Final Report: Demonstration of Bumble Bee and Indicator Plant Gardens (Year 2)

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Summary:
In 2014, a demonstration bumble bee and indicator plant garden was established at the BC Cranberry Research Farm. The primary goal of this garden was to collect data to demonstrate potential options for growers with regards to enhancing pollination services from bumble bees. In 2015, we continued to collect data on flower visits by native bumble bees. The bumble bees we observed from March to September were from four species *Bombus mixtus, B. melanopygus, B. flavifrons, B. californicus* and *B. vosnesenskii* and included queens both in the early spring and late summer. The most visited plants in the garden in the spring were rhododendron (var. PMJ Compacta and Red Eye) and heather (var. Kramer's Red and Phoebe). For the late summer, post-cranberry bloom, catmint (var. Dropmore Blue and Walker's Low) had the most bumble bee visits. Several other species (sedum, lavender, and summer heather) also produced abundant blooms and were regularly visited by bumble bees. A secondary goal of the demonstration garden was to explore the potential of indicator plants to help time pest monitoring, especially for challenging pests like Dearness scale. In 2015, we observed that the timing of scale crawler sprays in Richmond continued to correspond to ceanothus bloom phenology. Further, the hatch of first generation blackheaded fireworm continued to correspond to bloom observed in wild elderberry.

Introduction and Objectives:
Previous studies have established that bumble bees and other native pollinators can provide pollination insurance to commercial agriculture (Kremen *et al*. 2002, Ricketts 2004, Greenleaf and Kremen 2006, Rao and Stephen 2009). In other words, an abundant pollinator community can supplement the pollination services provided by rented European honey bees (*Apis mellifera*). For cranberries, native pollinators may be especially important as previous work has demonstrated that pollination of cranberry flowers is most efficiently done by bumble bees (Ratti *et al*. 2008, Macfarlane and Patten 1997).

The abundance of bumble bees surrounding a commercial cranberry farm will depend on the proximity of the farm to nesting and food resources. But growers can also provide these resources to ensure bumble bee populations are maintained around their farms. In order to do this queens (and workers) need pollen and nectar sources both prior to cranberry bloom and after bloom (Williams *et al.* 2014). While bumble bees can potentially utilize any source of pollen and nectar, they have clear preferences for certain types of plants (Williams *et al.* 2014) and not all types of pollen are of equal quality for bee development (MacFarlane and Patten 1997). Plant material ideal for shelter includes bunching grasses for species that nest above ground and logs, abandon rodent burrows, and other materials that provide cavity and below ground nesters with shelter (Williams

et al. 2014). Information about building and establishing a bumble bee garden is widely available (e.g. Earthwise Society 2012) but applying this information to commercial agriculture is not straightforward.

In 2014, a small (2 m X 20 m) bumble bee demonstration garden was established at the BC Cranberry Research Farm site in Delta, BC. We observed that many of newly planted species, that bloomed prior to cranberries, did not attract many bumble bees overall. In contrast, several of the post-cranberry bloom species had long bloom periods and were visited by bumble bees during all weeks of bloom (Fig. 1). Of these, the species that established quickly and were drought tolerant were Catmint (var. Dropmore and Walker's Blue), Sedum (var. Autumn Joy and Cherry Tart) and Heather (var. Flamingo). We also compared the timing of pest activity at nearby cranberry farms to the bloom phenology of the garden plants in order to identify potential indicator plants for cranberry pests. In 2014, we observed that the timing of bloom events for campanula, ceanothus and callicarpa correspond to Dearness scale crawler emergence (at Richmond farms) and cranberry fruitworm egg laying (at Delta farms).

The goals of the 2015 project were to continue the work started in 2014. Specifically, we continued to make observations of bumble bee activity in the demonstration garden, in the adjacent blackberry hedge and in the cranberry field. We also compared bloom phenology of bumble garden plants to pest activity at the research farm or at nearby farms.

