Assessment of the Native Bee Diversity of Camel's Hump Management Unit

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INTRODUCTION

The 25,000 acres of state lands that comprise the Camel's Hump Management Unit (CHMU) provide many environmental, recreational and aesthetic values to Vermonters. As part of the development of a Long Range Management Plan (LRMP) for these lands, staff from the Department of Forests, Parks and Recreation and their partners have prepared assessments of the resources found here. Similar to previous state lands LRMPs, these include assessments of environmentally and economically important natural resources, including natural communities, wildlife and timber. But due to a lack of funding or staff, LRMPs usually do not include assessments of some ecologically significant groups such as invertebrate animals and fungi. This document describes an inventory of one such group, native species of bees. The purpose of this assessment is to provide a preliminary picture of the diversity of this group at the CHMU, as well as some management recommendations for maintaining habitat for these animals.

Roughly 90% of the plants native to the northeast are dependent on animals for pollination, the transfer of pollen between flowers necessary for plant reproduction. This figure includes most of our forest and wetland herbs, forest trees such as sugar maple and black cherry, and key wildlife foods including raspberries, apple and blueberry. It also includes most of the rare, threatened and endangered plants found at CHMU, including alpine tundra species such as Boot's rattlesnake root (*Prenanthes bootti*) and northern bilberry (*Vaccinium uliginosum*). The vast majority of the animal-mediated pollination in this region is performed by bees, animals for which plant pollen is the only protein source. Most plant species compete for pollination services of multiple species of bees and other insects, but some benefit from visits by specialist pollen foragers ('oligoleges'), bees that provision their offspring with single source pollens. As pollinators, bees are keystone animals in the natural communities found at CHMU. Wild bees also perform the majority of the pollination of agricultural crops, meaning that pollination, like water filtration, is an 'ecosystem service' that people in the area around CHMU receive from these conserved lands.

Vermont has an estimated 275 native as well as 5-10 introduced species of bees, (of which the managed European honey bee is the most familiar). This figure is derived from historical collections, however, and overall the state's bees are poorly known.

Additionally, we know the status of only a few of these insects in Vermont, and in most cases would not be able to detect changes in their abundance and distribution. This is worrying because for the few bee groups we do know well (e.g., bumble bees), there is evidence of widespread species declines (Cameron et al. 2011, Colla et al. 2012, Bartomeus et al. 2013), including in Vermont (Richardson and McFarland *unpublished*). These declines are probably due to a combination of threats that include climate change, pesticides, introduction of new pathogens and changes in habitat. Given their functional significance to natural and human systems and the threats they face, the inventory of native bees, particularly on conserved lands, should be a priority. While the current effort is cursory, it should serve as a baseline of information on the bees of the Camel's Hump area.

METHODS

Bees were collected and identified from sites around Camel's Hump Management Unit in summer, 2013. Collection methods differed slightly from the initially proposed sampling scheme for practical reasons, and the inventory consequently included more sites, but fewer visits to each site. Bee specimens were collected on four dates from June to August 2013. A total of 15 sites were chosen to represent a broad cross-section of the habitats and elevations present at CHMU (Figure 1; Table 1). These habitats included rivershore grassland, weedy roadsides, an active sand and gravel pit, managed old fields, northern hardwood forests, outcrops, montane forests dominated by spruce and fir, and alpine tundra. Collections took place on sunny days when flowers attractive to bees were in bloom, and a day spent on the summit was timed to coincide with peak flowering of tundra plants.

Two collection methods were used, netting and pan trapping. During netting, a standard insect net was swept over flowers and bees caught were killed with hydrogen cyanide and later mounted on insect pins. Individual bees were netted regardless of their identity, except for bumble bees, which at some sites were not collected after each species had already been collected once. Pan trapping methods follow those of Droege (2012). Traps were 3.5oz white plastic Solo brand food cups, some of which were painted with blue or yellow fluorescent spray paint (Krylon brand), which is attractive to bees

and other insects. At each site, equal numbers of blue, yellow and white traps were placed on the ground >3 meters apart, filled with soapy water, and left for 4-12 hours, during which time insects landed on the water and become trapped. Pan traps were picked up at the end of each sampling day and collections were rinsed and stored in 70% ethanol. Insects were later strained, dried with a hair dryer and pinned. All specimens were databased and labeled. Most bees were identified to species, but for two difficult groups—the genera *Andrena* and *Lasioglossum*—specimens were typed only to morpho-species, and will be definitively identified at a later date. A variety of spiders, flies, wasps and other invertebrates collected in pan traps were retained, particularly when they came from specialized habitats (e.g., alpine areas).

