Native Willows as a Habitat Management Tool for Building Bee Pollinator Communities in Blueberry Fields

Don Ostaff, Alex Mosseler and John Major

Wild blueberries (*Vaccinium angustifolium*) are a major agricultural crop and economic driver for eastern Canada, with acreages expanding annually and a market value in excess of $56 million. Wild blueberry plants are essentially insect-pollinated and pollination by bees is critical for good fruit set and high yields. Most berry producers use honeybees (*Apis mellifera*) to augment native pollinators, as they can provide excellent pollination service for blueberries. However, increased berry production coupled with mounting management challenges with honeybees (e.g., new parasites, viruses and diseases) and general hive shortages, means additional strategies are desirable to sustain optimal pollination. Thus, there is increasing interest in conserving and promoting native pollinators for crop production. In wild blueberry, native bees are often more efficient pollinators than honey bees and tend to cope better with poor spring weather that is common in the Maritimes. At the same time, wild native bee populations have been declining due to loss and degradation of nesting sites and floral resources, landscape fragmentation, intensive agronomic and monoculture practice, displacement of native floral hosts by exotic plants, use of pesticides, decimation of host plants by high deer populations, and loss of open habitats due to suppression of fires and other checks to forest succession. Maintaining or supporting diverse wild pollinator populations is important to a broad range of agricultural crops for which honey bees alone may not be sufficient to maximize pollination and associated fruit and seed set.

There is surprisingly little data demonstrating the usefulness of habitat management for building natural and native bee communities that benefit crop production. We propose to build on existing relationships with berry growers to test the hypotheses that planting of native willows (*Salix* spp.) around wild blueberry fields can increase the diversity and abundance of native pollinators within and adjacent to the crop and, thereby, significantly increase natural pollination and fertilization success of blueberry flowers. Willows have many attributes that make them an ideal choice for enhancing native bee populations. They are fast-growing, propagation is easy and economical, they flower early and prolifically, and they are easily managed and adapted to a wide range of nutrient, moisture and climatic conditions. Willows provide excellent forage for bees (Ostaff et al 2015) and have highly palatable foliage that is useful to leafcutter species (Megachilidae), thereby supporting a rich diversity of pollinators. There are very early- and late-flowering willow species, allowing flowering phenology to be precisely tailored around the flowering phenology of the fruit crop of interest. The addition of native willows to landscapes being developed for blueberry production provides an off-season food supply of pollen and nectar for the promotion of resident pollinator populations. The objective of this study is to establish willow

populations in blueberry fields; determine the diversity and abundance of native pollinators foraging on these willows, and their ability to forage on and serve as effective pollinators of blueberry.

Rooted cuttings of willow seedlings from *Salix cordata* (COR), *Salix discolor* (DIS), *Salix eriocephala* (ERI) and *Salix viminalis* (VIM) were planted on 13 and 21 June, and on 5 July 2016 at four separate sites in blueberry fields belonging to John Schenkels (Figure 1A-D). The planting design allowed for future testing of willow species survival and development, the enhancement of blueberry pollination by these willows, and development of associated insect-pollinator communities.

The diversity and abundance of native insect species were monitored by trapping with colored cup traps and assessing foraging on flowers, both blueberry and other flowering plants in and around the four willow sites. Trapping was conducted during a 10-day period at the beginning of each month from June to September. At each visit to the blueberry fields, a 15-minute cruise was carried out at all willow planting sites. All flowering vegetation was carefully documented and insects foraging on them were either identified visually, i.e., *Bombus ternarius* and *Apis mellifera* are easily identified by their body coloration pattern, or collected using a hand-held battery operated vacuum aspirator. Collected pollinators were then stored in alcohol and returned to the lab for subsequent identification. Insect collections or observations were separated as to the flowering shrub that it was foraging on. In addition to 15-min cruises in and around willow planting sites, three blueberry fields were selected and any insects actively foraging on blueberry flowers were identified or collected for later identification.

A total of 1026 willow stem cuttings were planted on four sites. No willow mortality was noted on 21 June, nine days after establishment, but some limited mortality was observed on 5 July. On 5 August survival of seedlings ranged from 93% to 100%. At Site 1, COR was growing the best in height and vigor. At Site 2, a very dry blueberry field, the leaves appeared dried out and plants were just hanging on. Here, ERI and COR were doing the best. Good survival was observed at Site 3. Despite very heavy herbaceous competition at Site 4, survival was the best of all sites due to abundant moisture availability. By the end of the season (early October), it was common to see seedlings reaching a height of >45 cm (Figure 2).

In 2016, 527 bees (493 females and 34 males) belonging to four families (Halictidae – sweat bees; Apidae – carpenter, cuckoo, digger, bumble and honey bees; Andrenidae – ground-nesting bees; and, Colletidae – plasterer bees) were collected in colored traps on sites planted with willows with sweat bees representing 61% of the collection; Apidae 35%, Andrenidae 4% and Colletidae <1%. Trap collections of bees were fairly consistent during the summer months, however some bees were more common during particular months, e.g., *Andrena* spp. in May; *Bombus impatiens* and *Lasioglossum* spp. in July; *Lasioglossum* (*Dialictus*) spp. from May to July; and, *Bombus ternarius* in August and September. Thirty-five percent of all female bees were collected during May and June, the period during which blueberry

flowers were available for pollination. The majority of *Andrena* spp., the genus of native bees of particular interest to our study (Figure 3) were collected in May and June.

Fifteen different flowering species plus *Solidago* spp. were identified on the willow-planted sites. However, bees were observed or collected foraging on nine of these with spreading dogbane, *Solidago* spp., fireweed, flat-top goldenrod, burnweed, sheep laurel and pink spiraea being the most common flowering plants visited by foraging bees.

