Baseline Survey of the Native and Non-native Bees (Hymenoptera:Apoidea) of Catoctin Mountain Park (Frederick County, Maryland)

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Bombus perplexus July 14, 2009

Osmia taurus April 10, 2012

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ABSTRACT: A survey of the bees of Catoctin Mountain Park was conducted during the field seasons of 2008, 2012 and 2013. Bee bowl transects (1 day or less runs), propylene glycol cup transects (continuous runs) and targeted netting were used during the survey. Various habitats within the Park were targeted for sampling. Three-thousand and four (3004) bees were identified representing ninety-three (93) species or species groups. Forty-two (42) bee species had not previously been reported from the county one of which *Stelis nitida* proved to be new for Maryland. Japanese Stiltgrass and White-tailed Deer appear to be impacting the spring woodland native bees within the Park. Data on all bees were tabulated in an EXCEL database and a reference collection was made of the bees collected. Both the database and collection were provided to the National Park Service.

INTRODUCTION: The Catoctin Mountains are the eastern most ridge of the Blue Ridge Province. The National Park Service manages the 5,872 acres of Catoctin Mountain Park (CATO) in Maryland. The initial land purchase was acquired in 1935 by the National Park Service after the area had sustained nearly 200 years of logging. Most of the trees left at the time of the purchase were small. Over time the forest rejuvenated and at the present a nearly continuous forest exists from one side of the Park to the other (Means 1995).

The status of pollinators in North America has become a serious concern for scientists and resource managers (Kearns 2001). In most natural areas 30-60% of plants are insect, mainly bee, pollinated. While the declines in some taxa have already been demonstrated (Grixti et al. 2009, Burkle et al. 2013), the vast majority of bee species are too poorly studied to assess potential population level changes. Some species of bees utilize the pollen from just one genus or species of plant while others appear to more general in their selection. Species abundance and blooming patterns of plants impact the pollen and nectar sources that attract bees (Potts et al. 2004, Larsson and Franzen 2007). Landscape disturbance, including fire or invasive plants (Potts et al. 2003, Campbell et al. 2007) can affect bee community composition. These changes occur in a number of different ways including changing the availability of nesting resources (Potts et al. 2005, Cane et al. 2007, Russell et al. 2005) and by changing the thermoregulatory environment (Cane and Tepedino 2001). It has already been demonstrated that bees can respond to these changes by extinction at the local level (or at least fall below detection level) or switching to new host plants (Burkle et al. 2013). In addition, models suggest that climate change will modify the distribution of bee populations which may disrupt the necessary synchronization between plant and bee phenologies (Memmott et al. 2007). However, before the potential threat of climate change can be assessed, basic knowledge of the species involved and the interactions that sustain them are needed (Bascompte and Jordano 2007).

In 2005, the U.S. Geological Survey and U.S. Department of Agriculture jointly requested that the National Academy of Sciences review the status of pollinators in North America. The resulting report specifically recommended that "The U.S. Geological Survey, the Fish and Wildlife Service, and other agencies responsible for natural resource protection should establish discovery surveys for pollinators of rare, threatened, and endangered plant species" (National Research Council 2007). Catoctin Mountain Park harbors several rare plant species that rely on insect-mediated pollination for reproduction, but little is known about the specifics of these interactions, including which bee species are involved in pollination or what additional plant species are required to sustain these insects. In recognition that this is a national level problem, BLM, FWS, NPS, and USGS have signed MOUs with the N. A. Pollinator Protection Campaign to address this issue.

MATERIALS AND METHODS: The survey conducted in 2008 used short duration trap runs consisting of fifteen 3.25 oz. Solo brand soufflé cups placed in transects. Five fluorescent yellow, fluorescent blue and non-fluorescent white bowls were alternated and spaced approximately 5 meters apart. The traps were filled with water treated with a small amount of liquid soap. The traps were either set out in the morning and picked up at the end of the day (approximately 8 hours) or left overnight and picked up the following morning (approximately 24 hours). The trap protocol used was fine-tuned from that found in the LeBuhn, et al. 2007 paper.

The survey continued in 2012-2013 using 12 oz. plastic cups filled with Propylene Glycol and water. The cups were supported by a stake and ring to ensure their integrity overtime for continuous sampling. Trap runs consisted of alternated blue, yellow and white cups (9 cups total) spaced approximately 5 meters apart. Traps were visited and bees collected on a weekly basis. Trapping ended when no bees were captured in the runs. The protocol followed was that recommended in Droege, 2013.

Propylene Glycol Cup (Continuous)

Water Cup (24 hour)

Netting of bees for identification at various locations within the Park also took place. Netting almost always was restricted to the few areas where flowers were in bloom. The flower beds maintained at the front and side of the Visitor Center provided one of the few flowering spots during the summer. Although trapping and netting at the site was limited due to the movement of visitors through the Visitor Center some sampling was done on August 7th and 28th, 2012. *Augochlora pura* (29), *Megachile mendica* (5), *Bombus impatiens* (3), *Augochloropsis metallica* (2) and a single male *Lasioglossum* species were identified from the Visitor Center flower beds.