For purposes of comparison, pan trap data were standardized to bees*trap^{-1}*day^{-1}, assuming a 12 hour diurnal period of bee activity.

RESULTS

A total of 221 insects were collected, 169 of them bees. An estimated 57 species of bees from five families were collected (Table 2). Bees of the family Apidae, which includes the bumble bees, were most numerous. As in previous studies, netting and pan trapping produced complimentary assemblages of specimens, with larger species being less common in traps (likely because they can climb out of them) and smaller species sometimes eluding capture by net.

Pans were used on four days at 9 sites. A total of 253 pans were deployed for 1,747 pan-hours. Capture rate averaged 0.66 ($\pm$0.51) bees*trap^{-1}*day^{-1} (range 0-1.44). Bees were captured in all three trap colors, and no obvious patterns of attraction among them were evident.

Insects of other types were collected as by-catch at several sites and will be retained for identification. Noteworthy collections include wasps, spiders, sawflies and spiders from the alpine tundra of the summit of Camel's Hump.

DISCUSSION

This inventory presents a preliminary view of the bee diversity and distribution of Camel's Hump Management Unit. Despite a relatively small collecting effort on a limited

number of days, the effort identified >20% of the state's known bee diversity within the confines of the management unit. While pan trapping may appear to have been an inefficient method for bee capture, the catch rate for traps in this inventory was within the range of other studies in the eastern U.S. (Droege et al. 2010b). Bees were generally abundant during netting, except on the Camel's Hump summit, where abundance was extremely low, despite fine weather and peak flowering of very attractive plants such as blueberry and bilberry (*Vaccinium* spp.).

Three rare or uncommon bee species were collected. *Bombus terricola* (pictured at Appalachian Gap in lower right inset photo, p. 1) is a bumble bee that was once one of the most commonly collected species in the northeast, but has disappeared from much of its former range (Colla et al. 2012). This species accounts for <2% of the 10,000 collections made during a two year citizen science inventory of Vermont's bumble bees by the Vermont Center for Ecostudies (Richardson and McFarland, *unpublished data*) and was recently recommended for listing as Endangered by the state's Endangered Species Committee. *B. terricola* is also being recommended for federal protection under Canada's endangered species program, the Committee on the Status of Endangered Wildlife in Canada (Colla and Richardson 2013). *B. terricola* was collected at Appalachian Gap and on the summit of Camel's Hump during this survey. A second bumble bee of conservation concern, *B. sandersoni*, was collected along Route 17 near Appalachian Gap. This bee is broadly distributed across Canada and was formerly found as far south as the highlands of the southern Appalachians, but is now uncommon in collections from the northeastern U.S. Finally, *Nomada bethunei*, a kleptoparasitic species collected at the summit, is an uncommon northern species (Droege et al. 2010a) that may have a limited distribution in Vermont.

There are several notable absences from this collection that warrant mention. *Bombus affinis* was one of the most common bee species in the northeast until the late 1990s, when it abruptly disappeared from almost all of its former range. Formerly found in a variety of habitats, the most recent specimens from Vermont were collected in Underhill and Huntington in 1999 within a few miles of the CHMU. This bee was likely one of the most common at CHMU before its decline. Indeed, UVM's Zadock Thompson Zoological collections include a 1972 *B. affinis* specimen labeled "Bolton, Camel's

Hump". *B. ashtoni* (=*B. bohemicus*), another regionally rare bumble bee, was also absent from this inventory, but would most likely have been common at CHMU 20 years ago. A third bumble bee previously collected at Camel's Hump but not found in this inventory is *B. citrinus*, a social parasite of other bumble bee species. While still found in other parts of the state, this species appears to have declined over the last decade.

This inventory could be strengthened by additional surveys. In general, it would be good to do more extensive pan trapping and netting in a greater variety of habitats and sites around the CHMU. More work in the alpine zone is necessary to fully characterize the bees that live there, some of which are likely to be habitat specialists (e.g. pollen feeders on rare plants or arctic/ alpine in distribution). And, this effort is incomplete without a thorough collection of the bees that collect nectar and pollen from spring ephemeral wildflowers. (These collections were not made in 2013 due to logistical constraints.)