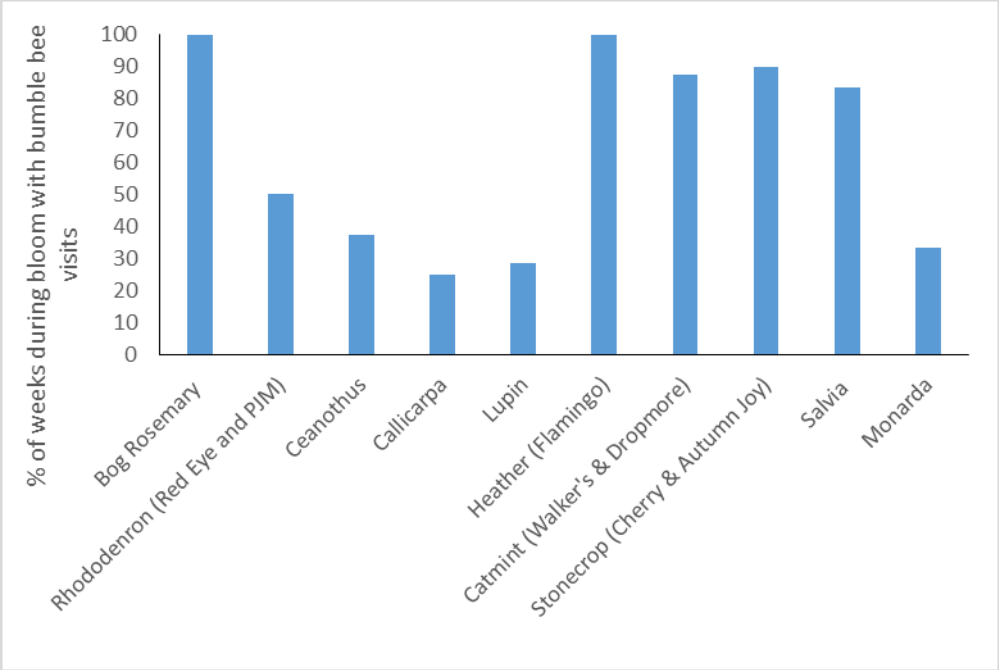

Figure 1. Summary of bumble bee visits to the different demonstration garden species in 2014. Data show the % of weeks during the bloom of each species when there was also at least one bumble bee visit observed.

Methods

Maintenance: In early April the garden was fertilized with granular fertilizer (5-10-5) sprinkled over the surface of the entire garden and around fine root zone of larger Rhododendrons. We did not do any fall or spring care of the perennials – in particular the recommended practice of pruning back stems – because the hollow stems of many perennials can provide nesting sites for other native pollinators. We observed that a few plants did not survive the 2014-2015 winter and these were removed and replaced with species that did survive the winter and are early bloomers (Rhododendrons and winter heathers). The garden was weeded thoroughly in late May and early September. The demonstration garden was only watered once during the 2015 field season in early-August.

Observations and Data Collection: Bumble bee activity in the demonstration garden was observed weekly from March 7 to September 23, 2015. The total number of bee visits to each of the different plant species during a continuous 15-minute interval was recorded. As our objective was to determine which plants were visited by bumble bees we recorded an individual bumble bee multiple times if different species of plants were visited during the 15-minute interval. During the 15-minute interval a single observer walked back and forth along a 10-m portion (i.e. East or West half) of the garden and observed all the plants in the 10-m long X 2-m wide portion. In addition to bumble bees we also recorded the activity of other pollinators, such as honey bees, syrphid flies, mason bees and solitary bees. Observations were done between 10 am and 5pm and not during heavy rainfall or showers. Weather conditions during our observation period were also recorded.

