Project Update for the Region 1 Native Bee Inventory Program, 2010-2012

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Summary

In 2010, Region 1 Branch of Refuge Biology (BRB) in conjunction with several Refuges initiated a pilot project to evaluate the feasibility of conducting bee inventories on National Wildlife Refuges (Refuges). This project was expanded in 2011-12 to include twelve Refuges and one Bureau of Land Management (BLM) site. Ten Refuges used a standard bee bowl transect protocol while 3 Refuges and the BLM site deployed a long-term monitoring protocol (array) designed to evaluate regional and continental-scale trends in bee populations. The latter protocol was used in shrub-steppe habitats to further evaluate genus-species distribution trends from northern WA to southern OR.

During 2011-2012, the 4 sampling arrays were operated for 1,184 trap-days producing a total of 108 samples and 14,455 bee specimens. Bee bowl transects were deployed on 10 Refuges (one Refuge used both protocols), sampling 46 different sites for a total collection effort of 377 samples. Approximately 21,014 bee specimens were collected from these samples.

Most sample processing was conducted by BRB and several Refuge staff and volunteers. The preliminary identification to genus and/or species of approximately 20,700 bee specimens was conducted by BRB. An Interagency Agreement with USDA in late 2012 allowed remaining samples to be forwarded to USDA for processing and identification. Where needed and if funding allows, the former specimens will also be forwarded to USDA and a private contractor for verification and/or identification to species.

To date, 36 bee genera and 131 species (of 21 genera) have been identified on Refuges through this project. Additional data analyses will include but are not limited to regional distribution trends, relative abundance indices, and genus/species phenology charts. Habitat affiliations will be summarized where possible.

Introduction

Native bees are critical components of both natural ecosystems and man-made landscapes due to their importance as pollinators of flowering plants, including many orchard and vegetable crops. Bees are found virtually worldwide except for Antarctica. While some bees are generalists and able to adapt to a variety of habitats and conditions, including residential areas and croplands, many bees are less adaptable and some are specialists dependent on a narrow range of floral resources and/or specific nesting habitat features.

Increasing focus has been placed on native bees in recent years due to the better documented decline of many honey bee colonies (a non-native bee in the USA), which are important for many agricultural flowering crops. Concurrently, there has been mounting evidence that native

bee populations are in decline, notably some bumble bee species. Declines of native bees (and other pollinators) are generally attributed to a myriad of factors including loss of habitat and fragmentation, loss of key floral components within existing landscapes, invasive plants, pesticide use, climate change, and prevalence of novel pathogens and diseases. No single factor has been definitely implicated for the decline of bees overall, and generally it is accepted that declines are a combination of several factors that work in concert to promote declining populations. Further, some work on the genetic structuring (haplodiploidy and biased sex ratios) suggests that hymenoptera (bees) may be less able to recover from population declines than other wildlife species, and low heterozygosity may make some bees less adaptable to climate change and/or extreme weather conditions.

The bee fauna on Refuges in the Pacific Northwest have not previously been inventoried and even cursory information on bee genera on Refuges is scant to non-existent. Remaining natural lands are vital for the continued population viability of many species of wildlife and plants, especially those that are not adaptable to disturbed habitats. These natural lands, including Refuges, are anticipated to support source populations of native species that could otherwise disappear due to loss of habitat and/or key habitat features required to support a bee's entire life cycle. The first step in understanding the role of wildlife refuges in maintaining bee populations is to inventory the genera and/or species present, their relative abundance, and evaluate their reliance on specific refuge habitats. This conversely will help to identify management actions or activities that affect specific bee genera, species, and the viability of these populations.

In order to address this first need for bee inventories, the Region 1 Branch of Refuge Biology (BRB) solicited several Refuges in 2010 to implement bee bowl transects to understand the feasibility of conducting an inventory program using permanent and seasonal staff, and more importantly utilizing volunteers. This was also aimed at understanding existing methodologies and the effort required to implement an inventory including field work, lab work, identification, and databasing. In 2011 and 2012, the program was expanded to include multiple refuges and evaluate two methodologies.

