The status of native bee species in Newfoundland and Labrador

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Introduction

Bees are very important to all life on this planet. They have co-evolved with flowering plants and now are the main animal pollinators of the majority of plants that humans use for food. The group is large and diverse with approximately 20,000 species worldwide (Michener 2000). Bees are in the insect order Hymenoptera which includes the bees, ants and wasps. Within the order, bees belong the suborder Apocrita. This group has members that have a constriction between the 1st and 2nd abdominal segments which appears as a "waist". Bees can be further separated from other Hymenoptera (superfamily: Apoidea) by the fact that they use pollen and nectar to feed their young rather than insect prey as in the wasps.

The typical bee is a hairy stout-bodied insect. The bees are separated from the ants and vespid wasps by having the tegula separated from the pronotum. Female bees have a modified ovipositor that has lost its function as an egg-laying structure and is used as a sting in defense. This use of the sting is different than some other members of the Hymenoptera where the sting is used to paralyze prey items or to insert eggs into a living host. All bees have two pairs of membranous wings with the forewings larger than the hindwings. The leading edge of the hindwings hook onto the trailing edge of the forewings by small hook-like structures known as hamuli. This allows the wings to be linked together during flight. Bees have mouthparts that allow them to suck nectar from flowers (the proboscis) and also mandibles used in nest construction. The bees are unique in the Hymenoptera because their larvae feed on pollen and nectar while other Hymenoptera have their larvae feed on invertebrate prey. In many species the female bees have modified legs for collecting and transporting pollen.

The life-histories of bees are diverse, from strictly solitary and communal to highly eusocial. The majority of bee species are solitary where a single female constructs her nest and provisions it with pollen without the help of others. The nest maybe dug into the ground or in existing cavities in dead wood, plant stems or even exposed on the surface of rocks or other substrates. In all cases, bees either line the cells with a glandular secretion or exogenous material (eg. mud, leaves or resin). After completion of the nest the female will collect all of the pollen and nectar that is required for the development of a larva. She places it into the cell and lays an egg on its surface and then closes the

cell completely. In communal species, part of the nest maybe used by several bees but each constructs her own cells, provisions it with pollen and nectar and lays an egg. This is different than in the highly social bees (eg honey bees and bumble bees). In that case, only one female bee is reproductive (the queen) and she initiates the colony, and the lays eggs. Her daughters (worker bees) do all of the tending, nectar and pollen collection and defense of the nest. Male bees (drones) are produced and their only function is to mate with new queens.

There is a global concern over the apparent reduction in the abundance and diversity of native bee species. Colla and Packer (2008) indicated that there is evidence that bumblebee species from eastern North American have declined in recent years. This is of major concern as these bees are important pollinators of many plants and the loss of these pollinators would have far-reaching negative effects on many plant systems.

Status of native bees in Newfoundland and Labrador

Many species of insects visit flowers in search of nectar and pollen. In return for these foods, the insects inadvertently pollinate the flowers. Many native insect species (especially bees) are important pollinators of commercial food crops. Presently, at least 76 species (Table 1) occur in Newfoundland and Labrador in 5 families: digger bees (Family: Andrenidae), sweat bees (Family: Halictidae), cellophane bees (Family: Colletidae), leafcutting bees (Family: Megachilidae) and bumblebees (Family: Apidae). Three of the bees on the list, *Bombus impatiens*, *Apis mellifera*, and *Megachile rountdata* have been purposely introduced. *Bombus impatiens* and *M. rotundata* have not become established and *A. mellifera* may be found around areas where people keep these bees but no feral *A. mellifera* are known in NL. The number of bee species recorded from Newfoundland differs considerably compared to mainland Atlantic Canada where 159 species have been recorded (Sheffield et al. 2003).

Andrenidae. All members of this large family nest in the soil and are strictly solitary, however the females of some species nest in dense aggregations and others may be communal (i.e. use a common part of a nest). These are referred to as digger bees because of the behavior for nesting in the ground. Newfoundland and Labrador have recorded species from only one genus, *Andrena*. Most members of this genus have strict nutritional needs and are restricted in their use of flower types.

