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# BEST MANAGEMENT PRACTICES GUIDE FOR HONEY BEE POLLINATION OF WILD BLUEBERRIES IN ATLANTIC CANADA

Prepared by the Atlantic  
Tech Transfer Team for  
Apiculture

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In collaboration with Perennia Food and Agriculture, the Government of Canada, the Canadian Agricultural Partnership, the Government of New Brunswick, the Government of Nova Scotia, the Government of Prince Edward Island, the New Brunswick Beekeepers Association, the Nova Scotia Beekeepers Association, the Prince Edward Island Beekeepers Association, Bleuets NB Blueberries, the Wild Blueberry Producers Association of Nova Scotia and the Prince Edward Island Wild Blueberry Growers Association.

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Wild blueberries



## FORWARD

Wild blueberries are one of the approximately 130 food crops in modern agriculture that rely on pollination by honey bees for production. Pollination services have significant impacts on the ultimate harvest value of a crop. Agriculture and Agri-Food Canada estimate the contribution of honey bee pollination to total harvest value by considering the crop's annual value, the crop's dependency on insect pollination and the proportion of that crop's pollination which is done by honey bees. In 2021, honey bees contributed to \$3.18 billion in additional harvest value of Canadian agricultural crops<sup>1</sup>. When hybrid canola seed is included, the value increases to approximately \$7 billion. By the same measure, honey bees contributed to \$280 million of the total harvest value for Canadian blueberries. Exceeded only by canola seed, honey bees contribute more to the total harvest value for blueberries than any other crop. As such, blueberry pollination is a major driver in the growing demand for honey bees.

In Atlantic Canada, wild blueberry producers and beekeepers work together to create a vibrant pollination industry. Cooperation and mutual gain between these partners will facilitate sustainable industry growth. In support of this, the Atlantic Tech Transfer Team for Apiculture (ATTTA) has engaged in applied, regionally appropriate research towards improving wild blueberry pollination using honey bee colonies. This guide reflects that research and other relevant information intended to provide best management practices for optimizing honey bee pollination of wild blueberries in Atlantic Canada.

## HOW TO USE THIS GUIDE

This guide provides a summary of best management practices for optimizing honey bee pollination services for wild blueberries in Atlantic Canada. Unless otherwise specified, Atlantic refers to the three Maritime provinces almost exclusively, and Maritime and Atlantic are used interchangeably throughout. The guide refers to the Atlantic region because Newfoundland and Labrador has the potential to contribute more significantly as the industry develops in the province. This guide is a compilation of ATTTA research results and supplementary information intended as a reference document for wild blueberry producers and beekeepers.

The guide is organized into sections based on relevant industry sectors. The first section introduces the wild blueberry and honey bee pollination industry in Atlantic Canada and discusses best practices around communication between these partners. Section two concentrates on pollination best management practices from a beekeepers perspective. Major topics include honey bee health and biosecurity, nutrition and hive strength. In section three, the focus shifts to wild blueberry management. The major topics in this section are stocking density, optimal timing of hive placement and hive movement during pollination.

The contents of this guide can be read in isolation, for focused guidance, or in completion, to explore the broad scope of pollination management. As a partnership, it is valuable to understand pollination services from the perspective of both the beekeeper and the blueberry producer. This guide is intended to progress that cooperation. Key messages are summarized at the end of the guide, followed by links for additional resources and references.

**The objective of this guide is to provide beekeepers and wild blueberry producers with information on best management practices to help facilitate efficient, sustainable pollination of wild blueberries using honey bee colonies.**

## SECTION 1: POLLINATION INDUSTRY

### POLLINATION IN ATLANTIC CANADA

Pollination in Atlantic Canada is a significant aspect of the region's agricultural industry, specifically as it relates to wild blueberry production. Some recent figures demonstrate this significance. In 2020, wild blueberries (*Vaccinium angustifolium* Aiton) were Canada's most economically significant fruit crop. The Maritime provinces contributed to 52% of this production. The nation produced 71,290 metric tons of wild blueberries, which equates to a farm-gate value of over \$112 million and an export value of over \$312 million<sup>2</sup>. Nova Scotia leads the region in both the number of beekeepers and colonies, with 890 beekeepers and 24,858 colonies reported to the provincial apiarist in 2022. The same year, New Brunswick reported 513 beekeepers and 14,306 colonies. To date, there is no regulatory obligation to register as a beekeeper in Prince Edward Island. However, a recent report from the provincial apiarist estimates that there are approximately 50 beekeepers and 6,500 colonies in the province. Newfoundland and Labrador does not contribute significantly to the wild blueberry industry in Canada<sup>2</sup>. A growing industry, the provincial apiarist estimates that there were 16 commercial beekeepers in 2022; however, like Prince Edward Island, Newfoundland beekeepers are not required to register with the government.

An entomophilous plant species, cross-pollinating wild blueberry species depend on insects for pollination. This means that the region's productive capacity is, in part, dependent on this biological relationship. Wild pollinators, such as bumble bees (*Bombus* spp.), *Andrena* bees, and halictid bees, contribute significantly to pollination but simply do not have the population abundance to meet the demands of modern, high-production agriculture. Fortunately, honey bees present a practical alternative.

Managed honey bees (*Apis mellifera* L.) can be supplied to production fields for organized pollination services. Though not native, their generalist-style foraging behaviour allows honey bees to utilize a wide range of floral sources for sustenance, including wild blueberry. Moving between flowers, honey bees inadvertently transfer pollen and initiate floral fertilization. Furthermore, where many native pollinators of wild blueberries are solitary, honey bees are social insects living in populous colonies. Single honey bee colonies are comprised of tens of thousands of individuals. In comparison, bumble bees (*Bombus* spp.) are social, native pollinators typically living in colonies of 100 individuals or fewer<sup>3</sup>. When brought to a field for pollination, honey bee colonies vastly increase the number of available pollinating insects.

**Through generalist foraging behaviour and abundant populations, managed honey bee colonies are effective pollinators of wild blueberry fields.**

Coordination between wild blueberry producers and local beekeepers has contributed to significant developments in the Maritime wild blueberry industry. Still, honey bee imports from out of the region remain necessary. The importation of honey bees is controlled by strict provincial regulations related to biosecurity concerns, which are elaborated on in the Honey Bee Health and Biosecurity section of this guide. With the current high demand for colonies and restricted capacity for importation, harnessing the collective potential of our regional pollination workforce is vital. The key to this is optimizing the use of our existing pollinating units. This guide is intended to offer research-based recommendations for improved pollination efficiency in Atlantic Canada.



Honey bee on a wild blueberry flower

## SECTION 1: POLLINATION INDUSTRY COMMUNICATION

Successful pollination of wild blueberry flowers is best supported by a professional relationship between beekeepers and blueberry producers. Essential to this relationship is ongoing communication. To help establish new partnerships, there are programs to facilitate connections between beekeepers and blueberry producers. Provincial beekeeper and wild blueberry producer associations are also great resources for connecting new entrants. For example, the New Brunswick Beekeepers Association connects these industries through “The Bee Yard” platform on their association website. Reach out to your association and refer to the resources section at the end of this guide for more information.

**Rental commitments for pollination services should be established at least one year in advance of pollination requirements through a written contract.**

Establishing needs well ahead of time will contribute to each season’s optimal production. Beekeepers need at least one full beekeeping season to increase hive numbers in response to market demand. Beyond this, in a progressive pollination relationship, long-term plans for expansion can be organized to support mutual growth and benefit.