Methods

Bees were captured using two methods suggested by USGS Patuxent Wildlife Research Center based on their and other's studies on efficacy and effort. The first protocol (Transect Protocol) deployed 30 standard (3.25 oz.) bee bowls along 2 transects (15 bowls in each transect), approximately once every 2 weeks for an 8 to 24 hour duration. The sampling period is a standard suggested by USGS based on minimum flight season periods of some bee species. This method differed from the standard single 24 to 30-bowl transect by placing each transect in or near different habitat types to potentially gather a wider diversity of bees. Three bowl colors (white, yellow, blue) are used in alternating fashion along each transect. The second protocol (Array Protocol) deployed a 9-bowl continuous monitoring array to identify the bee fauna associated within shrub-steppe habitat along a north-south gradient from northern Washington to

southern Oregon. Arrays capture bees continuously through the sampling period and contents are checked and emptied every 1-2 weeks. These bowls are also painted in 3 colors. Based on current knowledge of bee activity in the Pacific Northwest, sampling is conducted from early April through October, when feasible, though some bee activity may occur almost year-round, especially west of the Cascades.

A more detailed description of the methods can be found in the Branch of Refuge Biology's reports: 1) 2011-2012 Bee Monitoring Program, U.S. Fish and Wildlife Service, Region 1; 2) Project Update for the Region 1 Native Bee Inventory Program, June 2013.

Once collected, samples are placed in alcohol then sent to the BRB for processing and preliminary identification to genus and species; although some of the array samples were forwarded by BRB directly to contract entomologists. Processing includes washing, drying, pinning, positioning, and labeling each specimen. Due to the time-consuming nature of processing bees, several refuge staff and volunteers assisted with processing portions of their samples including Malheur NWR, Turnbull NWR, Conboy Lake NWR, and Little Pend Oreille NWR. The BRB has been assisted with identifications by Dr. Robbin Thorp (University of California-Davis) through a contract established in 2011. In 2012, an Interagency Agreement with USDA ARS Bee Biology and Systematics Laboratory (BBSL) was established to provide additional assistance with processing and identifications. Funding for this project has been provided through the Region 1 Inventory and Monitoring Program and the Office of the Science Advisor (Arlington).

All data collected are entered into an Access database developed by Erin Stockenberg, Data Manager with the Region 1 I&M Program. Sample data collected includes but is not limited to: location, date/time, weather information; floral resources and other habitat information has/is being collected at some sites. The BRB manages data for the project with periodic updates of identifications to participating Refuges.

Results

During the 2010 season, four Refuges (Malheur, Kootenai, Willapa, and Julia Butler Hansen) opted to implement the pilot project using the Transect Protocol. Nineteen samples were collected, thirteen of those by Kootenai NWR. Deploying bee bowls on a regular basis proved problematic for Refuges west of the Cascades, notably Willapa, due to regular high winds and rainfall. Modifying the bee bowl arrangement or having considerable flexibility in changing deployment days will be necessary to accomplish consistent effort in these areas.

Sampling was expanded in 2011-2012 to include 8 additional Refuges, as well as one BLM site at the Oregon Trail Interpretive Center (OTIC) in NE Oregon; this latter site was cooperatively operated by BLM and the Region 1 Land Management and Research Demonstration Program staff. Three Refuges (Malheur NWR, McNary NWR, Turnbull NWR) and the OTIC site implemented the Array Protocol. Ten Refuges implemented the Transect Protocol.

Arrays

Sampling arrays were open at the 4 sites for a total of 538 trap-days in 2011 (range: 106-169) and 646 trap-days in 2012 (range: 205-358). This sampling effort produced a total of 48 and 60 samples collected in 2011 and 2012 respectively, and sent to BRB for processing and identification (see Table 1). Of the 108 total samples, all have been processed and approximately 101 samples have had some preliminary genus/species identifications completed. As reflected in Table 1, approximately 1800 bees have not yet been identified to genus and/or species; these bees have been sent to BBSL.

The 4 sites selected for the Array Protocol were all located in shrub-steppe habitats however neither the similarity between sites, the quality of the habitat, or the arrays juxtaposition to other habitat types has yet been evaluated. The number of identified genera between the sites is somewhat consistent despite the marked difference in trap-days, however until all samples can at least be identified to genus, few firm comparisons can be made. The number of bees collected varied considerably between sites. All numbers presented should be considered preliminary until all samples are characterized to genus composition and sampling variations are assessed. Some cursory assessments are discussed below under **Bee Identification**. Appendix I contain current genera and species identifications sorted by Refuge. This data is further delineated with respect to species' verifications and current disposition of samples (housed internally or with BBSL) and can be found on the BRB Fishnet site at:
https://fishnet.fws.doi.net/regions/1/nwrs/NCR/BRB/Pollinator%20Monitoring/Forms/AllItems.aspx