Trapping sites were picked to survey as many different habitats as possible within the Park. Table 1 lists the sites selected along with the coordinates, elevation, habitat type, dates of the runs and type of traps used (PG = Propylene Glycol, CUP = Water). The forest sites (the dominant and majority of the Park's landscape) differed slightly in vegetation or elevation in the hopes of obtaining different assemblages of bee species. Both managed and natural open areas were small and most ended abruptly at the forest edge. The photographs following Table 1 provide visual examples of the habitats sampled.

Table 1: Trap Line Sites

SITES	COORDINATES	ELEVATION	HABITAT TYPE	TRAP TYPE	# OF TRAPS	DATES OF TRAP RUNS
Invasive Species	N 39° 38' 51.9" W 077° 29' 17.7"	1445 FT	FOREST	PG	9	Continuous 10-Apr to 17-Jul (2012)
Wildflower	N 39° 39' 9.9" W 077° 29' 14.6"	1330 FT	FOREST	PG	9	Continuous 10-Apr to 17-Jul (2012)
High Elevation	N 39° 38' 51.0" W 077° 28' 23.6"	1780 FT	FOREST	PG	9	Continuous 10-Apr to 17-Jul (2012)
Round Meadow	N 39° 38' 46.0" W 077° 29' 19.0"	1460 FT	OPEN MANAGED	PG	9	Continuous 7-Aug to 9-Oct (2012)
Lewis Property	N 39° 37' 25.9" W 077° 25' 21.0"	580 FT	OPEN MANAGED	PG	9	Continuous 9-Apr to 27-May (2013)
Green Top	N 39° 38' 43.0" W 077° 28' 34.0"	1750 FT	OPEN MANAGED	CUP	15	16-17 Apr, 6-7 May, 23-24 Sep, 9-10 Oct (2008)
Round Meadow	N 39° 38' 46.0" W 077° 29' 19.0"	1460 FT	OPEN MANAGED	CUP	15	16-17 Apr, 6-7 May, 28-29 May, 11-12 Jun, 2-3 Jul, 29-30 Jul, 20-21 Aug, 23-24 Sep, 19-20 Oct (2008)
Owens Creek PA	N 39° 39' 3.0" W 077° 29' 21.0"	1360 FT	SEMI-OPEN NATURAL	CUP	15	24-25 Apr-08 (2008)
Burned (Fire)	N 39° 38' 10.6" W 077° 26' 43.4"	1260 FT	OPEN NATURAL	CUP	15	16-17 Apr, 6-7 May, 28-29 May, 11-12 Jun, 2-3 Jul, 29-30 Jul, 20-21 Aug, 23-24 Sep, 9-10 Oct (2008)
Microburst (Tornado)	N 39° 38' 23.8" W 077° 26' 44.1"	1143 FT	OPEN NATURAL	CUP	15	16-17 Apr, 6-7 May, 28-29 May, 11-12 Jun, 2-3 Jul, 29-30 Jul, 20-21 Aug, 23-24 Sep, 9-10 Oct (2008)

Burn site (natural disturbance)

Microburst site (natural disturbance)

High Elevation Site (natural woodland)

Wild Flower site (natural woodland)

Lewis Property site (managed open area)

Round Meadow site (managed open area)

All specimens required identification in the laboratory using the identification guides on the Discover Life website (http://www.discoverlife.org). All preliminary identifications were made by the author but questionable species were double checked by Sam Droege (Bee Specialist, USGS) to ensure accuracy.

RESULTS: Table 2 lists all ninety-two (92) species or species groups known from CATO. Table 2 also provides the known flight period and the number of bees of each species found. Table 3 shows the forty-two (42) species that were new records for Frederick County. A species of Leaf-cutting bee *Stelis nitida* was a new record for the State of Maryland. Even though the species identification is still pending it is not a species previously recorded for the state. Table 4 shows the results of the continuous Propylene Glycol Trap runs by comparing woodland versus open area captures. Graph 1 shows the number of bees captured by month from the Propylene Glycol Trap woodland runs. Table 5 provides the results of the 24-hour cup runs broken down by location. All locations of the 24-hour cup runs are shown in Table 5 except for the Owens Creek PA site which had only limited trapping.

Table 2: Total Bees Recorded from Catoctin Mountain Park with Flight Period and Number Found

	FAMILY	GENUS	SPECIES	FLIGHT PERIOD	NUMBER RECORDED
1	Andrenidae	*Andrena*	*arabis*	17-Apr	1
2	Andrenidae	*Andrena*	*barbara*	6-May to 7-May	1
3	Andrenidae	*Andrena*	*carlini*	10-Apr to 14-May	10
4	Andrenidae	*Andrena*	*cressonii*	10-Apr to 30-Jul	43
5	Andrenidae	*Andrena*	*dunningi*	24-Apr to 25-Apr	1
6	Andrenidae	*Andrena*	*erigeniae*	1-Apr to 8-May	5
7	Andrenidae	*Andrena*	*erythronii*	9-Apr to 23-Apr	4
8	Andrenidae	*Andrena*	*forbesii*	17-Apr to 24-Apr	1
9	Andrenidae	*Andrena*	*imitatrix*	9-Apr to 1-May	8
10	Andrenidae	*Andrena*	*mandibularis*	17-Apr to 7-May	3
11	Andrenidae	*Andrena*	*nasonii*	10-Apr to 6-Jun	29
12	Andrenidae	*Andrena*	*perplexa*	16-Apr to 6-Jun	33
13	Andrenidae	*Andrena*	*pruni*	17-Apr to 8-May	5