Cruises through blueberry fields during the presence of blueberry flowers showed, as expected, the majority of insects observed or collected were *Apis mellifera* (54%) and *Bombus impatiens* (27%). In addition to these two imported species, *Andrena* spp. (6%), *Bombus ternarius* (5%), and insects belonging to Syrphidae (5%) and Bombyliidae (2%) were also found.

The early success of willow establishment, good height growth and vigor, and the observation of *Andrena* spp. foraging on blueberry flowers is encouraging, showing promise that planting willow could serve as an excellent management tool for blueberry growers. In our study, *Andrena* spp. were collected before blueberry flowers were available and after blueberries ceased flowering as well as during the flowering period. *Andrena* use low-bush blueberry as a major pollen source and have been shown to have the highest average pollination percentage of pollen-harvesting bees (95%), along with *Bombus* spp., which are limited in number in spring when only queens are present. Similarly, our study shows that the highest number of *Bombus ternarius*, the most common *Bombus* species, was collected after blueberry ceased flowering and those collected in traps or observed foraging on blueberry earlier in the spring, as well as, other *Bombus* species were all queens.

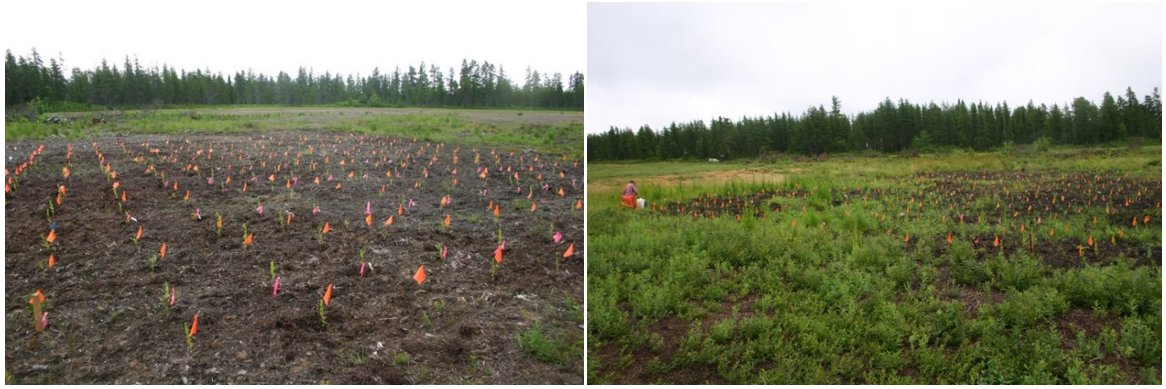
Except for imported honey bees and the bumble bee *Bombus impatiens*, a limited number of species were observed foraging on blueberry flowers. However, the presence of *Andrena* is encouraging to our study. Syrphidae (flower flies) may also be important pollinators of blueberry. Ostaff et al. (2015) showed that flower flies were common visitors to male willow flowers. Flower flies require protein-rich pollen to produce reproductive tissues and the carbohydrate-rich nectar to power flight and other activities and may also play an important role in the pollination of blueberry.

The provision of well-adapted native willow species in these landscapes not only provides an important vernal food source but encourages nest initiation close to crops, enhancing native pollinator availability when blueberries begin to flower. Increasing both *Andrena* spp. and flower fly populations should benefit the pollination of low bush blueberries.

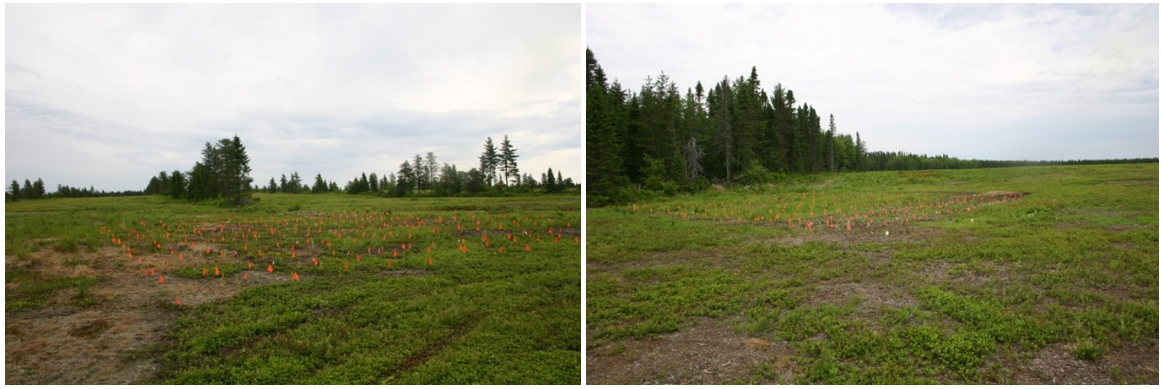
References

Ostaff, D.P., Mosseler, A., Johns, R., Javorek, S., Klymko, J., and Ascher, J.S. 2015. Willows as a source of pollen and nectar for insect pollinators of agricultural crops. Canadian Journal of Plant Science **95**: 505-516.

Figure 1. Study sites planted with four species of native willows (*Salix* spp.): site 1 after planting (A) and mid-season (B); sites 2 and 4 (C), showing the drier site 2 in foreground; and, mid-season site 3 (D).



(A) (B)



(C) (D)

Figure 2. Mid-season growth of *Salix cordata* at site 1.

Figure 3. *Andrena* sp. collecting nectar from a female willow catkin. Note the large pollen accumulation on the hind legs.