Table 1. Sample Data for Refuges Conducting Bee Arrays, 2011-2012

	Turnbull NWR	**McNary NWR**	**OTIC, BLM**	**Malheur NWR**
# Trap-days (2011-2012)	358	327	205	294
# Genera identified	23	21	28	22
# Species identified	42	25	62	18
# Bees with preliminary identification pending	1015	428	370	0
# Total Bees collected	4520	4994	2858	2083

Transects

Transect sampling was conducted on 10 Refuges from 2010-2012. The Transect Protocol outlined the selection of 2 sites (transects) per Refuge to be surveyed every 2 weeks from approximately April through October; the same sites were to be sampled in year 2. There was considerable variation between Refuges and years regarding implementation. Many Refuges

relied on volunteers or interns to conduct the sampling and thus were unable to meet the target seasonal timeframe as survey personnel were unavailable throughout the season. In other instances, Refuges opted to run multiple (>2) transects per season and/or different transects over the two years or within a season. To date, evaluating the potential for intra-Refuge comparisons has not been conducted due to the sampling variation between Refuges. All numbers presented should be considered preliminary until all samples are characterized to genus composition and sampling variations are assessed.

From 2010-2012, the 10 Refuges ran 46 different transects resulting in a collection of 377 samples. To date, 366 of these samples have been processed and had preliminary identifications completed. Table 2 and 3 summarize the sampling effort for each Refuge. Bees not yet identified to genus (~2500) have been sent to BBSL and are reflected in Table 3. Appendix I contain current genera and species identifications sorted by Refuge.

Table 2. Sample Data for Refuges Conducting Bee Transects, 2010-2012

Refuge	**# Transect Locations**	**# Samples Collected**			
		2010	**2011**	**2012**	**Total**
Kootenai NWR	8	13	26	14	53
Deer Flat NWR	2		14	26	40
Little Pend Oreille NWR	7		5	18	23
Conboy Lake NWR	6		52	32	84
Pierce NWR	2		29	24	53
Steigerwald Lake NWR	2		28	26	54
Ridgefield NWR	3		6	16	22
JB Hansen NWR	2	2	12		14
Willapa NWR	5	2	7		9
Malheur NWR	9	2		23	25
Totals	46	19	179	179	377

Table 3. Preliminary Identifications for Refuges Conducting Bee Transects, 2010-2012

Refuge	# Genera Identified	# Species Identified	# Bees with preliminary identification pending	# Bees Collected
Kootenai NWR	23	36	379	2569
Deer Flat NWR	19	23	372	3755
Little Pend Oreille NWR	25	30	0	1709
Conboy Lake NWR	28	48	759	5090
Pierce NWR	16	21	0	1237
Steigerwald Lake NWR	18	20	0	1074
Ridgefield NWR	15	19	0	791
JB Hansen NWR	12	11	0	172
Willapa NWR	4	6	0	34
Malheur NWR	30	78	999	4583
Totals			2509	21014

Bee Identification

Appendix I summarizes the current status of genus and species identification efforts. Bee taxonomy is quite varied and complex and identifications almost always require collection of specimens, keying out under a microscope and, in some cases, genitalia or mouthpart examinations. The identification process is further hampered by the lack of current taxonomic keys; and in some cases, even available keys defy their use by experienced entomologists.

Within the Appendix I table (Fishnet version), multiple columns exist reflecting the status of specimen identification for the Region 1 project. Columns with headers: <refuge name>_JDE indicate identifications made by BRB (J. Engler) but include specimens verified by Dr. Robbin Thorp (purple font). Columns with <refuge name>_LBL indicate identifications and/or specimens residing with the USDA ARS lab. It should be noted that the Turnbull, McNary, OR Trail, and Malheur Tower datasets pertain to bees collected using the Array Protocol; all other data refers to bees collected using the Transect Protocol.