Bumble bee activity in the closest cranberry field (Field 1) was also recorded during cranberry bloom (May 22 to June 23**)** and in the adjacent margins of the research farm site when blackberries were in bloom (May 22 to June 30). We flagged out our observation area in the cranberry field to approximately the same dimensions covered in a 15-minute observation period (2 m X 10 m). For each observation in the cranberry fields we pre-selected areas based on amount of bloom, thus we made observations in different areas each week. For farm margins we flagged out 10-m long transects along the East margin, adjacent to Himalayan blackberry bushes. As with the demonstration garden timed our observations along the margin and in the cranberry field for 15-minute intervals and recorded all pollinator activity in the observation area. Once a month a few bumble bees were collected, identified on site and then released. We excluded *Bombus huntii* from our data collection as these were introduced via two commercial hives on June 2. *Bombus huntii* were not among the native species observed at the research farm in 2014 or during 2015 (see below). There were no European honey bee hives at the research farm in 2015.

Results and Discussion

In 2015, we observed that the late winter and early spring activity in the bumble bee garden was much higher than in 2014 (Fig. 2A and B). This is because the plants were established and blooming this year but were only newly planted last year. Also there was a month more of observation in 2015 than in 2014. We were able to do a total of 19 pre-

bloom observations in 2015 compared to only eight in 2015. The most visited early blooming species in 2015 were rhododendron (var. PMJ Compacta and Red Eye), heather (var. Kramer's Red and Phoebe) and blueberry (var. Early Blue). In contrast, bog rosemary, skimmia, and ceanothus were the least visited (Fig. 2B). Further, bog rosemary did not survive the winter well, and the skimmia and the blueberries did not tolerate the drought stress and grew poorly during 2015. The bumble bee species we most commonly observed in the early spring were *Bombus mixtus* and *B. vosnesenskii*, including queens. These are among the species found to be active in cranberries by other studies (Ratti *et al*. 2008, Macfarlane and Patten 1997).