14	Andrenidae	*Andrena*	*vicina*	10-Apr to 13-Jun	23
15	Andrenidae	*Andrena*	*violae*	16-Apr to 22-May	41
16	Andrenidae	*Andrena*	*wilkella*	26-Jun	2
17	Andrenidae	*Andrena*	species	30-Apr to 7-May	1
18	Andrenidae	*Calliopsis*	*andreniformis*	29-Jul to 30-Jul	1
19	Halictidae	*Agapostemon*	*virescens*	28-May to 16-Aug	4
20	Halictidae	*Augochlora*	*pura*	10-Apr to 20-Oct	1231
21	Halictidae	*Augochlorella*	*aurata*	6-May to 10-Oct	19
22	Halictidae	*Augochlorella*	*persimilis*	19-Oct to 20-Oct	1
23	Halictidae	*Augochloropsis*	*metallica*	19-Jun to 7-Aug	3
24	Halictidae	*Halictus*	*confusus*	16-Apr to 20-Oct	34
25	Halictidae	*Halictus*	*ligatus*	29-Jul to 30-Jul	4
26	Halictidae	*Halictus*	*rubicundus*	2-Jul to 3-Jul	1
27	Halictidae	*Lasioglossum*	*callidum*	20-Aug to 20-Oct	3
28	Halictidae	*Lasioglossum*	*cattallae*	9-Oct to 10-Oct	1
29	Halictidae	*Lasioglossum*	*coeruleum*	1-May to 30-Jul	7
30	Halictidae	*Lasioglossum*	*coriaceum*	6-May to 20-Oct	7
31	Halictidae	*Lasioglossum*	*cressonii*	10-Apr to 20-Oct	17
32	Halictidae	*Lasioglossum*	*ephialtum*	6-May to 20-Oct	9
33	Halictidae	*Lasioglossum*	*fuscipenne*	9-Oct to 20-Oct	2
34	Halictidae	*Lasioglossum*	*gotham*	16-Apr to 14-May	4
35	Halictidae	*Lasioglossum*	*hitchensi*	29-Jul to 20-Oct	16
36	Halictidae	*Lasioglossum*	*illinoense*	30-Apr to 20-Oct	8
37	Halictidae	*Lasioglossum*	*imitatum*	23-Sep to 20-Oct	19
38	Halictidae	*Lasioglossum*	*laevissimum*	6-Jun to 13-Jun	1
39	Halictidae	*Lasioglossum*	*obscurum*	2-Jul to 20-Oct	3
40	Halictidae	*Lasioglossum*	*pilosum (group)*	16-Apr to 20-Oct	40
41	Halictidae	*Lasioglossum*	*platyparium*	2-Jul to 20-Oct	6
42	Halictidae	*Lasioglossum*	*quebecense*	9-Apr to 20-Oct	64
43	Halictidae	*Lasioglossum*	*rozeni*	19-Oct to 20-Oct	1
44	Halictidae	*Lasioglossum*	*smilacinae*	9-Oct to 10-Oct	3
45	Halictidae	*Lasioglossum*	*subviridatum*	9-Apr to 10-Oct	44
46	Halictidae	*Lasioglossum*	*tegulare*	16-Apr to 20-Oct	10
47	Halictidae	*Lasioglossum*	*trigeminum*	16-Apr to 20-Oct	13
48	Halictidae	*Lasioglossum*	*versans*	1-May to 24-Sep	8
49	Halictidae	*Lasioglossum*	*versatum*	16-Apr to 20-Oct	13
50	Halictidae	*Lasioglossum*	*viridatum*	9-Oct to 10-Oct	1
51	Halictidae	*Lasioglossum*	*weemsi*	30-Apr to 24-Sep	6
52	Halictidae	*Lasioglossum*	species (males)	2-Jul to 13-Jul	41
53	Halictidae	*Sphecodes*	species	28-May to 30-Jul	3
54	Colletidae	*Hylaeus*	*affinis/modestus*	26-May to 10-Oct	5