The Pacific Northwest (loosely defined here as WA, OR, and ID) supports between 800-900 species of bees in about 54 genera (American Museum of Natural History database 2010). Some of these genera are quite common and widely distributed while others are rare, at the periphery of their range (defined here as occurring in only 1 of the 3 states), require specialized habitats or floral resources, or are represented by only a single species. To date, this study has identified 36 genera on Region 1 Refuges. Appendix II provides a concise list of genera collected per Refuge; for Malheur NWR, this table combines both transect and array data. Of the 15 undetected genera,

6 are represented by only a single species, 3 are considered on the periphery of their range, and 6 are both peripheral and represented by only a single species. At this writing, it has not been determined which of these undetected genera might be expected within the range of the Refuges inventoried during this project.

Table 4 was constructed to indicate the expected bee genera to be found in the Pacific Northwest, the approximate number of PNW species within the genus, and notes regarding their general nesting substrate, or if the genera is a cleptoparasite. Most cleptoparasites have specific bee genera that they parasitize and thus their presence is correlated with that of the host genera. Within the bumble bee genus *Bombus*, 2 species detected on Refuges are cleptoparasites of other *Bombus* species. This table information is a first step for placing Refuge-specific data into a habitat context. Usually, most species within a genus have broad similarities in habitat requirements, but the considerable speciation in some genera indicate specialized niches and/or divergence for geologic or other reasons.

Table 4. Number of species per PNW genera and natural history

Genus	**~ # of species**	**Common Name**	**Nesting Substrate**
Andrena	146	Mining Bee	Ground
Calliopsis	12	none	Ground
Panurginus	3	none	Ground
Perdita	37	Miner Bee	Ground
Pseudopanurgus	6	Mining Bee	Ground
Anthophora	16	Digger Bee	Ground
Anthophorula	2	none	unknown
Apis	1	Honey Bee	Cavity - Hive
Bombus	27	Bumble Bee	Ground, Wood Holes
Ceratina	7	Small carpenter Bee	Cavity - Twigs
Diadasia	9	Sunflower Bee	Ground
Epeolus	6	none	Cleptoparasite
Eucera	19	Long-horned Bee	Ground
Habropoda	6	Digger Bee	Ground
Holcopasites	1	none	Cleptoparasite
Melecta	3	none	Cleptoparasite
Melissodes	32	Long-horned Bee	Ground
Neolarra	4	none	Cleptoparasite
Neopasites	1	none	Cleptoparasite of Dufourea
Nomada	69	Cuckoo Bee	Cleptoparasite
Oreopasites	2	none	Cleptoparasite
Peponapis	1	Squash Bee	Ground
Svastra	1	Sunflower Bee	Ground

Triepeolus	22	none	Cleptoparasite
Xeromelecta	1	none	Cleptoparasite
Xylocopa	2	Large Carpenter Bee	Wood, Twigs
Zacosmia	1	none	Cleptoparasite
Colletes	19	Polyester Bee	Ground
Hylaeus	20	Yellow-faced Bee	Cavity - Wood, Twigs
Agapostemon	7	Green Sweat Bee	Ground
Dieunomia	1	Large Sweat Bee	Ground
Dufourea	14	none	Cleptoparasite
Halictus	6	Sweat Bee	Ground
Lasioglossum Subgenus: Lasioglossum	14	Sweat Bee	Ground
Lasioglossum Subgenus: Evylaeus	10	Sweat Bee	Ground
Lasioglossum Subgenus: Dialictus	45	Sweat Bee	Ground
Nomia	1	Alkali Bee	Ground
Sphecodes	12	Cuckoo Bee	Cleptoparasite
Anthidiellum	1	None	Resin cells on vegetation
Anthidium	17	Carder Bee	Cavity - Wood, Twigs, Ground
Ashmeadiella	15	none	Cavity - Wood, Twigs
Atoposmia	5	none	Cavity - Wood, Twigs, Ground
Chelostoma	3	Mason Bee	Wood, Twigs, Ground
Coelioxys	20	Cuckoo Bee	Cleptoparasite
Dianthidium	9	none	
Dioxys	4	None	Cleptoparasite
Heriades	4	None	Cavity - Wood, Twigs
Hoplitis	16	Mason Bee	Wood, Twigs, Ground
Lithurgus	1	none	unknown
Megachile	40	Leaf-cutter Bee	Holes
Osmia	83	Mason Bee	Wood, Twigs, Ground
Protosmia	1	none	unknown
Stelis	21	Cuckoo Bee	Cleptoparasite
Trachusa	1	none	unknown
Hesperapis	1	none	Ground
Macropis	1	none	Ground

