UNIVERSITY OF VICTORIA

Monitoring and Enhancing Native Bee Populations

Monitoring Plan for the Galiano Conservancy

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1. Introduction

As one of the top pollinators in the world bees provide a seemingly invaluable service for humans both ecologically, and economically. Even so, the estimated "value of pollination to agriculture, provided primarily by bees, is >$200 billion/year worldwide, and in natural ecosystems it is thought to be even greater." (Lebuhn et al, 2013). It is therefore clear why the decline in bee species has been a major cause for concern in both the public and scientific communities. Although numerous species of bees are currently threatened or endangered, the European honey bee (*Apis mellifera),* is often the species of bee that is the focal point in public discourse. The European honey bee, a non-native bee introduced into North America, is most commonly associated with large scale crop pollination. Since the honey bee is now so closely associated with agricultural pollination, the decline in honey bee populations is of major concern; however what often gets left out of the discussion is the decline in native bee populations, who also play an integral role in maintaining ecosystem health and providing pollination to agricultural crops.

In BC native bees have proven to be excellent pollinators especially for certain vegetable crops. Indeed, "historically native bees and other pollinators were capable of pollinating farms and berry patches in North America when the areas provided sufficient habitat to native bees" (USDA, 2006). However, with modern day pressures, such as intensive forms of agriculture, native bees have been outcompeted by the European honey bee. To ensure the pollination of major crops, producers now rely on managed honey bees. However, "this has not been enough to meet the demand imposed by the simultaneous rapid >300% expansion of pollinator-dependent crops" (Button & Elle, 2014). In recent years there has been a growing body of research that suggests "that wild pollinators are needed to maximize yields in pollinator-dependent agricultural systems" (Button & Elle, 2014). This is particularly true when enough habitat is provided in agricultural areas (USDA, 2006).

1.1 Importance of Native Bees

There are many reasons to conserve and support native bee populations, some of which have been noted. Native bees can support crop pollination and make up for the disparities in honey bee pollination. In some cases native bees are more sufficient at pollinating than honey bees, actually "in over 40 crops worldwide, pollination by native wild bees increased yields in all of the crops studied, while pollination by the honey bee only increased yields in 14% of those same crops" (Xerces Society, 2015). Furthermore, with an increased diversity of pollinators, studies suggest that there is also a direct positive impact on crop pollination and growth (Morandin and Winston, 2005). In addition, native bees pollinate

in colder weather conditions than honey bees and have a longer pollination period. Some native bees such as bumble bees provide pollination to certain crops that honey bees cannot because they do not have sonication abilities, also known as 'buzz pollination'. For example, tomato flowers require that the anthers be sonicated in order for pollen to be released.

The Galiano Conservancy maintains a unique plot of land, Discrict n. 57. It is on this stretch of land I theorise that a monitoring plan for native bee species may be beneficial. Free from the pressures of intensive agriculture and urbanization, this site provides suitable habitat for native bees. In addition, honey bee hives are being implemented at this site near the 'Food Forest' as part of another on-going project. Through monitoring practises it can be established whether there is competition between the European honey bee and native bee species. Without the common pressures that bees face in modern urbanized locations, does the honey bee continue to out-compete the native pollinator species? This paper will recommend a monitoring plan for native bees at this site and further offer recommendations to enhance the native populations in the area. Although the monitoring plan will broadly encompass all native bees in the area, emphasis will be placed on the red listed Western bumble bee (*Bombus occidentalis*), which is considered a vulnerable species, and ways in which these populations can be enhanced. Lastly, further avenues of research to ensure the stability of native bees will be discussed.

1.2 Pressures on Native Bee populations

I. Disease

Transfer of disease between non-native and native bees is often cited as a concern. The importation of bees has been suggested to "be responsible for parasite introductions or a change in the dynamics of native parasites that ultimately increases disease prevalence in wild bees" (Graystock et al, 2016). In addition, insecticides and pesticides negatively affect both native and non-native bee. Some of the symptoms are death, paralysis, and an inability to fly.