55	Megachilidae	*Coelioxys*	*sayi*	19-Jun	1
56	Megachilidae	*Hoplitis*	*spoliata*	16-May to 12-Jun	2
57	Megachilidae	*Hoplitis*	*producta*	6-May to 30-Jul	12
58	Megachilidae	*Megachile*	*mendica*	19-Jun to 24-Sep	17
59	Megachilidae	*Megachile*	*rotundata*	2-Jul to 3-Jul	1
60	Megachilidae	*Osmia*	*atriventris*	9-Apr to 12-Jun	92
61	Megachilidae	*Osmia*	*bucephala*	16-Apr to 21-Aug	25
62	Megachilidae	*Osmia*	*collinsiae*	6-May to 7-May	1
63	Megachilidae	*Osmia*	*conjuncta*	16-Apr to 17-Apr	1
64	Megachilidae	*Osmia*	*cornifrons*	9-Apr to 8-May	43
65	Megachilidae	*Osmia*	*georgica*	9-Apr to 7-May	2
66	Megachilidae	*Osmia*	*pumila*	9-Apr to 3-Jul	294
67	Megachilidae	*Osmia*	*taurus*	9-Apr to 7-May	60
68	Megachilidae	*Osmia*	*virga*	6-May to 7-May	1
69	Megachilidae	*Osmia*	species of	6-May to 7-May	1
70	Megachilidae	*Stelis*	*nitida*	16-May to 22-May	1
71	Apidae	*Anthophora*	*ursina*	6-May to 7-May	1
72	Apidae	*Apis*	*mellifera*	24-Apr to 24-Sep	38
73	Apidae	*Bombus*	*bimaculatus*	24-Apr to 20-Oct	8
74	Apidae	*Bombus*	*griseocollis*	13-Jun to 17-Jul	3
75	Apidae	*Bombus*	*impatiens*	10-Apr to 20-Oct	33
76	Apidae	*Bombus*	*perplexus*	6-Jun to 14-Jul	4
77	Apidae	*Bombus*	*sandersoni*	26-May	1
78	Apidae	*Ceratina*	*calcarata*	9-Apr to 20-Oct	289
79	Apidae	*Ceratina*	*dupla*	16-Apr to 10-Oct	12
80	Apidae	*Ceratina*	*mikmaqi?*	23-Sep to 24-Sep	1
81	Apidae	*Ceratina*	*strenua*	17-Apr to 21-Aug	10
82	Apidae	*Eucera*	*hamata*	6-May to 7-May	1
83	Apidae	*Habropoda*	*laboriosa*	16-Apr to 17-Apr	1
84	Apidae	*Melitoma*	*taurea*	11-Jul to 17-Jul	1
85	Apidae	*Nomada*	*denticulata*	6-May to 16-May	2
86	Apidae	*Nomada*	*imbricata*	10-Apr to 20-May	9
87	Apidae	*Nomada*	*lehighensis*	9-Apr to 23-Apr	3
88	Apidae	*Nomada*	*luteoloides*	9-Apr to 29-May	22
89	Apidae	*Nomada*	*maculata*	10-Apr to 12-Jun	11
90	Apidae	*Nomada*	*pygmaea*	9-Apr to 29-May	64
91	Apidae	*Nomada*	*sayi/illinoensis*	6-May to 7-May	7
92	Apidae	*Nomada*	spp. (bidenate group)	10-Apr to 19-Jun	58
93	Apidae	*Nomada*	spp. (White-setae group)	6-May to 16-May	4
94	Apidae	*Xylocopa*	*virginica*	9-Apr to 26-May	3
				TOTAL # OF BEES	3004

Table 3: New Bee Records for Frederick County, Maryland

	GENUS	SPECIES		GENUS	SPECIES
1	*Andrena*	*cressonii*	2	*Andrena*	*dunningi*
3	*Andrena*	*erigeniae*	4	*Andrena*	*erythronii*
5	*Andrena*	*forbesii*	6	*Lasioglossum*	*laevissimum*
7	*Andrena*	*mandibularis*	8	*Andrena*	*pruni*
9	*Andrena*	*wilkella*	10	*Agapostemon*	*virescens*
11	*Augochlorella*	*aurata*	12	*Augochlorella*	*persimilis*
13	*Lasioglossum*	*callidum*	14	*Lasioglossum*	*cattallae*
15	*Lasioglossum*	*coeruleum*	16	*Lasioglossum*	*cressonii*
17	*Lasioglossum*	*ephialtum*	18	*Lasioglossum*	*fuscipenne*
19	*Lasioglossum*	*illinoense*	20	*Lasioglossum*	*obscurum*
21	*Lasioglossum*	*rozeni*	22	*Lasioglossum*	*smilacinae*
23	*Lasioglossum*	*trigeminum*	24	*Lasioglossum*	*versans*
25	*Lasioglossum*	*viridatum*	26	*Lasioglossum*	*weemsi*
27	*Coelioxys*	*sayi*	28	*Hoplites*	*producta*
29	*Osmia*	*collinsiae*	30	*Osmia*	*conjuncta*
31	*Osmia*	*virga*	32	*Anthophora*	*ursina*
33	*Bombus*	*sandersoni*	34	*Eucera*	*hamata*
35	*Habropoda*	*laboriosa*	36	*Melitoma*	*taurea*
37	*Nomada*	*denticulata*	38	*Nomada*	*imbricata*
39	*Nomada*	*lehighensis*	40	*Nomada*	*maculata*
41	*Nomada*	*pygmaea*	42	*Stelis*	*nitida*

Table 4: Comparison Between Bees Captured using Propylene Glycol Traps in Woodlands versus Forest Openings

	FAMILY	GENUS	SPECIES	WOODLANDS	FOREST OPENNINGS
1	ANDRENIDAE	*Andrena*	*carlini*	3	2
2	ANDRENIDAE	*Andrena*	*cressonii*	41	0
3	ANDRENIDAE	*Andrena*	*erigeniae*	4	0
4	ANDRENIDAE	*Andrena*	*erythronii*	0	7
5	ANDRENIDAE	*Andrena*	*forbesii*	1	0
6	ANDRENIDAE	*Andrena*	*imitatrix*	2	8
7	ANDRENIDAE	*Andrena*	*mandibularis*	1	2
8	ANDRENIDAE	*Andrena*	*nasonii*	17	4
9	ANDRENIDAE	*Andrena*	*perplexa*	12	20
10	ANDRENIDAE	*Andrena*	*pruni*	7	0
11	ANDRENIDAE	*Andrena*	*vicina*	16	8
12	ANDRENIDAE	*Andrena*	*violae*	5	2
13	ANDRENIDAE	*Andrena*	sp.	0	2
14	HALICTIDAE	*Agapostemon*	*virescens*	1	0