Halictidae. These are small to medium sized bees that are very diverse. They are the most common bees that one would encounter on flowers on NL. Many people may not recognize them as bees and identification to species level is difficult and in the majority of cases requires services of professional entomologists. Some of the species are metallic in coloration. Members of this family exhibit the whole range of social behavior from strictly solitary and communal to primitively eusocial. The halictid bees reported from NL belong to one sub-family, the Halictinae. These bees are referred to as sweat bees because of their propensity to be attracted to human perspiration during hot weather.

Colletidae. Members of this family are solitary bees that have a short, bilobed tongue. The females use this tongue to apply a glandular secretion from the Dufour's gland to the walls of the brood cells. The secretion is a mixture of macrocyclic lactones and when applied produce a clear, transparent cellophane-like membrane which is water proof and resistant to fungi. This is why these bees are

known as cellophane bees. Only members of the genus *Hylaeus* have been reported from NL. These are relatively hairless bees that lack a pollen scopa. The females swallow the pollen and carry it back to the nest in their crops. Many species nest in plant stems, in plant galls, in old beetle holes, unused cells of other bees and other nest in the ground.

Megachilidae. This is a very large family that are commonly refereed to as leaf-cutter and mason bees. Most are strictly solitary but a few species are communal. None of these bees secrete linings for the brood cells. Instead, the females collect exogenous materials to construct the cell walls or in some cases only the cell partitions. The majority of these bees make nests in pre-existing cavities while others construct exposed nests on the surfaces of rocks on the ground. The materials collected for nest construction depends on the species but may include: chewed leaves or petals, plant or animal hairs, plant resin, mud and small pebbles. Species from two genera (*Megachile* and *Osmia*) have been recorded from NL.

Anthophoridae. On a world-wide basis, this is a very large family with robust bees that resemble bumble bees. The large species are carpenter bees that excavate their own nest tunnels in wood rather then use preexisting cavities. However, in NL only members of one subfamily (Nomadine) have been recorded. These bees are cuckoos in the nest of other bees. They are very much like a wasp in appearance and are brightly colored. Because they are strictly cuckoos, they have lost the pollen scopa and do not collect pollen.

Apidae. Most members of this family are robust and hairy and contain the bumble bees and honey bees. They are highly eusocial that construct hives of several hundred to several thousand bees. Each hive is founded by a queen and she produces several broods of sterile worker females whose duty it is to tend the eggs, larvae and collect the nectar and pollen as food. The western honey bee, *Apis mellifera* and the bumble bee, *Bombus impatiens* have been introduced in to Newfoundland for pollination activities. The native species of this family are from two genera: *Bombus* and *Psithyrus*. The latter is a cuckoo in the nest of the former.

Table 1 lists the bee species that have been collected from Newfoundland and Labrador over the past several decades. The information contained in the table comes from a compilation of information from several sources including Larson (unpublished), Bowers and Pardy (1996), Hurd (1979), Laverty and Harder (1988), and personal observations by B. Hicks and C. Sheffield.

Table 1. The bee species recorded from Newfoundland and Labrador up to 2015.