All expectations of pollination services should be addressed in a written contract. The following sections of this guide provide detailed guidance for more technical aspects of this agreement, such as appropriate stocking densities, the timing of placement and establishing a hive strength standard. However, management details surrounding these major decisions must also be considered to ensure optimal pollination services. For example, parties must consider where exactly hives will be placed and how fields can be accessed. This is important to establish ahead of time, as hives should be deployed during the night while colonies are at rest. GPS technology is a useful resource in coordinating hive placement. Once placed, honey bee colonies are vulnerable to bear attacks. It is imperative to discuss who will set up protective bear fencing during pollination services and what will happen if an attack occurs.

### Considerations in a pollination contract:

- Number of colonies required
- Price per colony
- Timeline of hive placement and removal
- Percent bloom at time of placement
- Arrangements for hive movement
- Hive location in the blueberry field (e.g. GPS coordinates)
- Responsibility for protective bear fencing
- Hive strength standard
- Hive inspection
- Agrichemical use
- Implications of extreme weather events (e.g. frost)

Hive inspection entitlements and arrangements should be made in conjunction with the established hive strength standard. It is possible, for example, to have a third party provide colony inspections if this is agreeable to both parties.

Agrochemicals on wild blueberry fields can have health implications for honey bees, and pollination contracts should address their use during the pollination period. If a producer must apply pesticides which may harm honey bees, the beekeeper should be notified 48 hours prior. Compensation for costs associated with necessary hive relocation should be negotiated in the contract. The Lowbush Blueberry Pesticide Guide can be a valuable resource in this conversation.

As honey bees are managed pollinators, beekeepers and blueberry producers can be coordinated so that pollination services occur in optimal conditions for all parties. Find links to sample pollination contracts in the resources section of this guide.

## SECTION 1: POLLINATION INDUSTRY

### COMMUNICATION

#### Hive placement for pollination

- Ensure field access for placement and removal (e.g. gates)
- Choose an area with adequate drainage that receives direct sunlight
- Allow easy access to trucks for loading and unloading colonies
- Avoid close proximity to high density residential area
- Orient hive entrances to face fields and facilitate flight paths away from infrastructure
- Space hives irregularly to reduce drift
- After placement, do not move colonies less than 5km

Remember that communication between beekeepers and blueberry producers should extend beyond individual partnerships. Industry-wide communication via networking and information sharing will enable sustainable progress. This could be done, for example, at collaborative meetings and through extending invitations for association meetings to the wider community.

**Best Practice:** Establish clear expectations through a written pollination contract between the blueberry producer and beekeeper.

#### Key Points for the Pollination Industry

- » *Through generalist foraging behavior and abundant populations, managed honey bee colonies are effective pollinators of wild blueberry fields*
- » *Rental commitments for pollination services should be established at least one year in advance of pollination requirements through a written contract*



Honey bee colony



## SECTION 2: BEEKEEPERS

### HONEY BEE HEALTH AND BIOSECURITY

Beekeepers have a responsibility to maintain healthy honey bee colonies. The practice of managing a beekeeping operation to restrict the introduction and spread of disease-causing pests is referred to as biosecurity<sup>4</sup>. Honey bees present a biosecurity situation unique from other livestock because they have the freedom to roam and interact with other bees and apiaries.

**The health of the honey bee industry in Atlantic Canada depends on the participation of every beekeeper.**

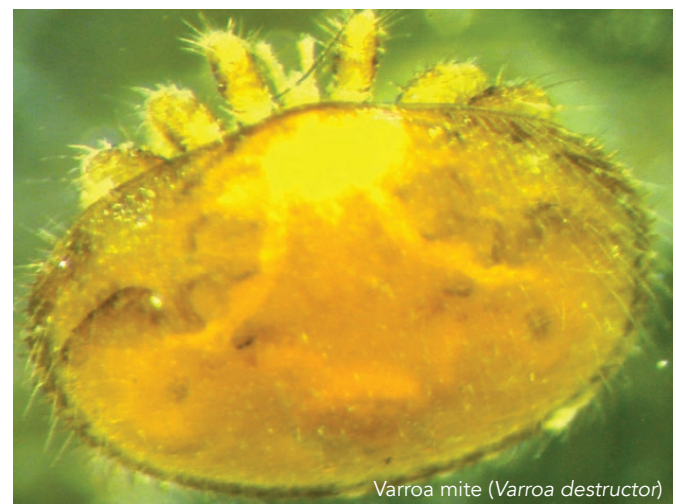
#### Beekeeping Biosecurity Practices

- Obtain bees from reliable sources with documented health records
- Maintain strong colonies
- Inspect hives regularly
- Anticipate treatment options in consideration of Integrated Pest Management
- Minimize contact between colonies
- Scorch used hive equipment before reuse
- Maintain clean equipment and tidy apiaries
- Keep records
- Train employees around best practices

Some biosecurity practices are not optional. For example, there are national and provincial protocols for moving bees. Moving bees across regions accelerates the introduction and spread of harmful pests. Furthermore, migratory beekeeping for pollination facilitates co-mingling of hives from different apiaries and presents an opportunity for pests and diseases to move easily between colonies. To reduce the risk, hive movement between provinces is strictly regulated.

Newfoundland and Labrador has extremely restrictive legislation regarding the importation of all honey bees and bee products, such as drawn comb, in an effort to maintain their exceptional Varroa-free status.

**It is not possible to import honey bees and bee products into Newfoundland and Labrador for typical beekeeping purposes.**



Varroa mite (*Varroa destructor*)

Nova Scotia has highly limited honey bee importation, as well. Importation of hives includes temporary movement, for example, during wild blueberry pollination. Beekeepers are permitted to import queens and packages of bees from outside of the country from approved sources only following application and inspection requirements. Queen importations from other Canadian provinces are permitted when sourced from NS Department of Agriculture approved breeding programs and after inspection by the Provincial Apiarist. Additionally, in Nova Scotia, importation of full-sized and nucleus colonies can only come from Newfoundland and must prove to be free of restricted honey bee pests and disease.

Compared to Nova Scotia and Newfoundland, there is more opportunity to import honey bee colonies and equipment into New Brunswick and Prince Edward Island, in accordance with inspection and movement criteria. Both provinces review the importation protocols for honey bees annually, and the permit requirements are amended each season according to current biosecurity threats. See the resources section of this guide for links to current provincial guidelines for honey bee importations. With protocols changing annually, it is important to be sure you are up to date on current requirements and protocols for each province prior to hive movement. Furthermore, the criteria for moving hives temporarily or permanently may vary between provinces.

## SECTION 2: BEEKEEPERS

### HONEY BEE HEALTH AND BIOSECURITY

**A permit must be obtained from your provincial apiarist prior to moving honey bee colonies and beekeeping equipment interprovincially.**

Biosecurity practices are applied at different scales within beekeeping. Beekeepers should be aware of the risks that exist working between hives, between apiaries and between operations. Reducing risk at the lowest level – between honey bee colonies – will have resounding impacts. For example, maintaining clean apiaries and minimizing contact between colonies will help to slow the spread of harmful pests between hives. This will then reduce risks between apiaries and between operations. Regular hive inspections and the knowledge to recognize pests and diseases are essential. Certain pests and diseases must be reported to your provincial apiarist if detected (e.g. American Foulbrood disease). Beekeeping courses and membership in provincial beekeepers associations can be a valuable resource for biosecurity education and regional updates.

Honey bee biosecurity is best supported by diligent integrated pest management (IPM). IPM involves regular monitoring for pests and diseases as well as using a variety of pest control strategies. For example, replacing brood comb every three to five years will suppress the accumulation of harmful pathogens and toxins in beeswax. Alternating between different chemical treatments against Varroa mites will help maintain product efficacy. Always follow label instructions for treatments! There are educational resources at the end of this guide on general aspects of biosecurity to help users develop a beekeeping IPM strategy.