15	HALICTIDAE	*Augochlora*	*pura*	6	44
16	HALICTIDAE	*Halictus*	*confusus*	1	0
17	HALICTIDAE	*Lasioglossum*	*coeruleum*	2	0
18	HALICTIDAE	*Lasioglossum*	*coriaceum*	0	1
19	HALICTIDAE	*Lasioglossum*	*gotham*	0	2
20	HALICTIDAE	*Lasioglossum*	*illinoense*	0	3
21	HALICTIDAE	*Lasioglossum*	*laevissimum*	1	0
22	HALICTIDAE	*Lasioglossum*	*quebecense*	14	10
23	HALICTIDAE	*Lasioglossum*	*subviridatum*	3	9
24	HALICTIDAE	*Lasioglossum*	*tegulare*	1	0
25	HALICTIDAE	*Lasioglossum*	*versans*	2	0
26	HALICTIDAE	*Lasioglossum*	*weemsi*	0	2
27	MEGACHILIDAE	*Hoplitis*	*spoliata*	1	0
28	MEGACHILIDAE	*Hoplitis*	*producta*	0	2
29	MEGACHILIDAE	*Megachille*	*mendica*	0	3
30	MEGACHILIDAE	*Osmia*	*atriventris*	1	26
31	MEGACHILIDAE	*Osmia*	*bucephala*	5	0
32	MEGACHILIDAE	*Osmia*	*cornifrons*	1	10
33	MEGACHILIDAE	*Osmia*	*georgica*	0	2
34	MEGACHILIDAE	*Osmia*	*pumila*	4	32
35	MEGACHILIDAE	*Osmia*	*taurus*	0	2
36	MEGACHILIDAE	*Stelis*	*nitida*	1	0
37	APIDAE	*Apis*	*mellifera*	2	7
38	APIDAE	*Bombus*	*bimaculatus*	4	0
39	APIDAE	*Bombus*	*griseocollis*	2	0
40	APIDAE	*Bombus*	*impatiens*	1	5
41	APIDAE	*Bombus*	*perplexus*	2	0
42	APIDAE	*Ceratina*	*calcarata*	2	85
43	APIDAE	*Ceratina*	*strenua*	1	6
44	APIDAE	*Nomada*	*denticulata*	1	0
45	APIDAE	*Nomada*	*imbricata*	4	8
46	APIDAE	*Nomada*	*lehighensis*	0	6
47	APIDAE	*Nomada*	*luteoloides*	12	12
48	APIDAE	*Nomada*	*maculata*	6	0
49	APIDAE	*Nomada*	*pygmaea*	8	50
50	APIDAE	*Nomada*	spp.	12	6
			TOTALS	210	388

Graph 1: Number of Bees Collected from Woodland Trap Lines in Propylene Glycol Traps by Month

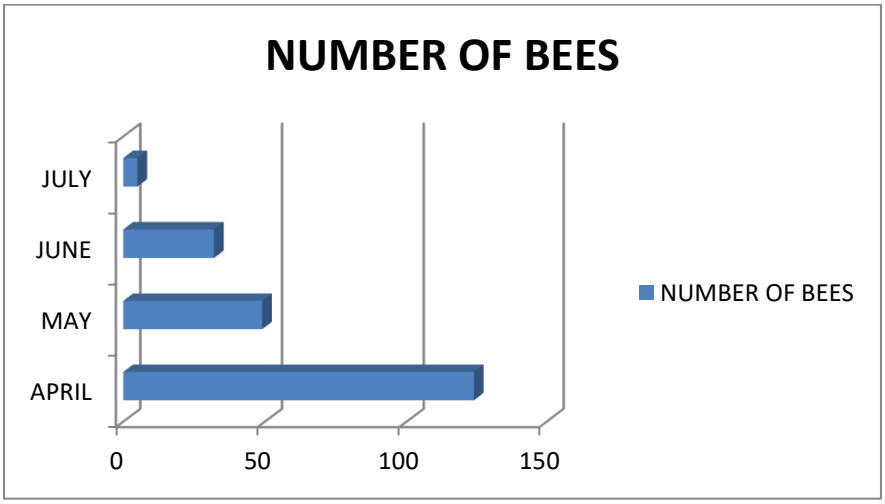

Table 5: Results of the Daily Bee Cup Runs by Location

GENUS	SPECIES	GREEN TOP	ROUND MEADOW	MICROBURST SITE	BURNED SITE
Andrena	*barbara*				1
Andrena	*carlini*	1	4	1	
Andrena	*cressonii*	8	12	3	1
Andrena	*dunningi*	1			
Andrena	*mandibularis*		1		
Andrena	*nasonii*	4	5		
Andrena	*perplexa*	1			
Andrena	*pruni*				1
Andrena	*violae*	14	17	3	1
Calliopsis	*andreniformis*				1
Agapostemon	*virescens*		1		
Augochlora	*pura*	692	391	42	29
Augochlorella	*aurata*	1	13	3	2
Augochlorella	*persimilis*		1		
Augochloropsis	*metallica*		1		
Halictus	*confusus*	21	12		
Halictus	*ligatus*		2		2
Halictus	*rubicundus*				1
Lasioglossum	*callidum*		3		
Lasioglossum	*cattallae*	1			
Lasioglossum	*coeruleum*			2	3
Lasioglossum	*coriaceum*	1	5		
Lasioglossum	*cressonii*	1	14		
Lasioglossum	*ephialtum*	1	9		
Lasioglossum	*fuscipenne*	1	1		