Family COLLETIDAE		
Subfamily Colletinae		
Tribe Colletini		
***Colletes* LATREILLE, 1802**		
Colletes compactus compactus CRESSON, 1868	LB	NL
Colletes consors mesocopus SWENK, 1907	LB	NL
Colletes nigrifrons TITUS, 1900	LB	NL
Subfamily Hylaeinae		
***Hylaeus* FABRICIUS, 1793**		
Subgenus *Cephalylaeus* MICHENER, 1942		
Hylaeus basalis (SMITH, 1853)	LB	NL
Subgenus *Hylaeus* FABRICIUS, 1793		
Hylaeus annulatus (LINNAEUS, 1758)	LB	NL
Subgenus *Prosopis* FABRICIUS, 1804		
Hylaeus modestus modestus SAY, 1837	–	NL
Family ANDRENIDAE		
Subfamily Andreninae		
***Andrena* FABRICIUS, 1775**		
Subgenus *Andrena* FABRICIUS, 1775		
Andrena carolina VIERECK, 1909	LB	NL
Andrena clarkella (KIRBY, 1802)	LB	NL
Andrena frigida SMITH, 1853	LB	NL
Andrena milwaukeensis GRAENICHER, 1903	LB	NL
Andrena rufosignata COCKERELL, 1902	LB	NL
Andrena thaspii GRAENICHER, 1903	LB	NL
Subgenus *Cnemidandrena* Hedicke, 1933		
Andrena hirticincta PROVANCHER, 1888	LB	NL
Subgenus *Euandrena* HEDICKE, 1933		
Andrena nigrihirta (ASHMEAD, 1890)	–	NL
Subgenus *Leucandrena* Hedicke, 1933		
Andrena barbilabris (KIRBY, 1802)	LB	NL
Subgenus *Melandrena* Pérez, 1890		
Andrena nivalis SMITH, 1853	LB	NL
Subgenus *Taeniandrena* HEDICKE, 1933		
**Andrena wilkella* (KIRBY, 1802)	–	NL
Subgenus *Thysandrena* LANHAM, 1949		
Andrena w-scripta VIERECK, 1904	LB	NL
Subgenus *Trachandrena* ROBERTSON, 1902		
Andrena miranda SMITH, 1879	LB	NL
Family HALICTIDAE		
Subfamily Halictinae		
Tribe Halictini		
Genus *Halictus* LATREILLE, 1804		

Subgenus *Protohalictus* Pesenko, 1984		
Halictus rubicundus (Christ, 1791)	LB	NL
Genus *Sphecodes* Latreille, 1804		
Sphecodes solonis Graenicher, 1911	–	NL
Genus *Lasioglossum* Curtis, 1833		
Subgenus *Dialictus* Robertson, 1902		
Lasioglossum lineatulum (Crawford, 1906)	–	NL
Lasioglossum planatum (Lovell, 1905)	?	NL
Lasioglossum sheffieldi Gibbs, 2010	–	NL
Lasioglossum tenax (Sandhouse, 1924)	LB	NL
Lasioglossum versans (Lovell, 1905)	LB	NL
Subgenus *Evylaeus* Robertson, 1902		
Lasioglossum cinctipes (Provancher, 1888)	–	NL
Subgenus *Hemihalictus* Cockerell, 1897		
Lasioglossum foxii (Robertson, 1895)	LB	NL
Lasioglossum inconditum (Cockerell, 1916)	LB	NL
Subgenus *Lasioglossum* Curtis, 1833		
Lasioglossum athabascense (Sandhouse, 1933)	–	NL
Subgenus *Leuchalictus* Warncke, 1975		
**Lasioglossum leucozonium* (Schrank, 1781)	–	NL
Subgenus *Sphecodogastra* Ashmead, 1899		
Lasioglossum boreale Svensson, Ebmer & Sakagami, 1977	LB	NL
Lasioglossum quebecense (Crawford, 1907)	–	NL
Lasioglossum seillean Gibbs & Packer, 2013	–	NL
Family MEGACHILIDAE		
Subfamily Megachilinae		
Tribe Osmiini		
Genus *Hoplitis* Klug, 1807		
Subgenus *Alcidamea* Cresson, 1864		
Hoplitis albifrons albifrons (Kirby, 1837)	–	NL
Genus *Osmia* Panzer, 1806		
Subgenus *Helicosmia* Thomson, 1872		
**Osmia caerulescens caerulescens* (Linnaeus, 1758)	–	NL
Subgenus *Melanosmia* Schmiedeknecht, 1885		
Osmia bucephala Cresson, 1864	–	NL
Osmia inermis (Zetterstedt, 1838)	LB	NL
Osmia nigriventris (Zetterstedt, 1838)	–	NL
Osmia proxima Cresson, 1864	–	NL
Osmia tersula Cockerell, 1912	–	NL
Tribe Anthidiini		
Genus *Anthidium* Fabricius, 1804		
Subgenus *Anthidium* Fabricius, 1804		
**Anthidium manicatum* (Linnaeus, 1758)	–	NL
Genus *Stelis* Panzer, 1806		
Tribe Megachilini		
Genus *Coelioxys* Latreille, 1809		
Subgenus *Boreocoelioxys* Mitchell, 1973		