Integrating biosecurity into your management practices will support stronger colonies with a more vigorous capacity for pollination and honey production, reduce overwintering losses, reduce treatment costs, and slow the timeline of pest resistance to synthetic chemical treatments.

**Best Practice:** Incorporate biosecurity into beekeeping management to support strong colonies.



Honey bee foraging on a dandelion flower

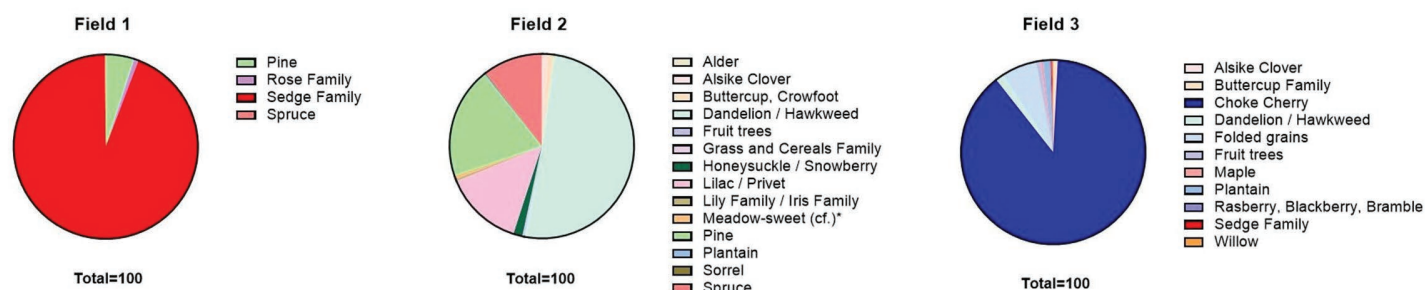


## SECTION 2: BEEKEEPERS

### HONEY BEE NUTRITION

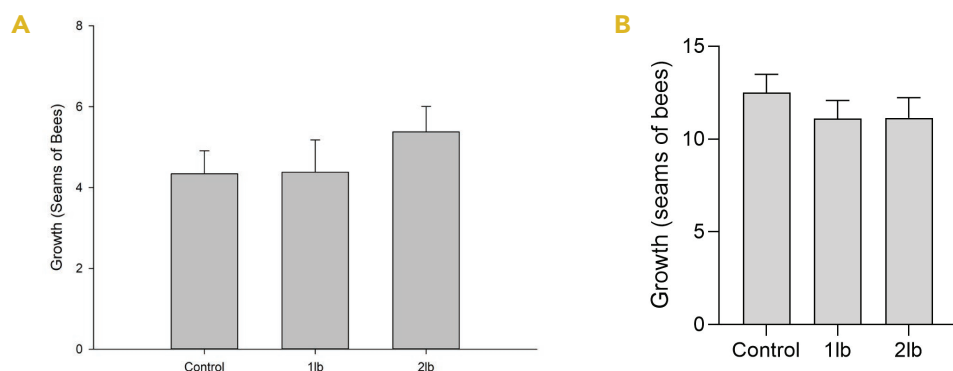
Honey bee nutrition is best supported by a poly-floral diet of high-quality pollen<sup>5</sup>. Three years of ATTTA pollen sampling from honey bee colonies placed on wild blueberry fields during pollination demonstrated that pollen availability is impacted by individual field conditions. As shown in figure 1, wild blueberry fields surrounded by a diversity of land use, such as agriculture and residential area, offered a variety of pollen sources to honey bees and greater potential to fulfil their dietary needs. On the other hand, vast blueberry fields enveloped in conifer forests offered fewer, less varied sources of pollen for foragers. The distance that honey bees travel to access pollen must also be taken into account, as long distance foraging is energy taxing and can negatively impact colony health<sup>6</sup>.

**Fields should be individually assessed to determine natural forage sources available to honey bees placed on wild blueberry fields for pollination.**



**Figure 1.** Pollen types identified from traps placed on hives for 24 hours during wild blueberry pollination. Field 1 represents a ~557-acre field in New Brunswick surrounded by forest. Field 2 was a ~127-acre field in Nova Scotia surrounded by residential area, wetland and agriculture. Field 3 represents pollen sources identified from a typical Nova Scotia honey yard at the time of wild blueberry pollination.

Placing pollen traps on a subset of honey bee colonies is a technique to indirectly assess pollen sources available to honey bees at a given point in time. After collecting pollen for 24 hours, cleaned samples can be sent for laboratory analysis. Alternatively, knowledge of local land-use around blueberry fields can provide limited insight into the pollen sources available to honey bees. Forage assessments can then guide management decisions to support colony nutrition. For example, fields offering low forage variety could be augmented with supplemental flower strips. The Pollinator Partnership has created regional planting guides to support pollinators. See the resources section for links to these helpful publications.



**Figure 2.** Growth of honey bee colonies placed on wild blueberry fields during the pollination period. Pollen patties were fed to colonies at the onset of pollination. A) Based on 54 colonies used for wild blueberry pollination in Colchester County, Nova Scotia, in 2019. B) Based on 60 colonies used for wild blueberry pollination in Cumberland County, Nova Scotia, in 2020.

## SECTION 2: BEEKEEPERS

### HONEY BEE NUTRITION

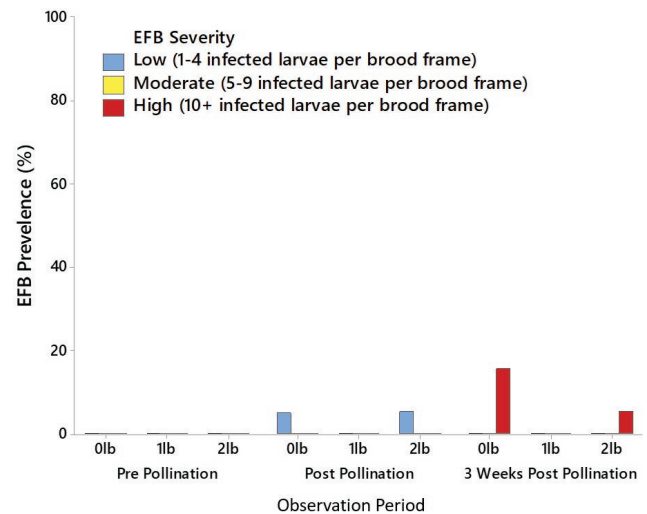
Pollen substitutes pose an alternative resource to provide colonies access to necessary proteins, amino acids, lipids and carbohydrates otherwise obtained through natural pollen. Two years of ATTTA research trials have demonstrated that colony growth is not significantly enhanced by feeding pollen substitute to honey bee colonies during wild blueberry pollination, see figure 2. This applies to strong colonies at or above the pollination standard, during favourable foraging conditions<sup>7</sup>. Discretion should be used to manage weaker hives in locations with poor surrounding forage and during inclement weather conditions. Pending regional research, it may be more beneficial to provide pollen supplements prior to wild blueberry pollination when weather and available forage are poor<sup>8</sup>.

**Current ATTTA research indicates that there is no economic benefit to supplementing hives with pollen substitute during wild blueberry pollination.**

There is a concern in the beekeeping community that moving hives to wild blueberry fields for pollination services induces stress-related disease due to nutritional deficiencies. European Foulbrood disease (EFB) is suggested to be associated with inadequate nutrition during blueberry pollination services<sup>9</sup>.

**Results from ATTTA research trials indicate that, under abundant natural forage and favourable weather conditions, healthy honey bee colonies are not at high risk of EFB infection during wild blueberry pollination<sup>7</sup>.**

As represented in figure 3, honey bee colonies placed for pollination which met or exceeded hive standard consistently showed low instances of EFB immediately after providing pollination services on Nova Scotia wild blueberry fields during 2019.