Lasioglossum	*gotham*	1	2		
Lasioglossum	*hitchensi*	4	12		
Lasioglossum	*illinoense*		6		
Lasioglossum	*imitatum*	7	12		
Lasioglossum	*obscurum*		2	1	
Lasioglossum	*pilosum* (group)	14	20	3	3
Lasioglossum	*platyparium*	2	4		
Lasioglossum	*quebecense*	1	32	8	
Lasioglossum	*rozeni*		1		
Lasioglossum	*smilacinae*	2			1
Lasioglossum	*subviridatum*	3	5	11	16
Lasioglossum	*tegulare*	1	5	2	1
Lasioglossum	*trigeminum*	6	5	1	1
Lasioglossum	*versans*	1	3	2	
Lasioglossum	*versatum*	6	6		1
Lasioglossum	*viridatum*			1	
Lasioglossum	*weemsi*	2	1		1
Lasioglossum	species (males)	12	24	1	1
Lasioglossum	species (female)		1		
Sphecodes	species				3
Hylaeus	*affinis/modestus*	1	1		1
Hoplitis	*spoliata*				1
Hoplitis	*producta*	2		8	
Megachile	*mendica*	1	5	1	
Megachile	*rotundata*		1		
Osmia	*atriventris*	47	10	9	9
Osmia	*bucephala*	9	1	5	3
Osmia	*collinsiae*	1			
Osmia	*conjuncta*	1			
Osmia	*cornifrons*	13	5	9	9
Osmia	*georgica*	1			
Osmia	*pumila*	69	76	84	45
Osmia	*taurus*	21	10	8	19
Osmia	*virga*	1			
Osmia	species of	1			
Anthophora	*ursina*			1	
Apis	*mellifera*	3	6		
Bombus	*bimaculatus*	1	2		
Bombus	*impatiens*		8	5	1
Ceratina	*calcarata*	26	132	23	3
Ceratina	*dupla*	6	28		

Ceratina	*mikmaqi*		1		
Ceratina	*strenua*			6	
Eucera	*hamata*	1			
Habropoda	*laboriosa*	1			
Nomada	*denticulata*				1
Nomada	*imbricata*	1			
Nomada	*luteoloides*	1		2	1
Nomada	*maculata*		1		1
Nomada	*pygmaea*	12	2	17	
Nomada	*sayi/illinoensis*	7			
Nomada	spp. (bidenate group)	21	2	16	3
Nomada	spp. (White-setae group)				1
Xylocopa	*virginica*	1			
	TOTALS (2428 Bees)	1058	924	278	168

DISCUSSION: Catoctin Mountain Park is set most entirely within the Catoctin Mountains. Little variation exists within the predominately oak-hickory forest that spans the Park except where small human-managed clearings are maintained. As the snow retreats several native wildflowers appear on the forest floor including, but not limited to: Spring Beauty (*Claytonia virginica*), Wood Anemone (*Anemone quinquefolia*), Dwarf Ginseng (*Panax trigolius*), Yellow Trout-lily (*Erythronium americanum*), Jack-in-the-Pulpit (*Arisaema triphyllum*), Swamp Saxifrage (*Saxifraga pensylvanica*) and several species of Violets (*Viola* spp.). These flowers appear only in the spring and generally do not persist once the tree canopy leafs out. The numbers of these spring flowers within CATO is not as extensive as that seen in the woodlands of Maryland's Piedmont or Coastal Plain but are still an important component of the vegetation within the Park.

It has long been recognized that adult bee numbers follow the rise and fall of spring wildflowers in forested areas of Eastern North America (Robertson, 1928, Droege, 2013). Graph 1 reflects this same pattern occurring within the forested sections of the Park. However, the rise and fall of the woodland bee populations were faster than expected, dropping nearly 2/3 from the first onset of bee activity compared to a month later. In addition, bee capture numbers from the Propylene Glycol traps were less than expected based on similar runs in oak-hickory forests from Maryland's coastal Plain (Droege, 2013).