Coelioxys porterae COCKERELL, 1900	LB	NL
Genus *Megachile* LATREILLE, 1802		
Subgenus *Eutricharaea* THOMSON, 1872		
**Megachile rotundata* (FABRICIUS, 1793)	–	NL
Subgenus *Megachile* LATREILLE, 1802		
Megachile centuncularis (LINNAEUS, 1758)	–	NL
Megachile inermis PROVANCHER, 1888	–	NL
Megachile montivaga CRESSON, 1878	–	NL
Megachile relativa CRESSON, 1878	LB	NL
Subgenus *Xanthosarus* ROBERTSON, 1903		
Megachile frigida SMITH, 1853	LB	NL
Megachile gemula CRESSON, 1878	–	NL
Megachile melanophaea SMITH, 1853	–	NL
Family APIDAE		
Subfamily Nomadinae		
Tribe Nomadini		
Genus *Nomada* SCOPOLI, 1770		
Nomada composita MITCHELL, 1962	–	NL
Nomada cressonii ROBERTSON, 1893	LB	NL
Nomada cuneata (ROBERTSON, 1903)	LB	NL
Nomada depressa CRESSON, 1863	–	NL
Nomada pygmaea CRESSON, 1863	–	NL
Subfamily Apinae		
Tribe Bombini		
Genus *Bombus* LATREILLE, 1802		
Subgenus *Alpinobombus* SKORIKOV, 1914		
Bombus balteatus DAHLBOM, 1832	LB	–
Bombus polaris CURTIS, 1835	LB	–
Subgenus *Bombus* LATREILLE, 1802		
Bombus terricola KIRBY, 1837	LB	NL
Subgenus *Cullumanobombus* VOGT, 1911		
Bombus rufocinctus CRESSON, 1863	LB	NL
Subgenus *Psithyrus* LEPELETIER, 1833		
Bombus bohemicus (SEIDL, 1837)	LB	NL
Bombus citrinus (SMITH, 1854)	–	NL
Bombus flavidus EVERSMANN, 1852	LB	NL
Bombus suckleyi GREENE, 1860	–	NL
Subgenus *Pyrobombus* DALLA TORRE, 1880		
Bombus frigidus SMITH, 1854	LB	NL
**Bombus impatiens* CRESSON, 1863	–	NL
Bombus melanopygus NYLANDER, 1848	LB	–
Bombus mixtus CRESSON, 1878	LB	–
Bombus perplexus CRESSON, 1863	LB	–
Bombus sandersoni FRANKLIN, 1913	LB	NL
Bombus sylvicola KIRBY, 1837	LB	NL
Bombus ternarius SAY, 1837	LB	NL
Bombus vagans vagans SMITH, 1854	LB	–
Bombus vagans bolsteri FRANKLIN, 1913	–	NL
Subgenus *Subterraneobombus* VOGT, 1911		
Bombus borealis KIRBY, 1837	LB	NL
Tribe Apini		
Genus *Apis* LINNAEUS, 1758		

Subgenus *Apis* LINNAEUS, 1758			
**Apis mellifera* LINNAEUS, 1758		LB	NL

* Introduced species

Bees and Pollination

The movement (importation) of bee species within Canada is regulated by the individual provinces. Blueberry and cranberry producers in the province of Newfoundland and Labrador have imported bees in the past to enhance their berry production. During 1997, Newfoundland blueberry producers in the Conception Bay North area tested Alfalfa leafcutting bees (*Megachile rotundata*) to increase berry production as this species is used successfully in the Maritime provinces. The species was not useful in this area mainly because of the cold and foggy weather conditions experienced during the time when blueberry plants are in bloom resulted in reduced activity of the foraging adults (Roger Churchill pers. com.). *Bombus impatiens* was first imported into Canada into the Fraser Valley of BC in late 1999. This has been the main bee species that has been imported into Newfoundland for blueberry and cranberry pollination in recent years.