**Figure 3.** EFB prevalence and severity in honey bee colonies in relationship to wild blueberry pollination services. 0lb, 1lb and 2lb refer to how much pollen substitute colonies were given at the beginning of the pollination period. Based on 54 colonies used for wild blueberry pollination in Colchester County, Nova Scotia, in 2019.

There were limited cases of more severe EFB infection three weeks after pollination. Interestingly, all infected colonies pollinated the same wild blueberry field and were also infected with chalkbrood disease. This suggests that there may be specific conditions under which colonies are more susceptible to EFB infection during wild blueberry pollination. This may be due to inadequate surrounding forage or internal colony conditions.

For beekeepers who are consistently experiencing EFB after providing pollination services to a particular field, consider establishing a relationship with a veterinarian to discuss management options. Treating colonies prophylactically with antibiotics can be a useful strategy in EFB management. Oxytetracycline hydrochloride, colloquially referred to as Oxytet, is the antibiotic used to treat EFB in honey bee colonies. Access to this microbial is controlled by law and requires a subscription provided by a veterinarian. For this, beekeepers must first establish a Veterinary Client Patient Relationship (VCPR), which begins by contacting a willing veterinarian. Provincial beekeepers associations are a useful resource for making this connection.



## SECTION 2: BEEKEEPERS

### HONEY BEE NUTRITION

*Vairimorpha* disease, previously known as Nosemosis, is another honey bee disease thought to be aggravated by nutritive stress. Symptoms of this disease are seen when there is an accumulation of *Vairimorpha* spp. spores within a honey bee colony. A year of monthly *Vairimorpha* spp. spore sampling revealed no significant difference in *Vairimorpha* disease between colonies taken to pollination and those that were not, suggesting increased levels of *Vairimorpha* spp. spores within honey bee colonies in the spring reflect the seasonal trends of *Vairimorpha* rather than the effects of pollination services.

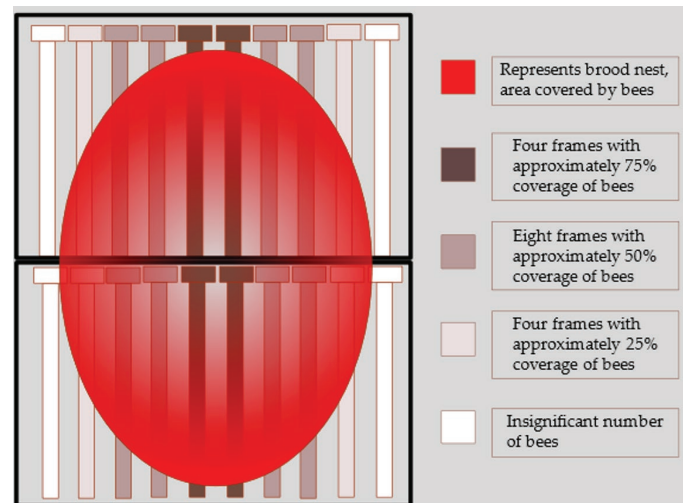
For further information on managing honey bee pests and diseases, refer to the resources section of this guide under Integrated Pest Management.

**Best Practice:** Assess wild blueberry fields individually to determine forage availability in regard to honey bee health.

### OPTIMAL HIVE STRENGTH

Hive strength is one of the many factors that impacts pollination and ultimate berry yield. A hive strength standard establishes measurable requirements of honey bee colonies used for pollination based on colony size and structure. Agreeing upon this standard will help foster a trusted relationship between beekeepers and blueberry producers and ensure a vibrant pollination force.

Based on regional research, local expertise, and in consideration of other accepted recommendations, the most up-to-date recommendation of hive strength **for an average honey bee unit is that at placement for wild blueberry pollination, a honey bee colony should be the equivalent of eight frames of bees and four frames of brood, a laying queen and approximately 20,000 bees in two 10-frame deep Langstroth hive bodies**, see figure 4.



**Figure 4.** A representation of a typical honey bee colony at hive standard.

A hive strength standard refers to the entire group of colonies deployed to a field for pollination services. The standard is considered an average, with some colonies being above and some below. The timing of this standard is significant, as each colony will develop and change during the pollination period. This standard reflects hives at the time of placement. This is presented as an optimal hive strength which will mitigate losses due to swarming and allow the beekeeper to split strong colonies after pollination for expansion. Various methods of assessing hive strength, presented in table 1, can be used collectively to gain a complete picture of colony strength within a beehive. Assessments of hundreds of colonies have revealed these categories to reflect different strengths and weaknesses for practical application. Table 1 considers the advantages and disadvantages of each method.

# SECTION 2: BEEKEEPERS

## OPTIMAL HIVE STRENGTH

Table 1. Brief review of methods of hive strength assessments based on Maritime colony assessments during the 2021-2022 wild blueberry pollination season.		
Method	Advantages	Disadvantages
Flying Bees	Quick	Inaccurate
	No beekeeping skills required	Dependent on weather conditions (temp., wind, precipitation)
	Non invasive	Used during optimal flying times only
	Allows snapshot comparison between hives	Less appropriate for our region
Seam Count	Relatively quick	Need to open hive
	No need to remove frames	
	Requires low level of beekeeping skill	
Frame Count	Most direct measure	Invasive
		Competent beekeeping skills required
Frames of Brood	Indicates activity of the hive	
	Reflective of hive health	
Overall Number of Bees	Allows comparison between hives	No reference point for numbers
		No credible methodology
		Number meaningless to most beekeepers

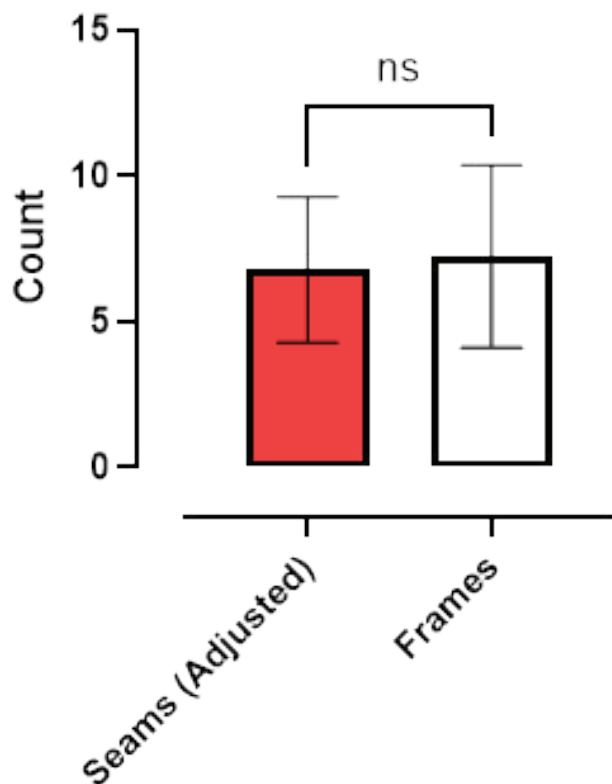
Foraging worker bees are the pollination workforce of a honey bee colony. Estimating the number of frames of bees and brood reflects the available and growing workforce. Eight frames of bees and four frames of brood refers to 100% front and back coverage, with partially full frames added together. The most accurate way to assess this is by examining each individual frame to estimate bee and brood coverage. A less invasive and time-consuming method to estimate frames of bees is to extrapolate based on seam counts. Seams refer to the interspace between frames and can be estimated by opening a hive and looking down between the frames. Like frames, partially full seams should be added together. Applying a correction of 0.65 to the total number of seams provides a reasonable estimate of total frames, see figure 5. For example, a colony containing 10 seams of bees across two deep Langstroth brood chambers would be estimated at 6.5 frames of bees.