Part of the explanation rests with the reduction in the number of wildflowers and the cooler springtime temperatures in the Catoctin Mountains compared to the nearby Coastal Plain. Bees were flying nearly a month earlier on the Coastal Plain than in the Catoctin Mountains. The reduction of spring wildflowers within the Park maybe due to the ubiquitous invasive Japanese Stiltgrass (*Microstegium vimineum*). The emergence of this species within the Park is explosive once the spring temperatures start to increase. The quick coverage of this grass on the forest floor has undoubtedly been facilitated by the unsustainable high-density of White-tailed deer (*Odocoileus virginianus*) that currently exist within the Park. The deer add to the problem by consuming native herbs and shrubs that might otherwise have slowed the spread of the invasive grass. Unfortunately, the deer will not eat Japanese Stiltgrass. This double attack on the native forest floor plants and the resulting increased spread of Japanese Stiltgrass has been well documented in a study from Pennsylvania (Knight et al. 2009). Based on the small number of bees and short spring bee pattern shown in this survey it appears that this damage to the native plants may well extend to the bees that pollenate them. The infestation of Japanese Stiltgrass of the forest floor where the spring wildflowers normally occur was so extensive within the Park that even the Wildflower Site, which was chosen as a site of minimum invasive plant contamination, was overrun as were all the other forested sites by mid-May.

Netting bees was limited at the Park mainly due of the lack of good stands of wildflowers. What netting was done concurs with the trapping results in that limited bee numbers and diversity was found.

A comparison between the efficacies of the two types of trapping methods used during the survey could not easily be done because of the variables of year, location, weather and duration of runs. However, clearly the 24-hour cups captured more bees than the Propylene Glycol traps but considering that more cups were used in the 24-hour runs (15) compared to the Propylene Glycol traps (9) and that the 24-hour runs were conducted in more open areas (more flowers) than in the forested areas (fewer flowers) this is hardly unexpected. In addition, the Propylene Glycol trap runs were mainly conducted in 2012 which was a dry year with a reduced number of blooming plants.

The Propylene Glycol traps were divided into woodland sites and open sites (Table 4). Because the open sites were never far from the surrounding woodlands there is little doubt that some woodland species were attracted to the open areas due to flower blooms and thus found their way into the traps. Still the differences in some species numbers between woodland and open sites were notable. Open areas drew more captures of *Augochlora pura* (44 open to 6 woodland), *Osmia atriventris* (26 to 1), *Osmia cornifrons* (10 to 1), *Osmia pumila* (32 to 4) and *Ceratina calcarata* (85 to 2). Based on known information about these bees this was not unexpected. However, *Andrena erythronii* (7 to 0) and *Nomada pygmaea* (50 to 8) was unexpected since the tendency for species in these two genera were either higher or at approximately the same number as the woodland sites. It should be noted that *Nomada* species are nest parasites of *Andrena* species and thus it is possible that *Andrena erythronii* and *Nomada pygmaea* are interconnected as host and parasite.

For the woodland sites *Andrena cressonii* (41 woodland to 0 open), *Andrena erigeniae* (4 to 0) and *Andrena nasonii* (17 to 4) where the big winners. Overall other *Andrena* and *Nomada* species (except for *A. erythronii* and *N. pygmaea* mentioned above) were in approximately equal or higher numbers at the woodland sites. It is well documented that in our area *Andrena* species and their nest parasite *Nomada* species are major pollinators of early spring woodland wild flowers (Droege, 2013).

The 2008 results of the 24-hour traps comparing open to semi-open human maintained sites (meadows or parkland-like areas) compared to natural temporary open sites (due to clearing from a tornado and fire) are shown in Table 5. Both of the natural-open sites were well on their way to reverting back to the surrounding forest by 2013. As expected higher diversity and greater numbers of bees were collected in the human-maintained sites since these sites were larger in extent and were maintained indefinitely while the natural-open sites were smaller and short-lived. Two species however appeared to utilize the natural-open sites more than the human-maintained sites. These were *Lasioglossum coeruleum* (5 natural to 0 maintained) and *Lasioglossum subviridatum* (27 to 8). It is not known if this ratio would continue to hold true with a larger sampling size, or if the ratio is truly significant, why these two species would prefer the natural open sites.

The forty-two bee species identified during the study were new records for Frederick County. A list of the species can be seen in Table 3. Most of these were trapped in 2008 by Becky Loncosky (Natural Resource biologist at Catoctin Mountain Park) using 24-hour cup runs. Many of the first records are of bees that later turned out to be common to the Park. The high percentage of new county records resulted from a lack of bee surveys prior to 2008 within the county's Catoctin Mountains region.

A new Maryland state record was also found during the study. *Stelis nitida* was captured at the Invasive Species Site (see Table 1) using Propylene Glycol traps. It was collected from a May 16-22, 2012 run. *Stelis* species are bee parasites on the genus *Hoplitis*. Both *Hoplitis producta* (12 found during study) and *Hoplitis spoliata* (2 found during study) occur in the Park. However, only *Hoplitis spoliata* was recorded from the Invasive Species Site and one was captured on the same May 16-22, 2012 run as *Stelis nitida*. *Stelis nitida* may well be a parasite of *Hoplitis spoliata*.

Stelis nitida (top view)*

Stelis nitida (side view)*

Both the continuous and the 24-hour trapping methods used in this study have the potential to be used to survey bees throughout the National Park system. Both types of trapping methods have their pluses and negatives and the decision to go with one trapping method over the other will depend on what data is desired and the area needing coverage. Since both use colored traps for attracting bees, it is reasonable to assume that there would be little difference in which bees are attracted. Propylene Glycol traps take a little more time to setup and maintain than 24-hour cups but neither method is really onerous. The use of Propylene Glycol traps are reasonably new but appear to have potential to be an inexpensive long-term monitoring method to measure bee activity. It is hoped that this new approach for sampling bee populations, at a continuous rate, might provide for a more comprehensive coverage and provide more precise temporal data than can usually be generated from short term trapping techniques.