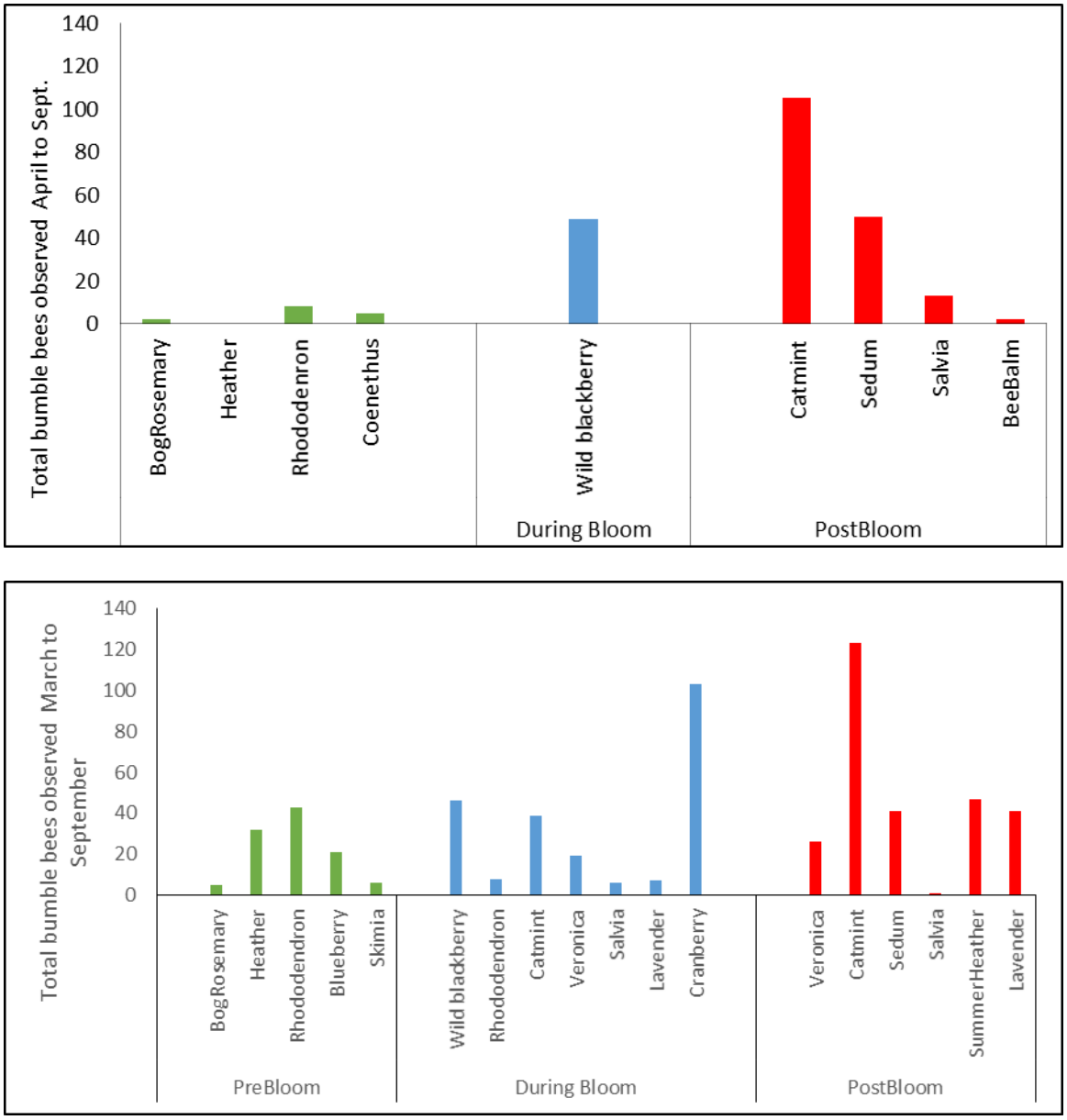

Figure 2. A (top) Total bumble bee visits to the different demonstration garden species in 2014 (planting year) and B (bottom) 2015. Demonstration garden located in Delta, BC.

In 2015, we did not remove any blossoms in the demonstration garden during cranberry bloom because we wanted to see if the small amount of bloom was really distracting bumble bees from the cranberry field. Our observations indicate that bumble bees were the most active in the cranberry field during cranberry bloom (Fig. 2B). Catmint and veronica were the two garden species that bloomed when cranberries bloomed and some growers may want to trim these back during bloom to reduce competition with cranberry flowers. Growers may want to consider managing wild blackberries that grow adjacent to commercial bogs, as both bumble bees (Fig. 2B) and honey bees (data not shown) were observed. It is important to note that the amount of blackberry growing at the research farm is relatively small compared to what has been observed surrounding some commercial fields. Although competition for pollinators may reduce the pollination on cranberries, it is important to note that bumble bees need a diversity of floral species and not just high densities of one type of flower (Jha and Kremen, 2013). So a small amount of other species blooming at the same time as cranberries may further promote a stable native pollinator community. We observed individuals from several common bumble bee species including *B. mixtus, B. melanopygus, B. flavifrons, B. californicus* and *B. vosnesenskii* as well as *A. mellifera* and *B. huntii* in the cranberry field, blackberries and demonstration garden.

Post-cranberry bloom activity in the demonstration garden was slightly higher in 2015 than in 2014 (Fig. 2A and B). Again, this is most likely because plants were well established. However, there were slightly more post-bloom observations intervals in 2014 than in 2015 – 30 versus 22 observations in 2015. The abundant cranberry bloom at the farm in 2015 may have attracted more bumble bees overall to the site than in 2014. The most visited species continued to be catmint (var. Dropmore Blue and Walker's Low). Both varieties were drought tolerant, established well, and continued to bloom for a very long period of time (June through to September). Additional pruning may further enhance bloom for catmint, but as with all plants in the demonstration garden there was minimal maintenance. Lavendar (var. Hidcote), summer heather (var. Flamingo) and the sedums (var. Autumn Joy and Cherry Tart) were visited equally throughout the post-cranberry bloom period. All of these species bloomed through August and September, thus providing floral resources for new queens. Some of the post-bloom species that performed poorly in the demonstration garden include monarda (Bee balm), salvia (var. Rose Queen), and campanula (Peachleaf bellflower). Again, growers may have better success with these species (same or different varieties) under different soil and watering conditions. We continued to observe bumble bees from the four species observed previously *B. mixtus, B. melanopygus, B. flavifrons, B. californicus* and *B. vosnesenskii* including queens through September.