**Seam counts provide the least invasive, yet still accurate assessment of hive strength in Atlantic Canada for hives used in wild blueberry pollination.**



## SECTION 2: BEEKEEPERS

### OPTIMAL HIVE STRENGTH



**Figure 5.** Based on assessments of 169 colonies in 2021 and 2022. There is no significant difference between the number of frames and seams counted in a hive after applying a correction factor of 0.65 to the seam count.

It is impractical to count every individual bee in a colony. Counting full frames of bees can be used to estimate the total population, using the accepted figure of 2400 bees per full frame as a guide<sup>10</sup>. Counting flying bees returning to the hive is NOT a recommended method for estimating hive strength of colonies during wild blueberry pollination in Atlantic Canada. Two years of sampling have shown this technique to be unreliable when compared to more direct measures of hive population, such as frame counts.

The number of frames in a hive is a precise way to assess hive strength on a field. Stocking density can be considered in terms of frames per acre rather than the conventional measure of hives per acre. While this is a more precise measure, it is also more invasive. Refer to the following section for more information on stocking density during wild blueberry pollination.

A laying queen is a sign of a colony in good health. Short of finding the queen, the presence of eggs and young larvae indicates a queenright colony. Housing colonies in two 10-frame Langstroth hive bodies is useful in swarm management, as wild blueberry pollination occurs at a time of year when colonies may be rapidly expanding. A colony that is too large and decides to swarm will not be a productive pollinating unit for the current season. For this reason, “bigger is better” does not apply to honey bee colonies being placed for wild blueberry pollination.



A seam of honey bees

## SECTION 2: BEEKEEPERS

### OPTIMAL HIVE STRENGTH

**Best Practice:** Deploy honey bee units for wild blueberry pollination at the equivalent of eight frames of bees and four frames of brood, a laying queen and approximately 20,000 bees in two 10-frame deep Langstroth hive bodies.

#### Key Points for Beekeepers:

- » *The health of the honey bee industry in Atlantic Canada depends on the participation of every beekeeper*
- » *It is not possible to import honey bees and bee products into Newfoundland and Labrador, for typical beekeeping purposes.*
- » *A permit must be obtained from your provincial apiarist prior to moving honey bee colonies and beekeeping equipment interprovincially*
- » *Integrating biosecurity into your management practices will support stronger colonies with a more vigorous capacity for pollination and honey production, reduce overwintering losses, reduce treatment costs and slow the timeline of pest resistance to synthetic chemical treatments*
- » *Fields should be individually assessed to determine natural forage sources available to honey bees placed on wild blueberry fields for pollination*
- » *Current ATTTA research indicates that there is no economic benefit to supplementing hives with pollen substitute during wild blueberry pollination*
- » *Results from ATTTA research indicate that, under conditions of abundant natural forage and favourable weather, healthy honey bee colonies are not at high risk of EFB infection during wild blueberry pollination<sup>5</sup>*
- » *At placement for wild blueberry pollination, a honey bee colony should be the equivalent of eight frames of bees and four frames of brood, a laying queen and approximately 20,000 bees in two 10-frame deep Langstroth hive bodies*
- » *Seam counts provide the least invasive, yet still accurate assessment of hive strength in Atlantic Canada for hives used in wild blueberry pollination*



## SECTION 3: WILD BLUEBERRY PRODUCERS

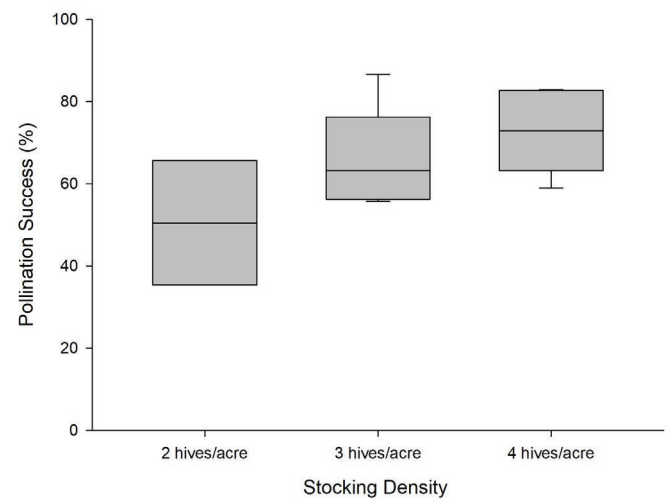
### STOCKING DENSITY

The number of hives per acre, i.e. stocking density, applied to wild blueberry fields during pollination is one of many factors which contribute to optimal berry yields in blueberry production. Stocking fields with managed honey bees ensures a reliable pollination force and reduces the risk associated with depending on wild populations<sup>3, 11</sup>.

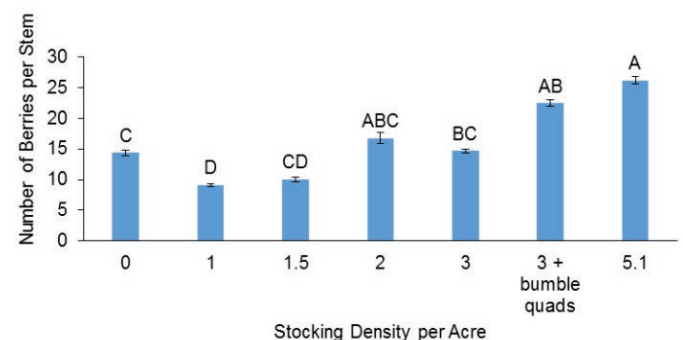
**With careful consideration, deploying the appropriate number of hives per acre has the potential to facilitate more consistent pollination and improve final berry yield.**

A blueberry flower must be successfully pollinated to begin the transition into a mature blueberry fruit. This transition, called fruit set, can first be observed in the plant as an immature, green berry. Given proper conditions, fruit set will then mature into a ripe, harvestable berry. Therefore, fruit set is the first observable sign of successful pollination.

ATTTA research trials from 2017 demonstrated that stocking wild blueberry fields at 1 to 1.5 hives per acre resulted in significantly lower berry yield compared to stocking at higher densities<sup>12</sup>. The minimum recommended stocking density to achieve adequate wild blueberry yield is two hives per acre<sup>11, 13</sup>. Complimentary to developments in other aspects of wild blueberry management, recommendations for minimum stocking densities have increased over time. ATTTA field trials reflect a trend of increasing pollination success with greater stocking density, up to four hives per acre<sup>14</sup>, see figure 6. Subsequent to a successful fruit set, higher stocking densities have also been linked to increased mature berry yields<sup>12</sup>, see figure 7. These increases depend on the characteristics of individual fields and given growing season. The effects of stocking density depend on the strength of the hives being deployed. Refer to the previous section for information on appropriate hive strength standards.



**Figure 6.** The relationship between hive stocking density and pollination success, as measured by percent fruit set. Data reflects results across 13 wild blueberry fields in the Maritime region in 2017 and 2019.



**Figure 7.** The relationship between hive stocking density and the mean number of berries per stem. Means which share the same letter are not significantly different at the 5% level. Data reflects results across 12 wild blueberry fields in the Maritime region in 2017.

## SECTION 3: WILD BLUEBERRY PRODUCERS

### STOCKING DENSITY

Wild pollinators contribute to the pollination force of a field, and their populations should be considered in managing honey bee stocking density. ATTTA research has considered the impacts of honey bee stocking density on wild pollinator populations. Reassuringly, field trials showed abundance and variety of wild bees were not impacted by increasing stocking up to four hives per acre, suggesting that increased honey bee densities did not cause displacement of wild bees<sup>14</sup>. The presence of wild pollinators is impacted by the size of a blueberry field and surrounding ecosystems. Smaller fields generally offer more pollinator habitat and require fewer managed pollinators. Peripheral vegetation is closer to the centre of a small field, therefore, wild pollinators have the potential to forage on a greater portion of the entire crop. Larger fields tend to offer less wild pollinator habitat, therefore, require a higher stocking density of honey bees. Refer to the Honey Bee Nutrition section of this guide for more information on forage availability in wild blueberry fields.