The rational for importing bees is to increase the density of bee pollinators at a time in the season when native bee activity is low. Berry producers have large acreage of managed land with considerable monetary and time committed to their endeavors. Many producers feel that increased pollination is necessary for their farms to be viable. Importation of bees (*Bombus impatiens*) has occurred in several locations over the past 10 years with mixed results. The success of the importations on pollination is a hit-and-miss exercise, with some years showing increase in pollination while other years are complete failures. Everyone is in agreement that the weather experienced during the blooming season appears to be the most important factor that limits the usefulness of imported pollinators. Very little research has been conducted of the utility of importing *B. impatiens* for the pollination of blueberry and cranberry in Newfoundland. And no research has been conducted on the potential impact that these introduction will have on native bee species.

The importation of bees from outside of NL poses a significant threat to native bee species. In addition, western honey bee (*Apis mellifera*) while introduced into Newfoundland many years ago, have the distinction of being one of a select few regions on the planet that have disease-free honey bees; a global resource worth preserving in this disease-free state. Importation of non-native bee species may introduce diseases or parasites that could spread to the native bumble bee and honey bee populations. The following section of this report outlines the diseases and parasites of non-native bumble bee species that can potentially affect the native species.

Parasites and diseases of non-native *Bombus* species.

While most people are familiar with the diseases of honey bees and the impact that they are having on honey bee population globally, little attention has been paid to similar threats to bumble bees. Virtually no research is conducted on the impact of bee diseases on native solitary bees in the other bee families. This review will be limited to the diseases affecting bumble bee species as this is the main potential threat in NL presently. Table 2 lists the possible threats to Newfoundland bumble species from mainland North America.

Table 2. The known diseases that affect bumble bee species in North America.

Parasite/Pathogen	Taxonomy	Target affects
Nosema bombi	Microsporidia: Nosematidae	Various body tissues
Locustacarus buchneri	Acarina: Podapolipodidae	Tracheal system
Crithidia bombi	Kinetoplastida: Trypanosomatidae	Digestive system
Melittobia acasta	Hymenopera: Eulophidae	Parasitoid
Melittobia chalybii	Hymenoptera: Eulophidae	Parasitoid
Aethina tumida	Coleoptera: Nitidulidae	Scavenger on comb
Galleria mellonella	Lepidoptera: Pyralidae	Comb and beeswax
Deformed Wing Virus (DWV)	Picornavirales: Iflaviridae	Morphological abnormalities
Israeli Acute Paralysis Virus (IAPV)	Group IV - positive-sense ssRNA viruses: Dicistroviridae	Nervous system

Nosema bombi - This is an obligate intracellular microsporidian parasite. The infective form is an environmentally resistant spore. The spore is ingested and germinated in the cytoplasm of the midgut epithelium and the Malphigian tubules. With proliferation of the parasite it spreads to other tissues. *Nosema bombi* primarily infects the Malphigian Tubules but also infects the thoracic muscles, nerve tissue, midgut and muscle tissue surrounding the gut epithelium (Fries et al. 2001). In heavy infects, the tissues are destroyed and spores are released into the intestinal lumen (Otti and Schmid-Hempel 2007).