The ability to identify all specimens to species level is limited by the lack of up-to-date keys, thus requiring contracting of an entomologist(s) trained in bee identification, which is further limited by funding. Other identifications are precluded as some genera require genus-specialists to effectively identify the species. Therefore, it is expected that some genera or subgenera in this study will not be identified beyond the genus/subgenus level. This may include the genera:

Nomada, *Hylaeus*, *Sphecodes*, *Stelis*, and the *Lasioglossum* subgenera *Evylaeus* and *Dialictus*. Species identification for the genera *Andrena* and *Osmia* will likely be only partially completed due to the high number of specimens relative to the cost of identification. However, it is anticipated that some of these genera/subgenera will be grouped into morpho-species (similar looking species) to gain some reference of diversity and the importance of an individual Refuge to this taxonomic grouping. A goal for this project is to identify as many species as possible so as to accumulate a working synoptic collection of regional bee species that can be utilized in future studies, recognizing that current and future funding for full identification is limited.

Discussion

Interesting trends or captures are starting to appear within the genera/species dataset (Appendix I) relating to bee diversity and distributional differences within taxonomic levels. While some of these differences may be expected, others are not as clear. Some trends appear directly related to general habitat requirements, while others may be specific to transect/array siting. Other considerations that affect capture rates include the flight range of the genera/species (usually unknown) and the proximity of trapping sites to nesting sites. The fact that not all species are equally attracted to bee bowls, data collection variables differed and environmental and habitat differences can influence daily capture rates, all genera/species numbers are considered comparable only on a relative scale, where sufficient specimens of a given genera/species exist. Once all possible identifications have been completed, these variables will be assessed to determine the applicable of comparisons and further analyses.

While most of the genera/species identified by BRB are considered final, some specimens identified still need verification through entomologists, as their presence in the PNW and/or on a specific Refuge would be unexpected, or their identification characteristics are subtle and require expert scrutiny. Parsing of the BRB data into final and preliminary identifications has not yet been completed. Species identified by BBSL and Dr. Robbin Thorp are considered final. Since approximately 12% of specimens still need to be identified to genus and sampling variability between Refuges has not been assessed, only a few preliminary observations will be presented in this report.

Five Refuges support habitats that are relatively non-diverse and/or are dominated by exotic plant species; due to low sampling effort, Willapa data was omitted from these initial assessments. These 5 Refuges have an average of 16 bee genera identified in this study (virtually all of the preliminary genus identifications are complete at this time). Contrastingly, 7 Refuges (including OTIC) have an average of 25 genera identified with many specimens still remaining to be identified. While habitat condition is expected to be a driving factor in this difference, normal distribution patterns may play into this disparity.

Four Refuges deployed trapping transects across multiple diverse habitat types and produced an average of 27 identified genera. In contrast, the remaining Refuges that sampled only 1 or 2 sites

produced an average of 20 identified genera. Not un-expectantly, this would suggest that operating multiple sample sites across different habitats will produce a greater taxonomic diversity of bees. Malheur, which utilized both protocols including 2 years of arrays but only 1 year with intensive habitat diversity sampling, captured 7 more genera with the transect sampling. This preliminary data suggests that Refuge objectives for bee monitoring need to be strongly considered before opting for a specific survey protocol.

Future Expectations

Continuing effort is being spent on the database including: rectifying discrepancies in the database, such as missing samples and potential duplications; additions of missing weather data; proofing the dataset with regards to ensuring that all pinned, vialed, and disposed specimens (the latter 2 captured in notes) are accounted for within the species table; the addition of a vegetation component to the database; refining the habitat data for each trap site; proofing the trap-day data; developing an interface with the USDA BBSL database to import identification records.

Once all of the remaining bees (~4300) have been identified to genus, the data will be evaluated for potential analyses. Analyses will need to be tailored to the specific dataset components since not all sampling across Refuges was consistent. This may include comparing data across select Refuges, between years, across similar habitats and/or for select species and genera. Once all genus/species identifications are complete, a phenology table will be developed for individual genera or species where sufficient data has been collected. Ultimately, the goal is to step this data down to Refuge-specific recommendations with regards to restoration and management opportunities that benefit pollinators.

