

2017

Documenting the Diversity, Distribution, and Status of Maine Bumble Bees: The Maine Bumble Bee Atlas and Citizen Scientists

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Recommended Citation

Bickerman-Martens, Kalyn, Beth Swartz, Ron Butler, and Francis A. Drummond. "Documenting the Diversity, Distribution, and Status of Maine Bumble Bees: The Maine Bumble Bee Atlas and Citizen Scientists." *Maine Policy Review* 26.2 (2017) : 43 -49, <https://digitalcommons.library.umaine.edu/mpr/vol26/iss2/8>.

Documenting the Diversity, Distribution, and Status of Maine Bumble Bees:

The Maine Bumble Bee Atlas and Citizen Scientists

by Kalyn Bickerman-Martens, Beth Swartz, Ron Butler, and Frank Drummond

Abstract

The Maine Bumble Bee Atlas (MBBA) is a multiyear (2015–2019) citizen science project coordinated by the Maine Department of Inland Fisheries and Wildlife (MDIFW) in partnership with the University of Maine. The project's goals are to increase scientific knowledge of Maine's bumble bee fauna and raise public appreciation for native pollinators and their conservation. Project partners accomplish these goals by training citizen scientists to conduct surveys statewide using standardized data-collection methods and by providing outreach to both project volunteers and the public on bumble bees and native pollinator conservation. During the project's first three years, 230 volunteers have been trained to participate in MBBA at six workshops held across the state. As of the end of the second field season, MBBA citizen scientists have documented over 10,300 species records in nearly 500 townships statewide. These data have already made a valuable contribution to species status assessments conducted by MDIFW and the US Fish and Wildlife Service. MBBA staff also maintain a website, Facebook page, and blog to keep volunteers and the public informed about the project and raise awareness of, and support for, native pollinator conservation.

et al. 2011; Corbet, Williams, and Osborne 1991; Drummond 2016; Grixti et al. 2009).

There are 250 species of bumble bees worldwide, 17 of which have been known to occur historically in Maine (<http://explorer.natureserve.org>; Dibble et al. in press). Because there is little comparable historical baseline data, however, researchers currently know little about the status of native bumble bee populations in the United States. But in the last few decades, researchers have observed population declines in bumble bee species throughout the country (Cameron et al. 2011; Grixti et al. 2009). In fact, in March 2017, the rusty-patched bumble bee (*Bombus affinis*) became the first bumble bee protected under the US

Endangered Species Act (ESA).¹ Once abundant and widespread across the East, Midwest, and southern Canada (Szymanski et al. 2016), there has been a nearly 90 percent decline in both numbers and range extent of the rusty-patched bumble bee since the late 1990s (Cameron et al. 2011). This species has not been observed in Maine for nearly a decade.

A second Maine native, the yellow-banded bumble bee (*Bombus terricola*), has also experienced significant declines throughout its range. Once commonly found from the Northeast, along the Eastern Seaboard, and across the Midwest through western Canada, scientists believe this species has declined by approximately 50 percent (Colla and Packer 2008). In 2017, the US Fish and Wildlife Service (USFWS) initiated a comprehensive status review to assess if the yellow-banded bumble bee also warranted listing under the

BACKGROUND

Researchers estimate that 87 percent of the flowering plants in the world—wild plants and agricultural crops alike—rely on animals for pollination (Bartomeus et al. 2013; Ollerton et al. 2011). In the United States, the value of insect-mediated pollination, including that provided by native bees, is around \$60 billion (Losey and Vaughn 2006). In Maine, native insects such as bumble bees provide valuable pollination services. With their large, furry bodies and ability to generate body heat, bumble bees are well adapted to our temperate climate and can forage in cooler air temperatures than the introduced honey bee (Heinrich 1979; Jones et al. 2014). Bumble bees are also valued for their distinctive *buzz-pollination*—a technique that is important in the pollination of Maine's lowbush blueberry crop (Cameron



*Above: Bombus impatiens, the common eastern bumble bee [Photos: Ron Butler],
Below: Bombus terricola, the yellow-banded bumble bee [Photos: Pat Hinds].*



federal ESA.² Fortunately for Maine, the yellow-banded bumble bee continues to be found in low numbers throughout the state.