Locustacarus buchneri - This is a small parasitic mite that resides in the trachea of *Bombus* species. The mite overwinters in the hibernating queen and upon establishment of a new colony begins to engorge on the host hemolymph. Eggs are produced and larvae hatch within a few days. Adult mites do not migrate but larvae will move onto worker bees that are in close association and penetrate their

trachea. The number of mites per worker bee increases over the summer months when severe affects can be observed. Under a high mite load, some workers are known to show signs of digestive abnormalities with diarrhea occur in some bees plus some bees with heavy infections often are lethargic and fail to forage (O'Conner and Klimov, 2004).

Crithidia bombi- This is a flagellated protozoan pathogen in Trypanosomatidae that attach themselves to the intestinal epithelial cells. After several days of growth and multiplication, the cells are passed out in the host's feces. The spread of the disease occurs when uninfected bees come into contact with infective cells that is located on nest material (Schmid-Hempel, 2001). Infected worker bees rarely have overt signs of disease and no dramatic increase in mortality. Instead, the effects of this gut trypanosome occur when the bees are subjected to stressful conditions, such as a restriction in food availability. In this situation, the parasite exhibits a significant increase on mortality. Moreover, since colony initiation occurs in the spring when flower resources may be limited, further stressful conditions as adverse weather may result in *C. bombi* exerting a higher than expected toll (Schmid-Hempel, 2001). While most infections occur within the same hive, Ruiz-Gonzalez and Brown (2006) have shown that this parasite can be transmitted in the field through the shared use of flowers.

Melittobia acasta and M. *chalybii*- These are gregarious ectoparasitoids primarily on the prepupae of aculeate Hymenoptera. They have not been recorded from Newfoundland. However, since these species are known to be polyphagous it is a concern that an accidental introduction could lead to these wasps becoming established here and affecting native bee species.

Aethina tumida - The small hive beetle (SHB) is typically a parasite and scavenger of honey bee colonies. The traditional view that this species is host specific to honey bees has been challenged. The beetle was shown to be able to switch host and reproduce in laboratory *Bombus impatiens* colonies (Stanghellini at al. 2000; Ambrose et al. 2000). Spiewok and Nuemann (2006) and Hoffmann et al. (2008) have shown that SHB quite readily infests *Bombus impatiens* colonies in the field. This beetle used olfactory cues from the hive to choose bumble bee nests instead of honey bee hives (Hoffmann et al. 2008). However, the defensive behavior of the bees help counteract the infestation of SHB but only when the beetle's eggs are in plain view and not concealed (Hoffmann et al. 2008).

The small hive beetle is destructive as adults and larvae by feeding on stored pollen and honey. In honeybees, the beetle larvae tunnel through combs, killing bee brood and ruining comb. The adults and larvae are known to defecate in the honey which results in it fermenting and becoming unsuitable for bee consumption. While no studies have shown whether SHB can infest natural nests of native *Bombus* species in the field, it is clear that the search behavior of the beetles and the fact that they infest commercial colonies in the field indicates that the potential risks are real (Hoffmann et al. 2008).

Galleria mellonella- This is a species that feeds as larvae on beeswax and sometimes forms a web over comb of neglected hives. It has not been recorded from Newfoundland but it maybe of concern since Spiewok and Neumann (2006) showed that *Bombus impatiens* colonies situated near honey bee hives all were infested with greater wax moth. Williams (1997) mentioned that infestations with wax moths led to a significant decline in bumble bee colonies.

Deformed Wing Virus (DWV) - This is a virus that is known mainly to affect honey bees when they are infected with *Varroa destructor* mites. Pupae are infected and develop into adults where they exhibit wing and other morphological abnormalities. The abnormalities include: vestigial or crumpled wings, shortened, bloated abdomens and discoloration (Martin 2001). DWV also can infect *Bombus* species and produce the characteristic wing crumpling as seen in honeybees (Genersch et al. 2006), even in the absence *Varroa* mite on the *Bombus* species.

