007). Despite their importance, many pollinators have experienced sharp declines, intensifying concerns regarding a "pollinator crisis" (Allen-Wardell et al. 1998, NRC 2007, Potts et al. 2010) that ultimately threatens global food security and the integrity of natural ecosystems. This has led to heightened interest in undertaking research to assess how land management influences pollinator populations and their associated pollination services. Indeed, concern over pollinators has become a national priority through the commission of an Executive Branch task force to identify priority areas for pollinator research and develop a strategy to promote pollinator health (WHPHTF 2015a,b).

Managed forests are vital to the world's economy because they provide wood fiber that supplies increasing demands of a growing global population (FAO 2016). Forests managed for timber production, especially those in temperate regions, can provide habitat for pollinators due to their thermal properties, floral resources, and nesting substrates (Hanula et al. 2016). Despite this, these habitats are virtually unstudied with respect to evaluating how intensive forest management influences pollinator populations. In turn, resource managers therefore have inadequate information for adjusting forest management in ways that can promote pollinator populations and the services they provide in managed forests. In this study we undertook an investigation of bee diversity in early successional Douglas-fir (*Pseudotsuga menziesii*) stands to evaluate the potential suitability of regenerating conifer forests as habitat for bees.

Methods and Preliminary Results

Sampling took place during summer 2014 on n=14 stands on at the MacDonald-Dunn Forest north of Corvallis, Oregon that ranged from 1–15 years post-harvest. All stands were planted with Douglas-fir except for a single stand that comprised both Douglas-fir and ponderosa pine (*Pinus ponderosa*), and all stands were treated with herbicides to control competing vegetation within 1 year of planting. We sampled bees across the 2014 summer flight season, with three separate sampling periods separated by 3–4 weeks (i.e., 2–4 July, 30 July–1 August, and 20–22 August). We used blue vane traps to capture bees, which work well for capturing bees in regenerating conifer forests (Rivers et al. 2018). Three traps were placed at the center of each stand without preservative or attractant and left out for 48 hours, at which time all insects were removed and killed by freezing. After capture, samples were sorted and bees were pinned and identified using genera-specific taxonomic keys and local expertise (A. Moldenke, Oregon State University).

During the course of field work, we captured >2000 bee specimens representing 65 species/morphospecies, 22 genera and 5 families (Appendix 1). Bee abundance and species richness increased shortly after the time since harvest, peaked at approximately three years post-harvest, and then declined markedly during the early-successional period (Figure 1). Of note, bee measures strongly followed floral resources on study sites (Figure 1), suggesting food played an important role in structuring bee communities. Additional analysis will focus on formal statistical modeling of bee communities and assessing life history traits of bees across the gradient of stand ages in this study.