II. Habitat Destruction

Urbanization and intensive agriculture has contributed to the destruction of suitable habitat for bees, particularly native bees. There is a vast variety of native bees that require different forms of habitat, however, most nest in the ground or in tunnels in logs left behind by beetles. Intensive models of agriculture have created uninhabitable regions for native bees.

Indeed, deep soil tillage and tree removal disturbs nests. Furthermore, herbicides and insecticides which are often applied in intensive forms of agriculture, threaten the health of native bee populations.

III. Competition

When introduced into an area honey bees have the tendency to "disrupt native pollination mutualisms and have a negative impact on native pollinators" (Geerts & Pauw, 2010). In addition Native bees often have a longer pollination period than that of the European honey bee or that of other pollinators. Finding enough food during the early spring and late summer/fall period is often a problem. Furthermore, during the peak pollination season humans often plant flowers for specifically honey bees instead of native bees.

Figure 1. Hurworth, Ella. *Pollination in Process*. 2014

2. The Site

Galiano Conservancy protects a unique strip of land on District lot 57. This site is home to numerous types of ecosystems that can support a variety of pollinators. Lot 57 lies within the Coastal Douglas fir

zone within which are sand cliffs, arbutus ridges, and swamp like areas. Historically this property was a mill site, and heavily logged which altered the landscape greatly (The Galiano Learning Centre Management Committee, 2013). Despite the degradation that has occurred on a vast portion of the property, many sites are beginning to recover, and increased pollinator diversity can increase recovery of these systems.

Lot 57 is also home to a 'food forest', a form of agroforestry that promotes the growth of a variety of different plant species. Following its mission "to preserve, protect and enhance the quality of the human and natural environment on Galiano Island" (2013) the implementation of the food forest by the conservancy, connects people to the land, and creates healthy ecosystems that promotes diversity.

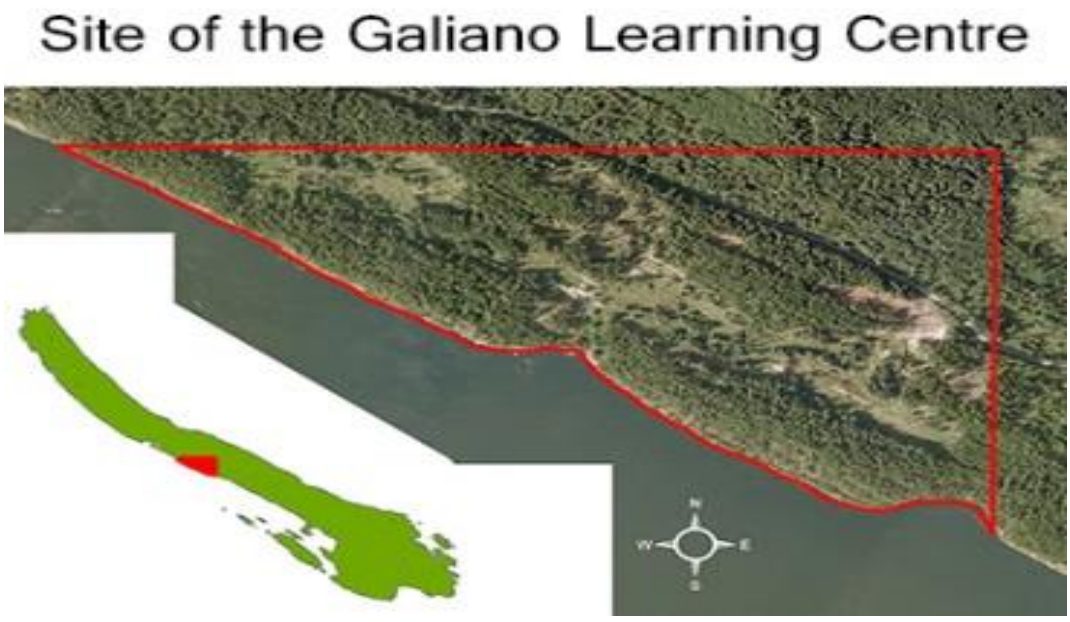

Figure 2 – Location of District Lot n. 57 on Galiano Island.