APPENDIX I: Genus and Species Identifications, Number Captured by Refuge, September 2014

Species	Species	Deer Flat Total	Kootenai NWR Total	Little Pend Oreille NWR	Turnbull_Total	McNary_Total	OR Trail Total	Malheur-other_Total	Malheur Tower (array)	Conboy NWR_Total	Pierce NWR	Steigerwald Lake NWR	Ridgefield NWR	Julia Butler Hansen NWR	Willapa NWR
Andrena	perarmata														
Andrena	schuhi														
Andrena	chalybioides														
Andrena	nothocalaidis						6	1							
Andrena	astragali						20								
Andrena	auricoma														
Andrena	caerulea														
Andrena	nigrocaerulea														
Andrena	cressonii														
Andrena	pertristis														
Andrena	transnigra						4								
Andrena	microchlora														
Andrena	piperi						1	1							
Andrena	prunorum					3	2	2							
Andrena	scurra														
Andrena	sladeni														
Andrena	walleyi														
Andrena	angustitarsata														
Andrena	candida														
Andrena	cupreotincta														
Andrena	cyanophyla														
Andrena	salicifloris														
Andrena	perplexa														

Andrena	subtilis														
Andrena	merriana														
Andrena	spp.	1	21	67	107		5	51	3	466	43	8	9	2	
Calliopsis	puellae	1						1							
Calliopsis	spp.			109				2	4	3		1			
Panurginus	spp.			8	44			30				9			
Perdita	spp.				5	4	4			1					
Anthophora	curta					17									
Anthophora	exigua							6							
Anthophora	pacifica						2								
Anthophora	porterae					1	12	1							
Anthophora	ursina				1		2	13							
Anthophora	ursina														
Anthophora	bomboides					1		2							
Anthophora	urbana					7	5	77							
Anthophora	edwardsii							10							
Anthophora	spp.			7		2		37	5	1					
Apis	mellifera	111	29	2	8	99	8			13	12	23	6	7	3
Bombus	nevadensis		2	1	17	1									
Bombus	occidentalis		2												
Bombus	griseocollis		2		18	4				1					
Bombus	rufocinctus		26	5	46	1	3	1	2	77	2				
Bombus	fernaldae														
Bombus	insularis		3	1			2	1	1	2	1				
Bombus	bifarius		5	53	3		1	3		51		1			
Bombus	calignosus													2	16
Bombus	centralis		3	1	1		6	1		8					
Bombus	flavifrons		2	4	1					2				2	
Bombus	huntii	1	2		33	1	4	31	13						
Bombus	melanopygus				1					2	1				
Bombus	mixtus		2	1			1			23	8	4	5	4	7
Bombus	sitkensis										1		1		
Bombus	vagans		13		4										

Bombus	vandykei									5					
Bombus	vosnesenskii									14	8	5			1
Bombus	vosnesenskii/ calignosus													1	
Bombus	appositus		7		18					1	1	1		1	
Bombus	californicus		1		3		1			7	31	19	6	30	2
Bombus	fervidus				13	34	29	6	5						
Bombus	spp.		2	6	209					9	2				
Ceratina	acantha	9	38	16	1			10		48	349	447	29	3	
Ceratina	micheneri								1	1		4			
Ceratina	nanula		5	5	40		3	19	10	19			1		
Ceratina	neomexicana							45	20						
Ceratina	pacifica				7		19	6							
Ceratina	sp.			1	30			7	4	1	56	27			
Diadasia	diminuta							2							
Diadasia	lutzi							2							
Diadasia	spp.	5	1			2	24	8	24						
Epeolus	spp.	3	1			1	2	1			1			1	
Eucera	actuosa						3	1	1						
Eucera	edwardsii				1	4	1					1	1		
Eucera	frater				3										
Eucera	fulvitarsus														
Eucera	hurdi			1											
Eucera	spp.	2	1	7	18		1	21	3	27		1	1		
Habropoda	spp.			1			1	3		1					
Melecta	pacifica				1		1	14	1						
Melecta	separata				1			2	1	1					
Melecta	spp.		1							1					
Melissodes	microsticta														
Melissodes	dagosa							4							
Melissodes	rustica														
Melissodes	agilis														
Melissodes	lupina														