Pollination of wild blueberries may be enhanced by supplementing fields with other managed pollinators in combination with honey bees. Field trials from 2017 showed that stocking fields at three hives per acre in conjunction with one bumble bee quad nearly doubled final berry yields<sup>12</sup>. Diversifying pollinator services can create a more stable pollination force from season to season. Alfalfa leafcutter bees (*Megachile rotundata*) are another managed pollinator to consider for pollinator diversification.

**Modern production practices and increasing yields require a minimum stocking density of three hives per acre (24 frames per acre) for optimal pollination of wild blueberries in Atlantic Canada.**

Stocking at higher densities can be economically beneficial during peak berry prices and when fields have appropriate high-yield potential. For example, yield potential is impacted by plant health and stem density. A greater number of flowers per stem and stems per square metre will require a larger pollination force. Typically, more mature fields have a higher density of plant coverage relative to younger fields, therefore requiring more pollinators. The varieties of wild blueberry plants also offer different yield potentials. Taking the time to consider each field individually is important in achieving the optimal stocking density of honey bees for a wild blueberry field. See the Resources section for tools on how to assess fields for pollination services.

**Best Practice:** Stock wild blueberry fields at a minimum of the equivalent of three hives per acre (24 frames per acre) for optimum yields. Fields with high yield potential will require increased pollination.

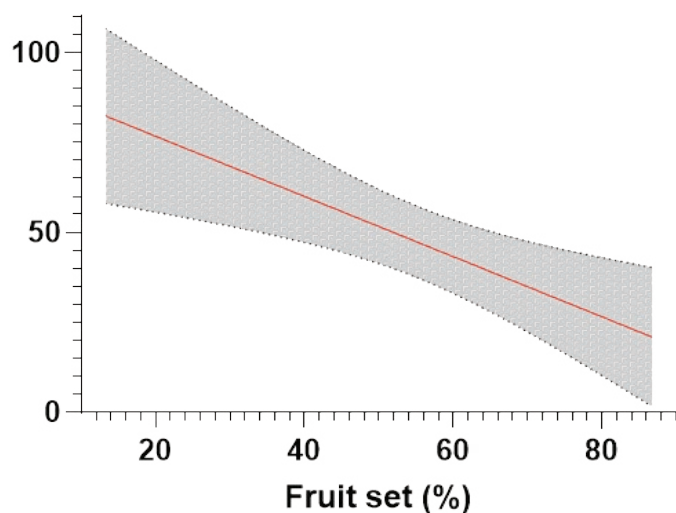


Honey bee hives placed for wild blueberry pollination with a bumble bee quad in the background

## SECTION 3: WILD BLUEBERRY PRODUCERS

### OPTIMAL TIMING OF HIVE PLACEMENT

The time at which honey bee hives are placed on wild blueberry fields for pollination can dramatically impact pollination success. Blueberry flowers are most receptive to pollination within two to three days of opening, and after seven to eight days, successful pollination is not likely<sup>3</sup>. Figure 8 demonstrates the significant correlation between percent bloom at hive placement and subsequent fruit set. Hive placement during the early stages of bloom reflects a higher success rate of pollination.

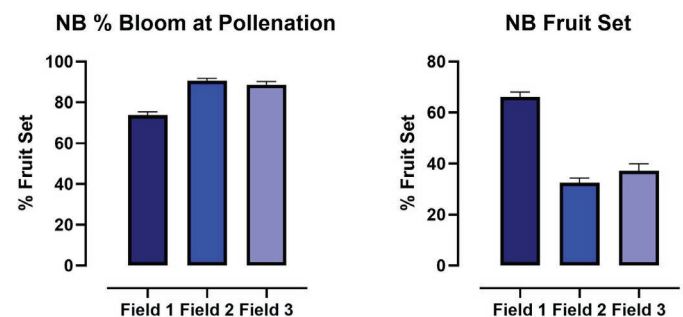


**Figure 8.** Fruit set versus percent bloom within 24 hours of hive placement. The red line indicates a negative relationship, and grey shading indicates the area between the error lines. The results of a simple linear regression model indicates the predictor, percent bloom at the time of placement, explained 41.26% of the variation in fruit set [ $F(1,16) = 4.69, p = 0.004$ ]. Data is based on 18 Maritime wild blueberry fields from 2021-2022.

**It is best practice to place hives for pollination when fields are at 10-25% bloom.**

This typically occurs within a few days of the initial bloom and can progress very quickly. For example, a field could start to bloom on May 24th, reach 10% on May 26th and be at 25% on May 28th. These dates are averages based on estimates from the Growing Degree Day Model developed by Dr. Scott White of Dalhousie University and specialists at Perennia Food and Agriculture, using data from weather stations on 20 wild blueberry fields in Nova Scotia.

As seen in figure 9, delaying hive placement can significantly impact fruit set. Once fields have reached around 50% bloom, there seems to be a sharp decline in pollination success. As an example of the importance of early pollination, one field trial in Prince Edward Island achieved an adequate fruit set, despite low final stocking density. The field was initially stocked at a high density, however, and reduced gradually as the bloom progressed and hives were required elsewhere.



**Figure 9.** The graph on the left represents the percent bloom on three New Brunswick wild blueberry fields at the time of hive placement for pollination. The graph on the right represents the subsequent fruit set on the same fields. \*indicates the level of significant difference.

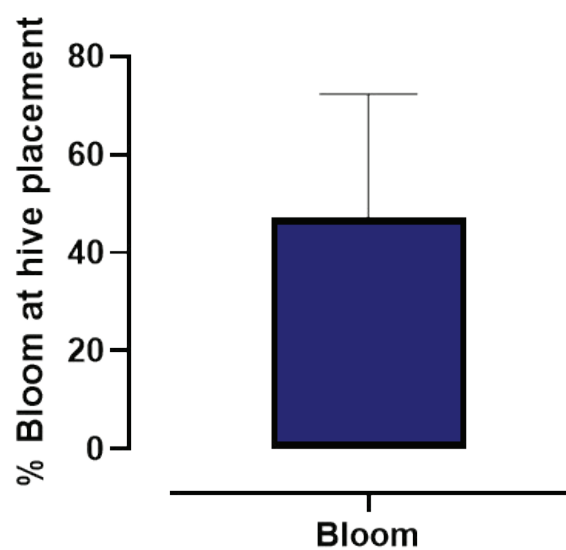
These results suggest that the consequences of placing hives for pollination too late seemingly outweigh the consequences of placing hives for pollination too early.

It can be difficult to estimate when exactly bloom will begin, especially considering our changing climate. Pollination fieldwork on 18 wild blueberry fields from the 2021 and 2022 pollination seasons demonstrated that many fields received honey bees well after optimal hive placement, see figure 10. On average, producers who participated in our research trials deployed honey bee colonies at 47% bloom.



# SECTION 3: WILD BLUEBERRY PRODUCERS

## OPTIMAL TIMING OF HIVE PLACEMENT



**Figure 10.** Percent bloom at the time of hive placement on fields. Data is based on 18 Maritime wild blueberry fields from 2021-2022.