The term agroforestry is applied in a very broad sense. Indeed, the definition of the term itself is very broad. Hyeone Park (2009) describes food forests as "edible polyculture systems that replicate forest structures and functions" (Park, 2009). Food forests are "inspired by tropical food forests, food forests are burgeoning in the Global North, particularly in temperate-to-cold regions of Canada" (Park, 2009). Food forests do not just produce edible plants for people, but also have the potential to support other species by creating habitat and a food source. Unlike intensive forms of agriculture, which primarily plant large scale mono-crops, the food forest plants a variety of crop that flower at different periods, and thus

provides more pollen and nectar sources. Extending the pollination period for bees is integral because native bees begin pollinating in the early spring and continue into the fall, unlike the honey bee which has a shorter pollination period.

Lot 57 poses as a unique site on which to monitor native bee populations. Representing a microcosm, the site is free from many of the modern day pressures on bee populations that are being experienced elsewhere, perhaps the most notable of which is the absence of large-scale urbanization and intensive agricultural practises on the site. As was noted previously, these two pressures leave little room for suitable habitat for native bees. Interestingly, although European honey bees have been introduced to the island, the site itself did not previously have managed honey bees. This year however, the Galiano Conservancy will implement hives onto the site near the food forest. Although this is a separate project geared to monitoring the effects of honey bee pollination within the food forest, it will nonetheless be interesting and important to monitor the potential effects the introduction of honey bee populations will have on native bees. In addition, pesticides and insecticides are not used on this site, which have been proven much more harmful to native bees than honey bees affecting their immune system and nesting patterns. Lastly, although this site was historically heavily disturbed, it now has the potential to create a large amount of habitat for native bees as the site is relatively undisturbed. Native bees have the opportunity to nest in the ground or in trees without major threat to their homes.

The proposed site for monitoring native bee populations will be located at the north-west region of the property, which is located in the same region as the ‘food forest’ and the newly implemented honey bee apiary.

Figure 2. Hurworth, Ella. *Managed honey bees at the Earthwise Society.* 201

3. Monitoring Plan

Accurately monitoring and assessing native bee populations on the site will be a challenging task, but extremely important nonetheless. According Kearns and associates, monitoring protocol in North America is not yet sufficient. Indeed, "baseline and trend data from other parts of North America are greatly needed to assess the population status of bumble bees" (Kearns et al, 2017). With time budget and time constraints in mind, I researched monitoring protocols which would be possible with limited resources. I propose to use the "Streamlined Bee Monitoring Protocol for Assessing Pollinator Habitat" (Minnerath et al. put forth by the Xerces Society. This method of monitoring has two main strengths, the first being that it "allows users to rank multiple pollinators plantings from least to most diverse in terms of bee communities supported" (Minnerath et al. 2014). Second, it utilises reference sites that have not been planted to establish whether plantings have increased pollinator populations and bee diversity.

4. Protocol

Monitoring will take place on several occasions in a season. The Xerces Society (2014) suggests that two visits to the site is sufficient. It is integral that the monitoring process occurs on days when the weather is warm because that is when bees are most active. In BC an optimal time to monitor is between May and July. To monitor the site will need to be divided into 100 ft. transects, all of which are ideally in the sun. The Streamlined bee monitoring protocol suggests only sampling each transect for 7.5 minutes and observing the number of bees visiting flowers within a 3 ft. width of the monitors position on the

transect. The bee needs to physically land on the flower for a minimum of 0.5 seconds for it to be recorded. It is also important to note the types of flowers that are in bloom during the monitoring process. During the second visit the same protocol will applied.