Several factors may be contributing to the declines in bumble bee populations: habitat alteration and fragmentation; loss of food resources through intensive land management practices; pesticides; and diseases and parasites introduced through widespread use of commercially raised bumble bees (Schweitzer et al. 2010). Although we know these declines have occurred in Maine, the state's lack of comprehensive statewide

occurrence data on bumble bees meant that MDIFW did not have the ability to confidently assess bumble bee species status and trends. Between 1864 and 2015, only about 1,300 bumble bee records had been documented in the state, many of which were recorded around the universities, particularly Orono, as well as more populated areas, leaving much of Maine's diverse landscape underrepresented.

To address the need for current and comprehensive data on Maine's bumble bee fauna, MDIFW partnered with the University of Maine and the University of Maine at Farmington in 2014 to initiate the Maine Bumble Bee Atlas (MBBA). MBBA was designed as a multiyear (2015–2019), statewide survey of bumble bees using trained citizen scientists with two main project objectives:

- Increase scientific knowledge of the diversity, distribution, and conservation status of Maine's bumble bees.
- Raise public awareness of native pollinators and their conservation.

There are several benefits to using citizen scientists in such projects. The use of trained citizens greatly reinforces the effectiveness of limited state agency staff and resources for a comprehensive, statewide survey. By increasing the number of people participating in the

bumble bee surveys, we improve the chances of finding a rare species and are able to collect finer-scale data on a landscape scale. Finally, people who participate in a citizen science project—an example of *experiential education*—learn through the action of participating in training workshops and surveys, which enhances their interest in, and support for, pollinator conservation (Brossard, Lewenstein, and Bonney 2005). A rewarding experience often leads participants to volunteer for additional citizen science projects, which generates a valuable pool of trained individuals for future conservation initiatives.

The MDIFW has a history of successfully using citizen scientists to assist with wildlife biodiversity projects, including two recent invertebrate surveys: the Maine Butterfly Survey (MBS) (2008–2016) and Maine Dragonfly and Damselfly Survey (MDDS) (1999–2005). Volunteers for MBS contributed more than 23,000 butterfly records, 10 of which were new state species records and 1 of which was a new US species record (MDIFW unpublished data). During the active years of MDDS, citizen scientists contributed 3,000–4,000 records annually for a total of more than 17,000 dragonfly and damselfly records submitted, with 10 new state species records and 2 new US species records (Brunelle and deMaynadier 2005). MBBA was modeled after these successful projects, with the intent of creating a partnership between professional and citizen scientists to survey Maine’s bumble bee fauna and document diversity, abundance, and habitat use.

The seed for the MBBA was planted in 2012 by the Vermont Center for Ecostudies’ two-year Vermont Bumble Bee Survey, which documented the distribution and status of bumble bees in that state. During that survey, over 10,000 bumble bee records of 12 species were collected. In 2013, NatureServe provided training in bumble bee identification and monitoring to northeastern state fish and wildlife agencies and showcased the successful Vermont Bumble Bee Survey (<https://vtecostudies.org/wildlife/insects/bumble-bees/>). This alliance built a foundation for MDIFW from which the Maine Bumble Bee Atlas was a next step.

HOW THE MAINE BUMBLE BEE ATLAS WORKS

We began the first stage of volunteer recruitment for MBBA in the spring of 2015 with the announcement of two training workshops. The MDIFW issued a press release, which was picked up by local news

organizations (Maine Public Broadcasting Network, *Portland Press Herald*, among others) and was also emailed to former MBS and MDDS participants, as well as members of the Maine Entomological Society. We created a website so potential volunteers could learn more about the project and how to participate. The website also serves as the primary vehicle for providing resources to project participants, as well as communicating project results and pollinator outreach to the public. A project Facebook page and blog serve as additional outreach tools.³

By increasing the number of people participating in the bumble bee surveys, we improve the chances of finding a rare species and are able to collect finer-scale data on a landscape scale.