The second proposed use of the plants in the bumble bee garden would be as indicator plants to forecast the activity of cranberry pests. The timing of first bloom, 50% bloom or 95% bloom of ornamental plants are used as an efficient method to time insect control activities for ornamental and landscape IPM (Frank 2010, Mussey and Potter 1997). Indicator plants do not replace monitoring, however they can be a tool to help time monitoring and if needed control for timing sensitive pests. In 2014 the timing of Dearness scale, cranberry fruitworm and blackheaded fireworm activity seemed to

correspond to bloom phenology for the planted species campanula, callicarpa and ceanothus, and wild elderberry (Table 1). However, in 2015 campanula and callicarpa did not perform very well with overall low survival of plants and poor bloom. Ceanothus bloom (50%) was observed on May 26 at the research farm and Dearness scale crawler emergence sprays were recommend for Richmond farms on May 23. The first cranberry fruitworm eggs were observed at the research farm on June 23 but unfortunately callicarpa did not tolerate drought and had low blooms. We also suspect that egg laying may have been a week earlier at the research farm. Salvia and lavender were at 50% bloom during these two weeks. For blackheaded fireworm, first generation hatch at the research farm was observed on April 14, which again seemed to correspond to 50% bloom of the elderberry bushes growing at the site.

Table 1. Observations of potential indicator plant and cranberry pest pairings, based on 2014 field season and pest activity at adjacent commercial cranberry farms.

Pest	Phenology and date	Plants	Phenology and date
Scale	Crawler emergence – June 5 (Richmond)	Campanula	First bloom – June 5
Scale	Crawler emergence – June 5 (Richmond)	Ceanothus	50% bloom – June 5
Cranberry fruitworm	Start seeing eggs on berries- June 23 (Delta)	Callicarpa	25% bloom – June 24
Blackheaded fireworm	First generation hatch – April 23 (Delta)	Elderberry (growing at BC Cranberry Research Farm)	50% bloom April 24

Recommendations

Based on the experience at the demonstration garden, the species (and varieties) that can be recommended to cranberry growers for bumble bee gardens at their own farms are those that established within a year of planting and appear to be drought tolerant. The early blooming species which provide resources for bumble bee queens as they become active in the late winter/early spring include rhododendron (var. PMJ Compacta and Red Eye) and heather (var. Kramer's Red and Phoebe). The recommended late blooming species that provide resources for new queens, ensuring sufficient resources to survive the winter, include catmint (var. Dropmore Blue and Walker's Low), lavendar (var. Hidcote), summer heather (var. Flamingo) and sedum (var. Autumn Joy and Cherry Tart).

Now that the garden is established, we do not see the need for additional funding to collect data on bumble bee activity. We recommend that information on bumble bee activity still be collected but as part of the regular weekly monitoring activities that happen at the research farm. Allocating 20 minutes each week for data collection and weeding would be sufficient to ensure that the garden remains attractive and continues to provide current information. Extension of this information to growers can be included in

the regular research farm updates that are provided via industry newsletters. Maintenance of the garden should consist of a yearly application of slow release granular fertilizer in the early spring; and removal of any dead plants and replacement with species that perform well at this site. We also recommend a regular application of compost or other types of mulch in the spring as a way to improve soil quality, retain soil moisture, and minimize weeds.

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