# Mapping Traditional Bird Knowledge for Urban Bird Conservation in Halifax, Nova Scotia, Canada

by

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## ABSTRACT

Urbanization is a worldwide trend resulting in loss of bird habitat, dominance of invasive species and higher densities of some predatory species. However, cities provide new opportunities for birds because of warmer winter climates and sources of artificial food. Proper management of urban habitat is significant for maintaining diverse bird communities and raising conservation awareness among city dwellers.

This study aimed at identifying important urban bird habitats as well as their characteristics in Halifax Regional Municipality, Nova Scotia. Fourteen local birders outlined bird habitats on maps, and the information was compiled and presented using GIS. In total, 28% of the study area was indicated as key habitat for urban birds. By comparing the GIS data with existing conserved areas, coastal areas, marine habitat and urban wetlands were found to be under-represented in conserved areas. Following from the research findings, recommendations for improving habitat identification and management are made.

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# CHAPTER 1 – INTRODUCTION

In a study carried out by Corporate Knights and two researchers (2008), Halifax Regional Municipality (HRM) was ranked second in a list of Canada's most sustainable cities in the medium-sized cities category, and fifth overall in Canada,. While this is an impressive record, Halifax did not score well in all of the classes of indicators examined. Among five indices that were used to examine the sustainability of cities, ecological integrity was reported as HRM's weakest aspect. Quebec City had a much higher score for its ecological integrity index, and Halifax has a long way to go if it wants to become a leader in urban environmental conservation in Canada (Halifax Regional Municipality, 2008a; Corporate Knights et al. 2008).

Urban ecology has two distinct meanings in the literature (Sukopp, 1998). From the ecological perspective, it mostly refers to studies of the distribution and abundance of organisms in and around cities while from the urban planning perspective urban ecology has focused on designing the environmental amenities of cities for people, and on reducing environmental impacts of urban regions (Deelstra 1998). Ecological integrity (EI) is an indicator of the health of ecosystems, and in order to increase urban ecological EI for bettering the quality of life of citizens, as well as reducing ecological footprints, the distribution and abundance of different organisms need to be surveyed and monitored for informing the process of urban planning.

However, due to government budget cuts in recent years in Canada, scientific research and monitoring activities usually are not be sustained over long periods (Sharpe & Conrad, 2006). NGOs, volunteers and other communities of interest have been encouraged to fill the gap, but many challenges are faced by these groups, such as the consistency of sampling methods, expertise and availability of research materials (Sharpe & Conrad, 2006). This thesis addresses one specific aspect of filling this "gap": gathering information about urban avian biodiversity.

In this thesis I chose to study the habitats of urban avian communities based on two assumptions: firstly, the distribution of urban birds is uneven because habitat quality varies in relation to urban activities such as housing development and horticulture. Habitat quality and bird distribution can thus reflect urban ecological integrity. Studies have shown that the global trend of increasing urbanization has led to the simplification of avifauna in cities (Melles et al, 2003). For example, some exotic and human-tolerant species, such as European Starling *(Sturnus vulgaris)* and American Robin *(Turdus migratorius)* come to dominate most habitats (Emlen 1974, Campbell and Dagg 1976, Lancaster and Rees 1979). However, other studies have also indicated that despite the alteration of natural habitats, urban areas may offer opportunities for foraging and other resources for diverse birds in harsh weather conditions (Clergeau et al., 1998). As urban ecotypes evolve, the abundance of birds is expected to be greater in the future because according to Clergeau et al. (1998), birds become more adapted to urban environment and require less territory to feed or breed. Therefore, important urban bird habitat should be identified, evaluated and integrated into urban planning processes for maintaining an urban avian fauna that is as diverse as possible. This requires that habitat factors which that provide for avian diversity be identified.

Secondly, local knowledge of naturalists is a very valuable source of information for urban bird studies. This includes knowledge of bird habitats and their potential risks, but this information is scattered and needs to be collected and organized. Local bird experts (often described as “birders”) are a group of people that enthusiastically watch and study birds. Compared with other community- based monitoring programs, such as water quality assessment, bird watching has a longer history and better established survey protocols. Gathered bird-watching information has been successfully utilized by organizations like the Cornell Laboratory of Ornithology for broad scale research on bird status. Also, activities such as the Christmas Bird Count have been carried out by birders for more than a century in some places (Audubon, 2010). These successful monitoring activities reveal the expertise and capability of birders.