All participants need to attend a volunteer-training workshop to participate in MBBA. Daylong workshops are limited to 40 to 50 people. The first half of the day is focused on bumble bee life history, biology, and conservation. After an hour-long lunch break, the afternoon session presents information on the project’s methods and protocols, followed by a demonstration on how to pin insects and the distribution of participants’ collecting supplies. Although the preferred collection method requires volunteers to kill and pin the bumble bees they document, we also give volunteers the choice to participate through a catch-and-release method using photography. Participants are encouraged to begin documenting bumble bees soon after the workshop and continue through the fall until the last bumble bees are seen foraging. Participants drop off their pinned collections at their local Cooperative Extension offices and submit photographs via email and DropBox.

Two training workshops have been held in the spring of each year since 2015, for a total of six workshops so far, and 230 volunteers have been trained through the 2017 season. Acknowledging that volunteers are most likely to survey near where they live, we

attempted to schedule training workshops in different areas of Maine to train people from diverse regions. Workshop locations have included Orono, Gorham, and Houlton, Maine.

In addition to the training workshops, MBBA staff also offered bumble bee identification workshops to participants in 2016 and 2017. Although volunteers are not required to identify their collections, and all collections are sent to a project partner for identification, many participants are curious about this aspect of the project. Identification workshops are half-day events and include presentations on methods and tools for identifying bumble bees followed by time for attendees to practice their skills using microscopes. Volunteers are encouraged to bring their own collections, but samples of several species are provided.

By the end of 2016, more than 2,430 individual sites visits have been conducted at 1,304 sites in nearly 500 Maine townships from all 16 counties.

PREWORKSHOP SURVEY FOR VOLUNTEERS

At the beginning of each training workshop in 2015 and 2016, we surveyed the participants to assess their demographics and previous knowledge about bumble bees and to ascertain how many had previously participated in citizen science projects. The survey was optional and participants remained anonymous. From the 230 trained volunteers, we received 145 completed surveys. We found that a little over half of survey respondents (52 percent) had volunteered previously for a citizen science project such as MBS or MDDS, and 14 percent were members of the Maine Entomological Society. Additionally, nearly 92 percent of volunteers who responded had completed at least an associate's degree, and 9 percent of those held doctorates. Most workshop attendees (~62 percent) were at least 51 years old while only 12 percent were less than 31 years old.

We included questions about participants' previous knowledge about bumble bees and pollinators to measure the learning outcomes for our citizen scientists. More than 95 percent of respondents had previously heard of colony collapse disorder (CCD) in honey bees, which was not surprising given the media attention in recent years. Volunteers answered approximately 50 percent of the general knowledge questions about bumble bees correctly, such as knowing there are 10 to 20 bumble bee species in Maine (80 percent) and that bumble bees are capable of delivering a sting (78 percent). This suggests they were generally well informed before the workshop. Fewer volunteers correctly answered that workers and queens were the ones that collect pollen for the colonies (45 percent) or that bumble bees buzz-pollinate (46 percent).

When presented with the names, both scientific and common, of five bumble bee species and asked to choose which species was possibly extirpated from Maine, the majority (78 percent) chose "not sure;" only 20 percent of respondents correctly chose the rusty-patched bumble bee. These surveys were conducted in 2015 and 2016, before the listing of the rusty-patched bumble bee under the ESA and before there was a significant amount of media attention on the species. Volunteers were also asked if the honey bee (*Apis mellifera*), introduced to North America from Europe in the seventeenth century, was a native species to the United States. Approximately 61 percent correctly responded that it was not a native species; only 7 percent thought that it was native.

We also asked the volunteer citizen scientists to list possible threats to bumble bee species in Maine. The top responses were chemicals and pesticides (91 percent), habitat loss (60 percent), climate change (29 percent), and parasites and diseases (25 percent).