Management Recommendations

Management activities typically used on state lands can both harm and help bees. The following specific recommendations will help to support the diversity of bees found at CHMU:

1) Alpine zone management: Continue to manage the summit of Camel's Hump to conserve the alpine tundra natural community and the plants that grow there. Some of the fragile vegetation present on the summit—in particular the rare plants *Diapensia lapponica* and *Prenanthes boottii*—have noticeably declined in recent years due to trampling by hikers and their dogs (Countryman 1980; Richardson, *personal observation*). This loss of nectar and pollen sources may negatively affect bees as well as other flower foraging insects.
2) Deciduous forest management: Northern hardwood forests dominated by deciduous trees provide some of the most extensive bee habitat at CHMU, yet they are among the most intensively managed forest types there. Spring ephemeral wildflowers that emerge before the tree canopy has leafed out support a large diversity of bees that complete the active part of their life cycle in just a few weeks of spring. Current forest management practices generally promote other forest stand values (e.g. by retention of legacy trees), yet they tend to reduce

understory herb diversity and abundance by favoring the spread of ferns and shrubs. This incremental change probably results in a gradual loss of habitat quality for the bees that rely on spring wildflowers. Whenever possible, timber management practices should seek to maximize retention of these understory plants.

3) Anthropogenic habitats: Native bee species are abundant in some 'unnatural' habitats at CHMU, and these habitats should be retained if possible. Old fields with a variety of native and non-native flowering plants such as those in Bolton where the Catamount Trail enters the property should be maintained. For bees, many of which are ground nesters, mowing in alternate years and/or late in the growing season is probably best. Additionally, the open sand and gravel pit on Duxbury (River) Road in Bolton is excellent habitat for certain species that depend on areas of open sand for nesting. The current active management of the site for extraction of road materials supports this habitat.
4) Maintenance of plant hosts for specialists: The CHMU supports many types of plants that are the sole source of pollen for particular bee species, and land managers can encourage these species by managing with those plants in mind. These include willows (*Salix* spp.), spring beauty (*Claytonia caroliniana*), blueberries, cranberry and bilberry (*Vaccinium* spp.), dogwoods (*Cornus* spp.), asters (*Symphyotrichum* spp. and allies) and goldenrods (*Solidago* spp.).
5) Pesticides and herbicides: Minimize or eliminate the use of these chemicals if possible. Where pesticides must be used, avoid spraying flowering plants and do not use neonicotinoids (e.g. imidacloprid), which are very toxic to herbivorous insects including bees.

In summary, a preliminary assessment reveals that the Camel's Hump Management Unit supports a diversity of Vermont's native bee species, although some important species have declined in or disappeared from the area. More inventory is needed to fully characterize this functionally important group of invertebrates at CHMU. Most typical management activities undertaken by state lands managers probably have a neutral or positive effect on bees, but certain changes, in particular to timber harvest

practices in hardwood stands, would likely improve bee habitat. Recreational activities in alpine areas may have a negative effect on bees via trampling of flowering plants, and this effect could be avoided with increased management, especially in the alpine tundra on the summit of Camel's Hump.

FIGURES AND TABLES

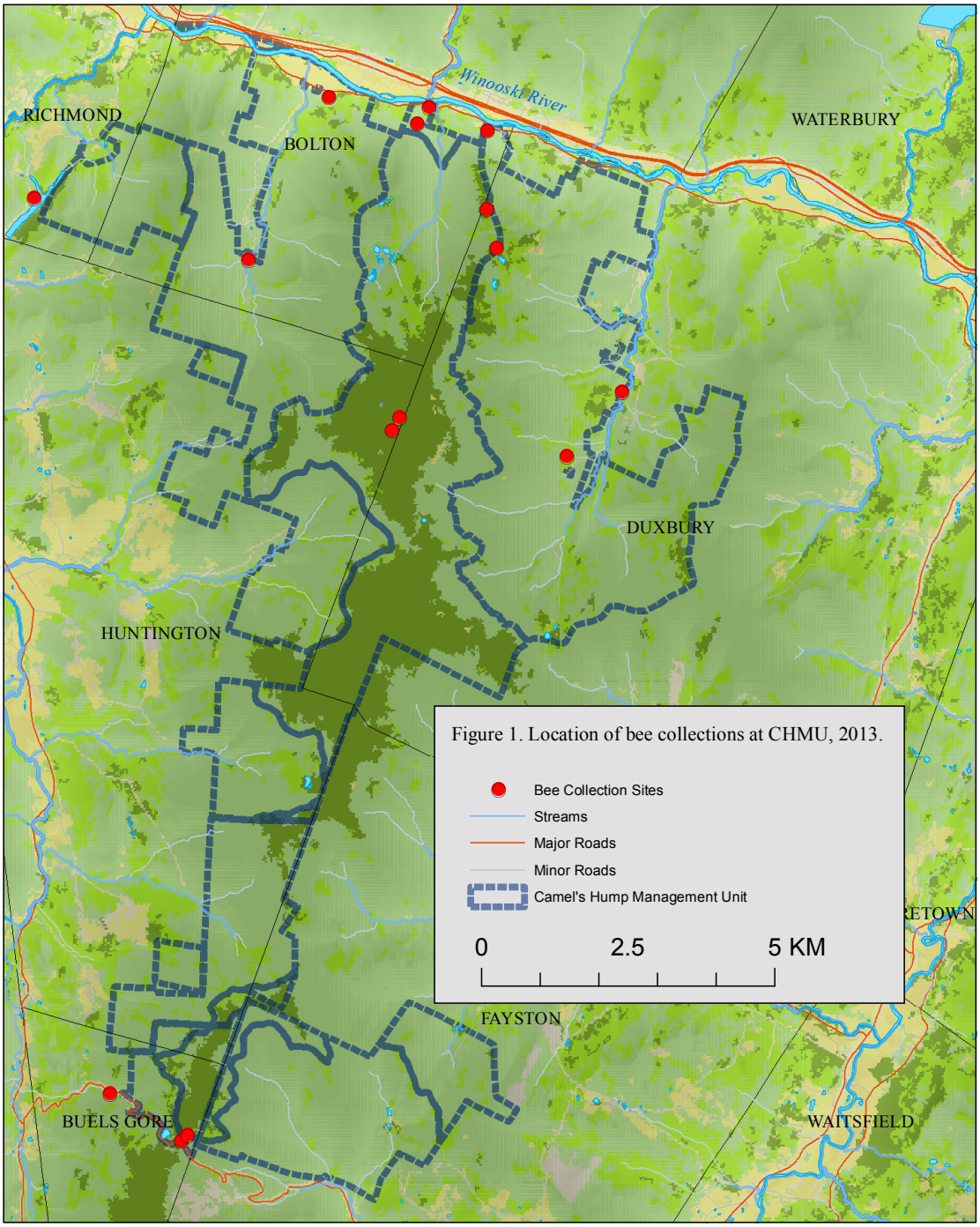
Table 1. Bees were collected at 15 sites around the CHMU on four days in 2013. Bees were collected by a combination of netting and pan trapping.