Israeli Acute Paralysis Virus (IAPV)- IAPV is a common infective agent of bees, frequently detected in apparently healthy colonies. However, it has been reported as the major factor contributing to the mortality of honey bees affected with *V. destructor* and has been implicated in colony collapse disorder (CCD) in honey bees (Chen and Evans 2007). Currently, the presence of IAPV has not been confirmed in Canada. However, it is possible that the virus may already be present in Canadian bees. The IAPV virus has been identified from bees shipped into the United States from Australia and in royal jelly from China (Chen and Evans 2007). Because Canada has imported queen bees from Australia as early as 1987 and package bees since 1990, it is possible that the virus may already be present here.

The impact of bee importation on native bee species in Newfoundland

While the list of bee parasites and diseases is somewhat small, it is important to note that most parasites of bumble bees are unknown and virtually nothing is known about their effects, epidemiology and evolutionary ecology (Schmid-Hempel 2001). There has never been an examination of possible bee diseases in the native bees of Newfoundland and Labrador. Not enough is known on the variation in the virulence of bee pathogens. Newfoundland's genetic isolation from mainland areas may result in variation in the susceptibility of native bee species to the diseases where what seems to be a rather benign pathogen in one part of North America may be highly infectious and deadly to species in Newfoundland.

The major concern for the native bee species for insular Newfoundland is the possible negative impact that introduced pathogens and parasites may have on this vulnerable fauna. It has been demonstrated that disease transmission between commercial imported bumble bees and native wild populations has occurred in the field (Colla et al. 2006). These authors have shown that in Canada, bumble bees that forage near greenhouses that have imported bees were 3 times more likely to be infected with *Nosema bombi* than those bees that foraged further away. A similar higher incidence of the gut trypanosome *Crithidia bombi* occurred in those wild bees that foraged nearby (Colla et al.

2006). Transmission of the disease was determined to be through the shared use of flowers (Otterstatter and Thomson 2008; Ruiz-González and Brown 2006). Graystock et al. (2013) in the UK, showed that commercially supplied bumble bees harbour diseases that can be transmitted not only to native bumblebees but also to honey bees. This may put into jeopardy the clean-free status of the Newfoundland honey bee population.

While most of the emphasis is on *Bombus* diseases, another noteworthy example of a disease that could affect other native bee species is the chaulkbrood fungus, *Ascosphaera aggregata*. This is commonly found infecting *Megachile rotundata*, a leafcutting species that has been imported into Newfoundland for blueberry pollination in the past. This same fungal species is known to infect the native leafcutter bee, *Megachile relativa* (Goerzen et al. 1990).

The direct competition for food between native species and introduced bumble bees is an important consideration. *Bombus impatiens* has a tendency to remain close to the colony and is believed to not pose a considerable competition threat to native bees in large agricultural monocultures when the bees are used during the crop flowering period (Whidden 1996). However, Javorek (unpublished data) has suggested that a decline in the previously abundant native bee, *Bombus terricola*, corresponds to the same period when the once infrequent *B. impatiens* has become the most abundant bee species in the Maritime provinces (in Winter et al. 2006). The exotic bee *Bombus terrestris* displaced two smaller native Megachilid species from foraging in Tasmania (Hingston and McQuillan 1999). In this case the larger *Bombus* species depleted the nectar resources and thus limited food for the native species.

With the decline in native species for various reasons (see Colla and Packer 2008), it may open up new niches that may be filled by exotic species. Some exotic species (*B. terrestris* for example) are able to move into new environments very easily even when the founding numbers are quite low (Buttermore et al. 1998). With global warming, Newfoundland may be at greater risk of having non-native bees establish here as the climate becomes milder this may allow exotic bee to survive here when historically they were excluded. A recent example is the discovery of the invasive Wool Carder bee, *Anthidium manicatum,* in several locations on the Island (Hicks 2011).

In Newfoundland, many of the spring and fall flowering plants rely on native *Bombus* species for their pollination. The loss of native species by diseases and competition with exotic species may result in significant changes to the island's ecosystem. We may see substantial changes in the availability of seeds and berries that will negatively impact biodiversity of birds and mammals (Winter et al. 2006).

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