WHAT WE HAVE LEARNED SO FAR

The Maine Bumble Bee Atlas is designed to have five years of citizen science contributions. As of August 2017, we have completed three years of volunteer-training workshops and are in the middle of our third season of bumble bee surveys. In 2015, approximately 4,500 bumble bee records were contributed to the project (specimens and photo vouchers), and in 2016, we received around 5,800 records, for a total of approximately 10,300 records for the first two years

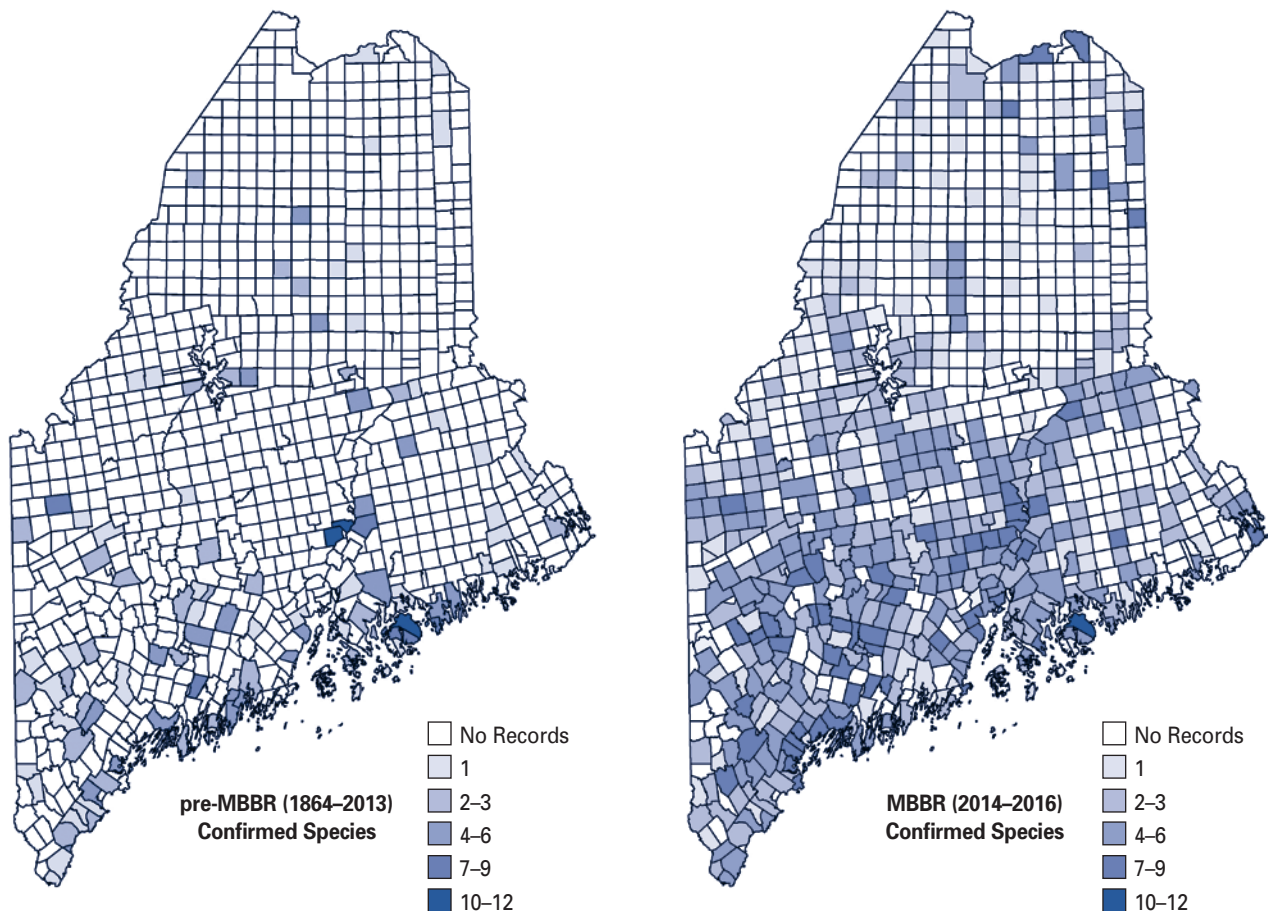
of the project. By the end of 2016, more than 2,430 individual sites visits have been conducted at 1,304 sites in nearly 500 Maine townships from all 16 counties. Fifty-six percent of our trained citizen scientists have contributed data to the project thus far.