Site	Latitude	Longitude	Elevation (M)	Dates
Alpine Trail terminus	44.322	-72.885	1,164	06/20/2013
Appalachian Gap	44.211	-72.931	686	8/1/2013, 08/20/2013
Banforth Ridge	44.348	-72.865	651	06/06/2013
Banforth Ridge outcrops	44.354	-72.867	527	06/06/2013
Camel's Hump Road	44.326	-72.838	313	08/01/2013
Camel's Hump Summit	44.320	-72.887	1,244	06/20/2013
Catamount Trailhead	44.371	-72.901	111	6/6/2013, 08/01/2013
Duxbury Road (sand pit)	44.366	-72.867	137	08/01/2013
Honey Hollow	44.346	-72.918	316	08/01/2013
Long Trail (Winooski River)	44.370	-72.879	110	06/06/2013
Long Trail (N of App Gap)	44.212	-72.930	780	08/01/2013
Monroe Trailhead	44.316	-72.850	439	08/01/2013
Rich NHF along LT	44.367	-72.882	152	06/06/2013
Robbin's Mtn WMA roadside	44.355	-72.964	221	08/01/2013
Route 17	44.218	-72.947	503	08/01/2013

Table 2. Approximately 57 species of bees were collected during four days of inventory at CHMU. Species of *Andrena* and *Lasioglossum* were sorted to morpho-species only, and will later be identified to species.

Family	Species	No. Specimens
Andrenidae	*Andrena* (~ 10 species)	13
Apidae	*Apis mellifera*	2
	Bombus bimaculatus	4
	B. borealis	1
	B. impatiens	12
	B. perplexus	5
	B. sandersoni	1
	B. ternarius	29
	B. terricola	13
	B. vagans	26
	Bombus sp.	1
	Ceratina dupla	1
	Nomada bethunei	1
	N. cressoni	1
	N. depressa	1
	Nomada sp.	1
Colletidae	*Hylaeus annulatus*	1
	Hylaeus sp.	1
Halictidae	*Agapostemon texanus*	1
	Augochlorella aurata	4
	Halictus (2 species)	3
	Lasioglossum (~25 species)	41
Megachilidae	*Hoplitis producta*	1
	M. relativa	4
	Megachile inermis	1
Total		169

Figure 1. Bees were collected in a variety of habitat types around the Management Unit. Refer to Table 1 for a list of locations.



APPENDIX 1

Insects collected during this survey were databased using Filemaker Pro 12 software. A Microsoft Excel table version of the database accompanies this document, and the original Filemaker Pro file is available upon request. Specimens collected during this assessment will be given to the Department of Forests, Parks and Recreation, or donated to a scientific collection of the Department's choosing (e.g. UVM's Zadock Thompson Zoological Collection).

LITERATURE CITED

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