Given the new activities occurring in the area (e.g. the food forest development and implementation of the apiary), I suggest that monitoring two locations on the property would be beneficial. The first location is within the food forest. Since monitoring will already be conducted with the introduction of honey bees into the area, native bee monitoring should also occur to determine which pollinators are more dominant, whether there are positive interactions between native and non- native bees, and to determine which plants are attract different types of bees. The second approximate location could occur down the slope from the food forest in the valley depth, where there is less wind exposure, many suitable places to nest in old wood, or in the ground, and near a marshy area which is a water source. The exact length and location can be more flexible if time restraints are an issue.

By monitoring two locations we can determine the quality of the site since the number and diversity of bees can reflect the health of a site. If there is high bee diversity at a site we can infer it is a higher quality site. In this way we can determine whether the food forest which still requires a level of human intervention and manipulation supports native bees, or whether areas that experience less human manipulation are helping native bee populations.

5. Recommendations/Enhancement

The current state of the site proposed for monitoring has many attributes that would support healthy native bee populations. Free from degrading practises that destroy habitat, bees have the potential to nest within trees or in the ground. They also have access to food with various wildflowers, trees, and the food forest in bloom. Nonetheless, there are many ways in which this site can be enhanced to support more diversity and ensure a longer pollination period.

5.1 Plants for Habitat

There are a number of plants that can potentially be incorporated into the site that attract native pollinators, but also provide habitat. Since many native bees prefer to nest in tunnels, planting plants with stems that can host bees are important. Some examples include:

- Box elder (Acer negundo)
- Agave (Agave spp.)
- Sunflower (Helianthus spp.)
- Sumac (Rhus spp.)
- Wildrose (Rosa spp.)
- Raspberry, blackberry (Rubus spp.)
- Elderberry (Sambucus spp.)

(Xerces Society, 2013)

5.2 Pollen Producing Plants

Other plants that could be incorporated or added into the land scape that are a good source of pollen include:

- Yellow (tulip) poplar
- Maple, basswood, and black cherry, in the overstory to benefit pollinators.
- Ginseng,
- Goldenseal

(USDA, 2006)

5.3 Native Plants for Native Bees

Native pollinators are often most attracted to native plants (Xerces Society, 2015). Some plants that could be planted for an early source of pollen and nectar for native bees in the early spring, particularly for the Western bumble bee (Bombus *occidentalis),* includes the Oregon grape (Mahonia *aquifolium)*, Bigleaf lupine (Lupinus *polyphyllus)* and the Oregon vine maple (Acer *circinatum*). In the late season bumble bees and other native bees prefer the Canada goldenrod (Solidago *canadenis*), Coyotebush (Baccharis *pilularis*) and Ocean spray (Holodiscus *discolor*). These plants provide a critical source of pollen and help to extend the pollination season.

5.4 Agroforestry

Agroforestry has often been cited as a partial solution to unstable and unhealthy bee populations. As noted, the food forest on the site falls under the category of agroforestry. Beyond the notable benefits of food forests which have the potential to provide ecological and social resilience, agroforestry has been

suggested as tool to help enhance native pollinator species. The presence of trees in an area “acts as a windbreak, making it easier for bees to visit flowers and to stay warm on cooler days” (Xerces Society, 2006). In addition, depending on the types of trees planted, they can provide a great source of pollen.

6. Future Considerations

Future considerations or avenues of research to promote native bees could be creating corridors for bees across the property or even more broadly on the island. By ensuring there is adequate pollen sources across the property bees can forage farther and for a longer period. Another consideration is the threat that deer pose on the island. Although not a direct predator to bees, deer’s have the capacity to greatly limit floral diversity due to browsing. Therefore, selecting plants that Deer will not typically browse will be an important factor to consider. Lastly, citizen science can be a valuable source of information regarding bee monitoring. There are many ways in which the public can contribute to a scientific body of knowledge.

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