Melissodes	paulula														
Melissodes	spp.		18	5	3	9	2	2	8	33	6	10	1		
Nomada	spp.		4	10	16	1	8	11	4	28	12	14	17		1
Triepeolus	spp.					2	1			1					
Colletes	consors						1	3							
Colletes	spp.		1	1	4	1	1	4		2				10	
Hylaeus	spp.	3	35	13	6			5		14	37	50	3		
Agapostemon	femoratus	104				147	107	269	105						
Agapostemon	melliventris	1													
Agapostemon	texanus			169	5	20	6			96		2	4		
Agapostemon	virescens	32	48	75	51	2	2	3	3	69	43	63	96	1	
Agapostemon	angelicus / texanus	240	51		97	325	350	562	1237						
Agapostemon	spp.							68							
Dufourea	spp.			1			2	2	2	1					
Halictus	farinosus		12	105	47	152	13	24	2	742		1			
Halictus	ligatus	60	1	14	22	30	169	41	61		12	28	26		
Halictus	rubicundus	7	54	16	12	18	41	9		26	31	15	5	1	
Halictus	confusus		58	32				4	4	17	58	56	39	7	
Halictus	tripartitus	365	19	107	575	690	347	572	130	210	8	4	3		
Halictus	virgatellus		10	3			1								
Halictus	Sub: Seladonia				7			62	62	1					
Lasioglossum	Sub: Dialictus.	1403	343	476	360		446	316	72	758	192	107	205	34	1
Lasioglossum	Sub: Evylaeus	32	96	90	169	6	7	17	30	109	51	30	10		1
Lasioglossum	Dialictus/ Evylaeus				563	560	10	88			4				
Lasioglossum	anhypops			22						5					
Lasioglossum	athabascense			1											
Lasioglossum	colatum		14	1				1							
Lasioglossum	egregium		24	2				2		11			2		
Lasioglossum	mellipes									29	1		1		
Lasioglossum	olympiae			5						389	16	8	1		
Lasioglossum	paraforbesii		7												

Lasioglossum	pacificum				1					1	26	3	2		
Lasioglossum	sisymbrii	2		1	5	25	54			4	1	1			
Lasioglossum	titusi		1		311			43		15		5	89	1	
Lasioglossum	trizonatum				1					2					
Lasioglossum	zonulum		826	1						84	134	77	187	41	2
Lasioglossum	all subgenera	950	297	8	503	2300	590	87	3	453		3	1		
Sphecodes	spp.	2	9	11	12	33	6	14	14	18	17	13	3	8	
Anthidiellum	spp.						2			2					
Anthidium	clypeodentatum						2								
Anthidium	collectum			1											
Anthidium	emarginatum							1							
Anthidium	illustre									1					
Anthidium	placitum						3	3							
Anthidium	formosum						10								
Anthidium	mormonum							1							
Anthidium	utahense	1	1	4	2					2					
Anthidium	spp.							3							
Ashmeadiella	spp.							7	1						
Atoposmia	spp.							1							
Coelioxys	spp.	1	1			4	1					1			
Dianthidium	curvatum	4													
Dianthidium	pudicum					4									
Dianthidium	pudicum	5				34	2	9	2						
Dianthidium	subparvum		1	2	1			1	2						
Dianthidium	ulkei		1	1	1					1					
Dianthidium	spp.	1						2							
Dioxys	pacifica							3							
Dioxys	pomonae						8	3							
Dioxys	spp.							6							
Heriades	spp.			1				1	1						
Hoplitis	grinnelli						1	3							
Hoplitis	producta							1							
Hoplitis	hypocrita							7							

Hoplitis	albifrons						1	18							
Hoplitis	fulgida						1	1							
Hoplitis	louisae							1							
Hoplitis	spp.	2	11	15	1		2	18	1	18	6		2	2	
Megachile	spp.	11	20	4	7	12	5	11	3	31	3	2	1	2	
Megachile	apicalis					1									
Megachile	gemula		1												
Megachile	lippiae						5	1							
Megachile	montivaga		1		1		1			10					
Megachile	onobrychidis	10			2	2	2	1							
Megachile	pascoensis							1							
Megachile	perihirta		1							3					
Megachile	rotundata	3	1												
Megachile	umatillensis					1									
Osmia	atrocyanea				2			8		6					
Osmia	austromaritima														
Osmia	bakeri						5								
Osmia	brevis	1					1	1							
Osmia	bruneri						11	66							
Osmia	bucephala														
Osmia	californica				3		7	9							
Osmia	calla	1			1		5	35		1					
Osmia	claremontensis						3	1							
Osmia	coloradensis														
Osmia	cyanella						1	1		1					
Osmia	densa									3					
Osmia	ednae	1					1	15							
Osmia	exigua						1								
Osmia	grinnelli							1							
Osmia	integra					2		8							
Osmia	juxta									1					
Osmia	kincaidii						7	8							
Osmia	lignaria							1							