To prepare for pollination, individual fields can be assessed for percent bloom using the formula presented below. It is essential that producers can assess fields individually for an accurate bloom stage, as delaying the placement of hives can result in a significant reduction in yield. Communication between blueberry growers and beekeepers is essential leading up to the bloom period. Through collaboration with local beekeepers, the timing of colony placement can be more precise around optimal bloom conditions.

Percent bloom can be assessed by counting open and closed flowers on a selected stem and applying the following formula.

**% Bloom = (Open Flowers / All Flowers) X 100**

It is best to count several stems and take the average % bloom for a broader field representation.

Most producers seem to underestimate percent bloom when timing the placement of honey bees

**In order for yields to be optimal, pollination units must be placed at the correct time during the bloom to achieve pollination!**

**Best Practice:** Fields must be accurately assessed for percent bloom. Place hives on wild blueberry fields when bloom reaches between 10-25%.



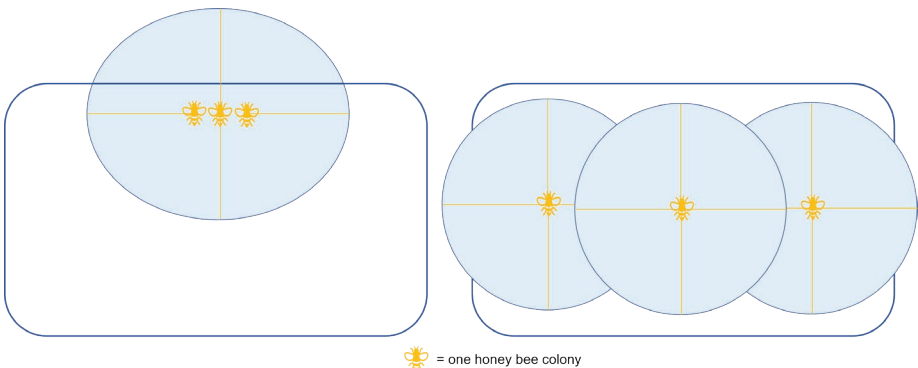
SECTION 3: WILD BLUEBERRY PRODUCERS

HIVE PLACEMENT AND MOVEMENT DURING POLLINATION

Honey bee hives should be placed in wild blueberry fields where there are good apiary conditions. See the Communication section of this guide for more information on hive placement from this perspective. From the perspective of wild blueberry pollination, ATTTA field trials have found that there is no dilution of pollination success, as measured by fruit set, number of berries at harvest and berry weight, up to approximately 150 meters from honey bee hive locations. This suggests that there is a 150-meter radius around colonies which will be evenly pollinated.

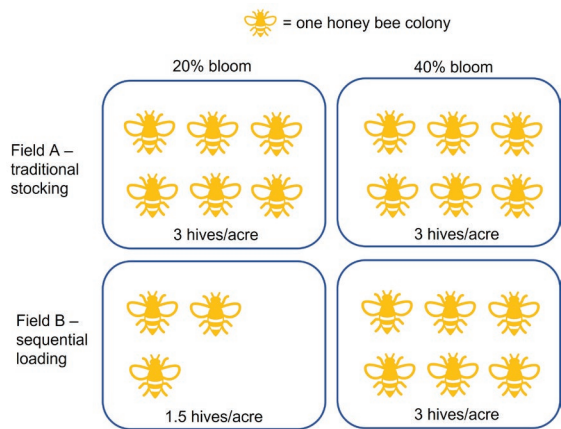
**Hives can be placed on wild blueberry fields at least 300 meters apart without impacting pollination services throughout the field.**

Field conditions and accessibility to hives will have a meaningful impact on hive distribution during pollination. Hives need to be in good apiary conditions, and producers and beekeepers need accessibility. Within these constraints, greater pollination can be achieved by distributing colonies strategically throughout a field<sup>15</sup>, as represented by figure 11. The distribution, that is the number of colonies per drop, should consider pollination range, field topography and the desired stocking density.



**Figure 11.** Visual representation of the impact of hive distribution on hive use efficiency. Blue circles represent the known optimal range of pollination around a honey bee colony.

Sequential loading during blueberry bloom is currently being practiced in wild blueberry production by a limited number of producers. Sequential loading involves increasing the stocking density of honey bee colonies to reflect bloom development during the pollination period. For example, a field could be initially stocked at 1.5 hives per acre and then increased to a final stocking of 3 hives per acre as bloom progresses, see figure 12. In doing this, honey bee colonies can be used more efficiently, as fewer colonies are needed at the initial deployment.



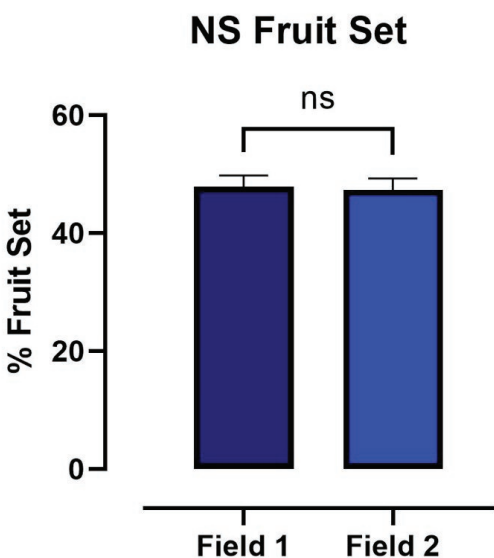
**Figure 12.** Visual representation of traditional stocking compared to sequential loading on a two-acre wild blueberry field. Field A is stocked at 3 hives per acre for the entire pollination period. Field B is stocked at 1.5 hives/acre at 20% bloom, then increased to the final stocking density of 3 hives/acre at 40% bloom.

# SECTION 3: WILD BLUEBERRY PRODUCERS

## HIVE PLACEMENT AND MOVEMENT DURING POLLINATION

ATTTA field trials in 2022 revealed wild blueberry fields managed through sequential loading to be as well pollinated as comparison fields which were stocked at the total density for the entire pollination period, as shown in figure 13. There was no significant difference in fruit set, as a measure of pollination, between the two study fields, which were stocked differently but otherwise managed the same. Field 1 was stocked at one hive per acre at 55% bloom and then increased to two hives per acre at 90% bloom. Conversely, Field 2 was stocked at two hives per acre for the entire pollination period, beginning at 55% bloom. Overall, Field 1 used fewer honey bee hives and was equally well pollinated. This demonstrates that sequential loading can achieve equal pollination services with greater efficiency of hives and may allow flexibility in initial deployments of hives. As the requirement for pollination increases with opening blossoms, the number of colonies on the field can be increased.

**Through sequential loading methods, limited hives in Atlantic Canada can be dispersed more efficiently between wild blueberry fields based on bloom progress.**



**Figure 13.** Relationship between stocking management and fruit set. Field 1 was sequentially loaded, and Field 2 was managed through traditional stocking. Based on data collected in 2022 from two Nova Scotia wild blueberry fields.

**Best Practice:** Increase hive efficiency through sequential loading by first placing minimal hives at 0-10% bloom, then increasing to optimal stocking density at 25% bloom. Pollination during early bloom is critical to achieve a successful fruit set.

### Key Points for the Pollination Industry

- » With careful consideration, deploying the appropriate number of hives per acre has the potential to facilitate more consistent pollination and improve final berry yield
- » Modern production practices and increasing yields require a minimum stocking density of three hives per acre (24 frames per acre) for optimal pollination of wild blueberries in Atlantic Canada
- » It is best practice to place hives for pollination when fields are at 10-25% bloom
- » The consequences of placing hives for pollination too late seemingly outweigh the consequences of placing hives for pollination too early
- » In order for yields to be optimal, pollination units must be placed at the correct time during the bloom to achieve pollination
- » Hives can be placed on wild blueberry fields, at least 300 meters apart without impacting pollination services throughout the field
- » Through sequential loading methods, limited hives in Atlantic Canada can be dispersed more efficiently between wild blueberry fields based on bloom progress



## SECTION 4: SUMMARY

Following best management practices when using honey bee hives for the pollination of wild blueberries will optimize industry efficiency and promote sustainable growth. The following points summarize best management practices for the Atlantic pollination industry.