It is the author's opinion that if one is after maximum capture at a specific time and wishes to cover numerous locations quickly the 24-hour cup may be the method of choice. If one needs a continuous coverage (e.g. for matching bee flight times to flower blooms) of selected areas over an extended period of time Propylene Glycol traps may best meet their needs. Using both trapping approaches simultaneously may prove the best approach for covering a National Park (or any large area) by running the continuous traps in areas of suspected high bee diversity or at a site of conservation interest while supplementing the continuous traps with 24-hour trap runs at other locations within the Park along with targeted netting on specific flower species to maximize the total coverage.

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LITERATURE CITED:

Bascompte, J., Jordano, P., 2007. Plant-animal mutualistic networks: The architecture of biodiversity. Annual Review of Ecology Evolution and Systematics 38, 567-593

Burkle, L. A., J.C. Marlin and T.M. Knight. 2013. Plant-Pollinator Interactions over 120 years; Loss of Species, Co-Occurrence and Function. Science, Vol. 339, March 29, 2013

Campbell, J. W., J. L. Hanula, and T. A. Waldrop. 2007. Effects of prescribed fire and fire surrogates on floral visiting insects of the blue ridge province in North Carolina. Biological Conservation 134:393-404.

Cane, J. H. and V. J. Tepedino. 2001. Causes and extent of declines among native North American invertebrate pollinators: detection, evidence, and consequences. Conservation Ecology 5:1. [online] URL: http://www.consecol.org/vol5/iss1/art1/

Cane, J. H., T. Griswold, and F. D. Parker. 2007. Substrates and materials used for nesting by North American Osmia bees (Hymenoptera: Apiformes: Megachilidae). Annals of the Entomological Society of America 100:350-358.

Droege, S.W. 2013. *Investigation of the Spring Bee Fauna (Hymenoptera: Apoiea) of Seven Woodland Sites in the oastal Plain of Maryland using Continuously-trapping Arrays of Propylene Glycol Cup Traps*. The Maryland Entomologist, Volume 6, Number 1, pages 43-55.

Grixti, J. C., L. T. Wong, S. A. Cameron, and C. Favret. 2009. Decline of bumble bees (Bombus) in the North American Midwest. Biological Conservation 142:75-84.

Knight TM, Dunn JL, Smith LA, Davis J, Kalisz S (2009) Deer facilitate invasive plant success in a Pennsylvania forest understory. Nat Areas J 29:110–116

Kearns, C.A., Inouye, D.W., Waser, N.M., 1998. Endangered mutualisms: The conservation of plant-pollinator interactions. Annual Review of Ecology and Systematics 29, 83-112.

Larsson, M. and M. Franzen. 2007. Critical resource levels of pollen for the declining bee Andrena hattorfiana (Hymenoptera, Andrenidae). Biological Conservation 134:405-414.

LeBuhn G., S. Droege, and M. Carboni, 2007. Monitoring methods for solitary bee species using bee bowl in North America. A report submitted on: Monitoring the status and trends of pollinators for the first State of the Worlds' Pollinators Report, 28pp.

Means, J. 1995. Maryland's Catoctin Mountain Parks. McDonald & Woodward Publishing Company. Blacksburg Virginia, 168 pages.

Memmott, J., Craze, P.G., Waser, N.M., Price, M.V., 2007. Global warming and the disruption of plant-pollinator interactions. Ecology Letters 10, 710-717.

National Research Council 2007. Status of pollinators in North America. National Academies Press, Washington, D.C.

Orr, R.L. 2010. Preliminary List of the Bees (Hymenoptera: Apoidea) of Assateague Island National Seashore, Worcester County, Maryland. The Maryland Entomologist, September, 2010, Volume 5, Number 2, pages 41-50.

Potts, S. G., B. Vulliamy, A. Dafni, G. Ne'eman, C. O'Toole, S. Roberts, and P. Willmer. 2003. Response of plant-pollinator communities to fire: changes in diversity, abundance and floral reward structure. Oikos 101:103-112

Potts, S. G., B. Vulliamy, S. Roberts, C. O'Toole, A. Dafni, G. Ne'eman, and P. G. Willmer. 2004. Nectar resource diversity organizes flower-visitor community structure. Entomologia Experimentalis et Applicata 113:103-107.

Potts, S. G., B. Vulliamy, S. Roberts, C. O'Toole, A. Dafni, G. Ne'eman, and P. Willmer. 2005.

Robertson, C. 1928. *Flowers and Insects: lists of visitors of four hundred and fifty-three flowers*. Science Press Printing Company, Lancaster, PA. 221 pp.

Russell, K. N., H. Ikerd, and S. Droege. 2005. The potential conservation value of unmowed powerline strips for native bees. Biological Conservation 124:133-148.

Lasioglossum rozeni (face)*

Lasioglossum rozeni (side view)*

* = Photos taken with the USGS Bee Laboratory photographic equipment in Beltsville, Maryland.