Osmia	longula							3							
Osmia	marginipennis						1								
Osmia	melanopleura						7	14							
Osmia	montana						1	1		2					
Osmia	nemoris	3					3	57		4					
Osmia	nigrifrons							7							
Osmia	parkeri							7							
Osmia	physariae							1							
Osmia	raritatis				1		1	2							
Osmia	regulina	1						9		1					
Osmia	sculleni									1					
Osmia	subaustralis														
Osmia	texana							1		1					
Osmia	thysanisca														
Osmia	trevoris	1			1		32	55		2					
Osmia	universitatis						1								
Osmia	vandykei						5								
Osmia	spp.	3	53	204	77	2	12	530	233	334	62	28	34	12	
Protosmia	rubifloris									2	1	2			
Stelis	spp.		1	12	1	1		8	5	1					
Un-ID Bee		372	379		1015	428	370	999		759					
Total Bees		3755	2569	1709	4520	4994	2858	4583	2083	5090	1237	1074	791	172	34

APPENDIX II: Summary of Genera Captured by Refuge, September 2014

	Family	Genus	Deer Flat	Kootenai	LPO	Turnbull	McNary	OR Trail-BLM	Malheur	Conboy	Pierce	Steigerwald	Ridgefield	JBH	Willapa
1	Andrenidae	Andrena	1	1	1	1	1	1	1	1	1	1	1		
2	Andrenidae	Calliopsis	1		1				1	1		1			
3	Andrenidae	Panurginus			1	1			1			1			
4	Andrenidae	Perdita				1	1	1		1					
5	Apidae	Anthophora			1	1	1	1	1	1					
6	Apidae	Apis	1	1	1	1	1	1		1	1	1	1	1	1
7	Apidae	Bombus	1	1	1	1	1	1	1	1	1	1	1	1	1
8	Apidae	Ceratina	1	1	1	1		1	1	1	1	1	1	1	
9	Apidae	Diadasia	1	1			1	1	1						
10	Apidae	Epeolus	1	1			1	1	1		1			1	
11	Apidae	Eucera	1	1	1	1	1	1	1	1		1	1		
12	Apidae	Habropoda			1			1	1	1					
13	Apidae	Melecta		1		1		1	1	1					
14	Apidae	Melissodes		1	1	1	1	1	1	1	1	1	1		
15	Apidae	Nomada		1	1	1	1	1	1	1	1	1	1		1
16	Apidae	Triepeolus					1	1		1					
17	Colletidae	Colletes		1	1	1	1	1	1	1				1	
18	Colletidae	Hylaeus	1	1	1	1			1	1	1	1	1		
19	Halictidae	Agapostemon	1	1	1	1	1	1	1	1	1	1	1	1	
20	Halictidae	Dufourea			1			1	1	1					
21	Halictidae	Halictus	1	1	1	1	1	1	1	1	1	1	1	1	
22	Halictidae	Lasioglossum	1	1	1	1	1	1	1	1	1	1	1	1	1
23	Halictidae	Sphecodes	1	1	1	1	1	1	1	1	1	1	1	1	
24	Megachilidae	Anthidiellum						1		1					
25	Megachilidae	Anthidium	1	1	1	1		1	1	1					
26	Megachilidae	Ashmeadiella							1						
27	Megachilidae	Atoposmia							1						
28	Megachilidae	Coelioxys	1	1			1	1				1			
29	Megachilidae	Dianthidium	1	1	1	1	1	1	1	1					
30	Megachilidae	Dioxys						1	1						

31	Megachilidae	Heriades			1				1						
32	Megachilidae	Hoplitis	1	1	1	1		1	1	1	1		1	1	
33	Megachilidae	Megachile	1	1	1	1	1	1	1	1	1	1	1	1	
34	Megachilidae	Osmia	1	1	1	1	1	1	1	1	1	1	1	1	
35	Megachilidae	Protosmia								1	1	1			
36	Megachilidae	Stelis		1	1	1	1		1	1					
		Total	19	23	25	23	21	28	30	28	16	18	15	12	4