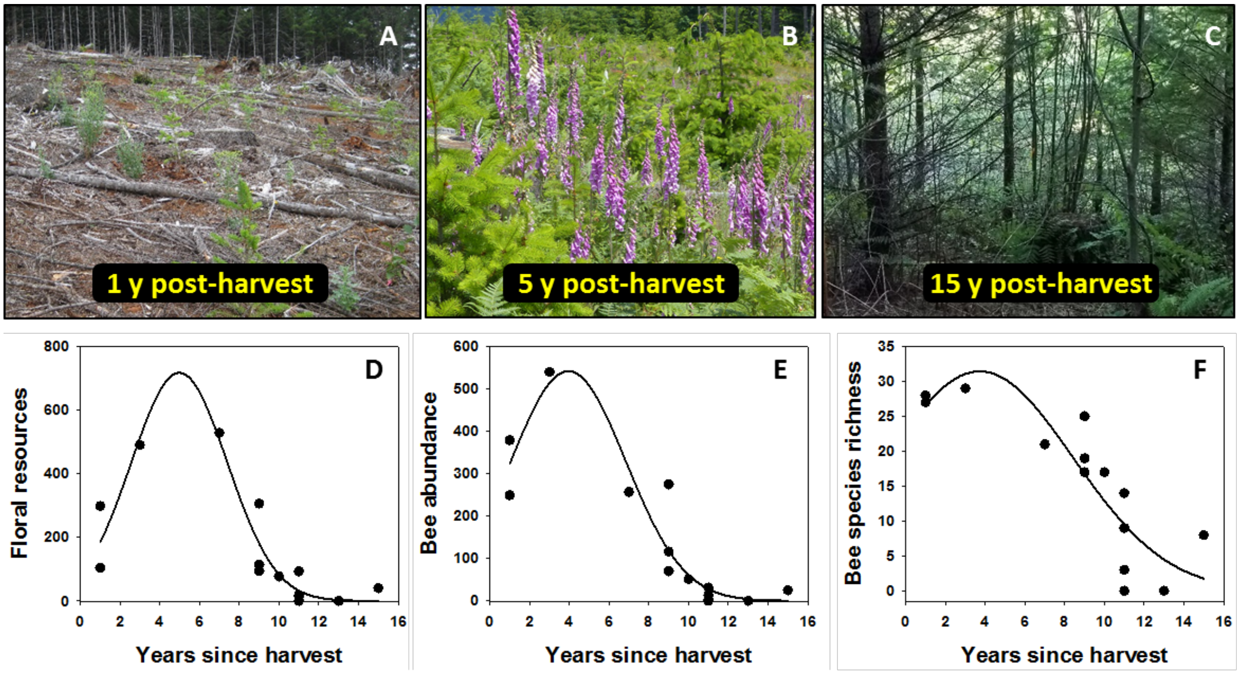

Fig. 1. Managed conifer forests of the Pacific Northwest provide highly dynamic habitat for pollinators. Floral resources available to pollinators are typically (A) low immediately after harvest, (B) undergo a rapid increase in the first several years, and then (C) are mostly devoid of floral resources from canopy closure (~15 y) until harvest at 35-40 y. Data from *n*=14 Douglas-fir stands in the MacDonald-Dunn Forest illustrate (D) the marked change in floral resources during stand development that parallel changes in (E) bee abundance and (F) bee species richness.

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Appendix 1. Taxonomic diversity and abundance of bees captured at the MacDonald-Dunn Forest across three sampling period during the summer 2014 flight season.

Family	**Species**	**Abundance**
Andrenidae	*Andrena prunorum*	2
Apidae	*Anthophora bomboides*	3
Apidae	*Anthophora furcata*	4
Apidae	*Anthophora urbana*	6
Apidae	*Apis mellifera*	473
Apidae	*Bombus appositus*	87
Apidae	*Bombus californicus*	27
Apidae	*Bombus caliginosus*	225
Apidae	*Bombus griseocollis*	48
Apidae	*Bombus mixtus*	29
Apidae	*Bombus nevadensis*	50
Apidae	*Bombus sitkensis*	6
Apidae	*Bombus vosnesenskii*	302
Apidae	*Bombus (Psithyrus) suckleyi*	1
Apidae	*Ceratina acantha*	126
Apidae	*Ceratina micheneri*	1
Apidae	*Ceratina pacifica*	1

Apidae	*Eucera edwardsii*	2
Apidae	*Melissodes lupina*	12
Apidae	*Melissodes metenua*	4
Apidae	*Melissodes microsticta*	12
Apidae	*Melissodes rivalis*	71
Apidae	*Melissodes robustior*	3
Apidae	*Nomada mutans*	2
Colletidae	*Hylaeus bisinuitis*	5
Colletidae	*Hylaeus citrinifrons*	1
Colletidae	*Hylaeus episcopalis*	1
Halictidae	*Agapostemon texanus*	3
Halictidae	*Agapostemon virescens*	27
Halictidae	*Halictus farinosus*	198
Halictidae	*Halictus ligatus*	59
Halictidae	*Halictus rubicundus*	32
Halictidae	*Halictus tripartitus*	80
Halictidae	*Lasioglossum (Dialictus)* sp. 1	1
Halictidae	*Lasioglossum (Dialictus)* sp. 2	2
Halictidae	*Lasioglossum (Dialictus)* sp. 3	1
Halictidae	*Lasioglossum (Dialictus)* sp. 4	4
Halictidae	*Lasioglossum (Dialictus)* sp. 5	2
Halictidae	*Lasioglossum (Dialictus)* sp. 6	1
Halictidae	*Lasioglossum (Dialictus)* sp. 8	1
Halictidae	*Lasioglossum (Dialictus)* sp. 10	3
Halictidae	*Lasioglossum (Dialictus)* sp. 11	1
Halictidae	*Lasioglossum (Dialictus)* sp. 13	3
Halictidae	*Lasioglossum (Dialictus)* sp. 15	2
Halictidae	*Lasioglossum (Dialictus)* sp. 23	1
Halictidae	*Lasioglossum (Evylaeus)* sp. 6	1
Halictidae	*Lasioglossum egregium*	14
Halictidae	*Lasioglossum olympiae*	1
Halictidae	*Lasioglossum pacificum*	15
Halictidae	*Lasioglossum pavonotum*	23
Halictidae	*Lasioglossum sisymbrii*	2
Halictidae	*Lasioglossum titusi*	5
Halictidae	*Sphecodes* sp. 3	1
Megachilidae	*Anthidium manicatum*	1

Megachilidae	*Ashmeadiella californica*	1
Megachilidae	*Heriades carinata*	1
Megachilidae	*Hoplitis producta*	3
Megachilidae	*Megachile montivaga*	4
Megachilidae	*Megachile pascoensis*	2
Megachilidae	*Megachile perihata*	3
Megachilidae	*Megachile relativa*	1
Megachilidae	*Megachile rotundata*	1
Megachilidae	*Osmia atriventris*	1
Megachilidae	*Osmia densa*	3
Megachilidae	*Osmia juxta*	1
	Total abundance	**2009**