Figure 1 is a comparison of bumble bee species distribution records in Maine from before MBBA began (1864–2013) and records collected for MBBA (2014 and 2016). Some records were collected in 2014 before the official start of the project. The maps clearly show how many more townships in Maine we have been able to reach using citizen scientists in just two years as compared to historical collections. The maps also show where there are gaps (e.g., western mountains, north, Downeast) that we can target during later stages of MBBA.

THE FUTURE OF THE MAINE BUMBLE BEE ATLAS

Results from MBBA have already contributed to RUSFWS species status assessments for the rusty-patched and yellow-banded bumble bees. As we enter the final two years (2018–2019) of MBBA, we hope to focus on and encourage collections in undersurveyed parts of the state so we have comprehensive, statewide species diversity and distribution data. One way we hope to increase participation in less surveyed areas is to hold our 2018 and 2019 training workshops in regions where we have received fewer vouchers. Another idea is to get in touch with organizations, such as conservation associations, libraries, and schools, in those areas to give public informational talks that may pique interest

FIGURE 1: **Historical Species Distribution Map (Left) Compared to Species Records Collected for MBAA from 2014 to 2016 (Right)**



in MBBA. Finally, although we do announcements for workshops through larger publications like the *Bangor Daily News* and the *Portland Press Herald*, a targeted series of articles in local publications may be more effective for these areas.

These data will be invaluable to MDIFW and its partners, including the US Fish and Wildlife Service, in assessing the status and conservation needs of all of Maine's bumble bee species and in promoting support for bumblebees and other native pollinators. In addition, we hope that the efforts put forth through the Maine Bumble Bee Atlas will spawn other related projects such as the Maine Pollinator Study being conducted by the Maine Department of Transportation and the Maine Island Bumble Bee Survey conducted by Bowdoin College. 🐝

ACKNOWLEDGMENTS

The *Maine Bumble Bee Atlas* is funded by grants from the U.S. Fish and Wildlife Service (State Wildlife Grant Program), the Maine Outdoor Heritage Fund (www.maine.gov/ifw/MOHF.html), and by contributions to the Maine Endangered & Nongame Wildlife Fund (Chickadee Check-off, Loon License Plate), and in-kind staff time contributions from the University of Maine.

ENDNOTES

1. More information is available on the USFWS website <https://www.fws.gov/midwest/endangered/insects/rpbb/>
2. More information on the status review for the yellow-banded bumble bee is available at the USFWS website <https://www.fws.gov/midwest/es/soc/Batch90DayMarch2016.html>
3. Maine Bumble Bee Atlas website: <http://mainebumblebeeatlas.umf.maine.edu/>
Facebook page: <https://www.facebook.com/MaineBumblebeeAtlas/> and
blog: <http://www.maine.gov/wordpress/bumblebeeatlas/>

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Kalyn Bickerman-Martens is a Ph.D. candidate in ecology and environmental sciences at the University of Maine. Her work focuses on the health of Maine's native bumble bees in wild blueberry fields and her research interests include parasitology, disease ecology, toxicology, and citizen

science and science communication.

Beth Swartz is a wildlife biologist with the Maine Department of Inland Fisheries and Wildlife and coordinator for the Maine Bumble Bee Atlas. She serves as the department's lead biologist on a wide range of invertebrate taxa, with recent efforts devoted to assessment and conservation of the Clayton's copper butterfly, rare freshwater mussels, rare mayflies, and bumble bees.



Ron Butler is a professor of biology at the University of Maine at Farmington, with research interests in behavioral ecology, community ecology, and conservation biology. During the past 30 years, he has worked on a variety of projects concerning the ecology and conservation of seabirds,

dragonflies, butterflies, and native pollinators. Butler helps coordinate three statewide citizen scientist initiatives: the Maine Damselfly and Dragonfly Survey, the Maine Butterfly Survey, and the Maine Bumble Bee Atlas.



Frank Drummond is a professor of insect ecology at the University of Maine. His training is in botany, entomology, and quantitative ecology. He has researched wild blueberry pest management, pollination, bee biology, blueberry genetics, blueberry physiological ecology, flower cold tolerance,

and food safety microbiology and its relationship to dung beetle diversity. His latest research project assesses means of enhancing roadsides to increase plant and pollinator diversity.