- Establish clear expectations through a written pollination contract between the blueberry producer and beekeeper.
- Incorporate biosecurity into beekeeping management to support strong colonies.
- Assess wild blueberry fields individually to determine forage availability in regard to honey bee health.
- Deploy honey bee units for wild blueberry pollination at the equivalent of eight frames of bees and four frames of brood, a laying queen and approximately 20,000 bees in two 10-frame deep Langstroth hive bodies.
- Stock wild blueberry fields at a minimum of the equivalent of three hives per acre (24 frames per acre) for optimum yields. Fields with high yield potential will require increased pollination.
- Fields must be accurately assessed for percent bloom. Place hives on wild blueberry fields when bloom reaches between 10-25%.
- Increase hive efficiency through sequential loading by first placing minimal hives at 0-10% bloom, then increasing to optimal stocking density at 25% bloom. Pollination during early bloom is critical to achieve a successful fruit set.

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## RESOURCES

### Assessing a Wild Blueberry Field

- [UMaine Estimating the Strength of Your Pollinator Force in Wild Blueberry](#)

### Atlantic Canadian Provincial Beekeepers Associations

- [New Brunswick Beekeepers Association](#)
- [Newfoundland and Labrador Beekeeping Association](#)
- [Nova Scotia Beekeepers Association](#)
- [Prince Edward Island Beekeepers Association](#)

### Atlantic Canadian Provincial Wild Blueberry Producers Associations

- [Bleuets NB Blueberries](#)
- [Prince Edward Island Wild Blueberry Growers Association](#)
- [Wild Blueberry Producers Association of Nova Scotia](#)

### Biosecurity

- [Canadian Beekeepers' Practical Handbook to Bee Biosecurity and Food Safety](#)
- [Guide for Beekeepers on Procedures to Move, Export, or Sell Honey Bees Across Canada](#)
- [Honey Bee Producer Guide to the National Bee Farm-level Biosecurity Standard](#)
- [The Canadian Bee Industry Safety Quality Traceability Producer Manual – Good Production Practices](#)

### Integrated Pest Management

- [ATTTA Factsheet Comb Rotation](#)
- [ATTTA Factsheet Summer Disease and Pest Monitoring in Honey Bees](#)
- [ATTTA Factsheet Varroa Mite Management Options for Atlantic Canada](#)

- [Pernal SF, Clay H. Honey Bee Diseases & Pests Third Edition. Canadian Association of Professional Apiculturists 2013.](#)

### Pollinator Partnership Selecting Plants for Pollinators

- [Nova Scotia Highlands](#)
- [Prince Edward Island Ecoregion](#)
- [Planting Forage for Honey Bees in Canada](#)
- [South-Central Nova Scotia Uplands](#)
- [Southwest Nova Scotia Uplands](#)

### Programs to Connect Pollination Partnerships

- [Bee Connected](#)
- [NBBA Bee Yard](#)
- [PEIBA Pollination](#)
- [WBPANS Marketplace](#)

### Provincial Guidelines for Hive Movement

- [2023 Protocol for the Importation or Transit of Honey Bees within Canada for New Brunswick](#)
- [2022 Protocol Regarding the Importation of Honey Bees in Prince Edward Island](#)
- [A Guide for Beekeepers on Procedures to Move, Export or Sell Honey Bees Across Canada](#)
- [Newfoundland and Labrador Import Regulations for Honey Bees](#)
- [Nova Scotia Bee Industry](#)

### Sample Pollination Contracts

- [Canadian Honey Council Pollination Contract – Hive Rental](#)
- [NBBA Pollination Contract](#)
- [NSBA/WBPANS Joint Pollination Committee Sample Pollination Contract](#)
- [PEIBA Pollination Contract](#)



## APPENDIX A

### NBBA POLLINATION CONTRACT

This contract is made between \_\_\_\_\_ ("Grower"), and \_\_\_\_\_ ("Beekeeper") for the 20\_\_ growing season.

#### 1. BEEKEEPER RESPONSIBILITIES

A. The Beekeeper agrees to provide \_\_\_\_\_ hives (colonies) to the Grower at dates and location as follows:

Approximate delivery date \_\_\_\_\_

Location of delivery \_\_\_\_\_

B. If the delivery date is to change, the Grower shall notify the Beekeeper 72 hours prior to the planned delivery date.

C. The Beekeeper shall place his/her hives as instructed by the Grower.

D. The Beekeeper agrees to provide hives at a minimum strength as outlined by the Department of Agriculture, Aquiculture and Fisheries of the Government of New Brunswick Guideline B.4.0.

The Grower is entitled to inspect the strength of the hives during the first few "flying" days following the delivery. The Beekeeper, upon request of the Grower to inspect the strength of the hives, shall attend the location of the hives and shall open and demonstrate the colony strength to the Grower upon request. In the event the strength of the hives does not meet the requirements of Guideline B.4.0, the parties shall re-negotiate the terms of this Contract.

E. The Beekeeper agrees to leave his/her bees on site for a period of \_\_\_\_\_ days for the purpose of pollination.

F. Upon completion of the above pollination period, the Beekeeper shall have \_\_\_\_\_ days to remove the hives from the location at which they were delivered.

G. The Beekeeper is responsible for all costs relating to the transportation and the delivery of the hives during the term of this Contract.

#### 2. GROWER RESPONSIBILITIES

A. The Grower agrees to meet the Beekeeper on site during delivery or agrees to give their GPS coordinates to the Beekeeper to insure accurate placement of colonies.

B. The Grower agrees to provide a suitable location for the hives. The location shall be accessible by truck and other vehicles used for handling hives.

C. The Grower shall allow the Beekeeper access to the site on an "as needed" basis to tend the hives. Once the hives are put in place, the Grower agrees not to move or manipulate the hives.

D. The Grower shall not use or allow to be used pesticides or other chemicals that are known to be harmful to bees during the pollination period or immediately before the arrival of the colonies if product residue can endanger bee health. Should application of pesticides become necessary during pollination period, the Beekeeper shall be given 48 hours notice by the Grower to remove the colonies from the location.

E. The Grower is responsible for the protection of the colonies from wildlife and vandalism while on site. The Grower shall compensate the Beekeeper in the event of damaged colonies due to wildlife and vandalism while on site.

F. The Grower shall inform the Beekeeper within 24 to 72 hours if a frost significantly damages the crop.

G. The Grower agrees to pay the following for pollination services:

H. Grower renting \_\_\_\_\_ colonies at a rate of \$\_\_\_\_\_ per colony, for a total of \$\_\_\_\_\_.

I. The grower agrees to pay \$\_\_\_\_\_ by the end of \_\_\_\_\_ (month) and the balance is to be paid by \_\_\_\_\_, 20\_\_\_\_\_.

### 3. WAIVER IN FAVOR OF NBBA

The parties to this Contract expressly agree that the New Brunswick Beekeepers Association Inc. is not liable for any breaches of this Contract nor any damages suffered by any party to this Contract.

### 4. CONTRACT SIGNATURE

Grower Signature \_\_\_\_\_

Address \_\_\_\_\_

Home Phone \_\_\_\_\_

Cell Phone \_\_\_\_\_

Beekeeper Signature \_\_\_\_\_

Address \_\_\_\_\_

Home Phone \_\_\_\_\_

Cell Phone \_\_\_\_\_



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