Therefore, my study aims to discover the key habitats of urban birds in HRM during different seasons, including their characteristics and potential risks to their quality, by interviewing local birders. The results of this study can then be used to feed into municipal urban planning processes for more effective conservation of urban birds. The study also provides insights into some of the environmental benefits of urban birds to citizens.

# CHAPTER 2 – INTRODUCTION TO BIRDS IN THE CITY

## 2.1. Urbanization and urban biodiversity

Urbanization is a predominant and irreversible phenomenon. More than half of the world's population now lives in cities (Wu, 2008) and it is estimated that by 2025 the population living in cities will be 5 billion, which will be about two thirds of the total world population (Freedman, 2007). Although cities only cover about 5% of the land's surface of the world (Acar et al., 2007), they account for most resource consumption and pollution. Because cities cannot be self-supporting with respect to energy and materials, all urban areas are dependent on other ecosystems to provide resources and assimilate wastes. This is the reason why the ecological footprints of cities are much bigger than the actual area they occupy. For example, the five largest cities in Canada (Toronto, Montreal, Vancouver, Ottawa-Hull, Calgary) need approximately 76 times their area to supply energy, materials and to dispose of waste (Freedman, 2007).

Urbanization not only has a conspicuous influence on biochemical cycles, climate and hydrosystems (Grimm et al., 2008), but it also profoundly changes land cover and landscape patterns, resulting in the loss of natural habitat, degradation of ecosystems, and impoverishment of native biodiversity. Urbanization has eliminated a large majority of native species from within the cities themselves and produced local extinctions (McKinney, 2002). Furthermore, it has homogenized ecosystems by introducing many non-native species (Blair, 2001; McKinney, 2006). Compared with other classes of land-use area, urban areas are the hardest to restore back to the climax condition (McKinney, 2002). In the next few decades at least, urbanization is an irreversible trend and will continue to sprawl quickly across landscapes, driven particularly by the fast growing populations in developing countries. The pace of growth of urban areas is much faster than that of national parks and other conservation areas (McKinney, 2002). Therefore, an imperative challenge is to determine how urban ecosystems interact with their peripheral ecosystems.

Many studies have modeled the relationship between a city and its natural matrix as a gradient from the human-dominated center to the surrounding natural, environment (Blair & Launer, 1997; Kowarik, 1995; McIntyre, 2000; McKinney, 2008). Along the gradient, human population density, road density, the percentage of impervious surface, the number of small and fragmented green patches (Medley, McDonnell, & Pickett, 1995; Collins et al., 2000), pollution, soil alkalinity and the amount of energy and material used by people all typically increase towards the city center (McKinney, 2002). The species richness of many taxa has been studied along this gradient in order to explore the influence of urbanization on biodiversity.

In general, native species show a decreasing trend towards the center of urbanization while non-native species tend to increase from a few in natural environments to over 50% in the city (McKinney, 2002). The lowest species richness, which is less than half of that of native ecosystems, occurs in the most urbanized center (McKinney, 2002). The communities of butterflies (Blair & Launer, 1997), birds (Marzluff, Bowman, & Donnelly, 2001), plants (Kowarik, 1995) and insects (McIntyre, 2000) all show this general trend of declining species richness. The progressive loss of species richness towards the city center is correlated with the loss of vegetation. One third of the native vegetation, and even the topsoil, have usually been removed for housing developments (Sharp, Stearns, Leitner, & Dorney, 1986). When houses have been built, more than half of the surface is paved and what is left is usually replanted with alien ornamental species. The non-native vegetation cover together with the increase of predatory animals like domestic cats substantially lessens the ecosystem's ability to sustain a diverse group of native species.

However, human disturbance isn't entirely negative to biodiversity. The peak of species richness of major groups of organisms does not occur in the primary (original) environment but in places where human activity exists but has not changed the ecosystem dramatically. Yet the level of disturbance corresponding to this peak of species richness varies with the scale that is applied to examine the urban-nature gradient. The peak is also subject to the characteristics of individual ecosystems. Birds in primary tropical

habitats, for example, are generally more sensitive to disturbance and have more difficulty adapting to the urban environment (Bell, 1986). Also, each taxon reacts to different levels of human interference in its unique way. Plants along the urban-nature gradient have distinctly different patterns from those displayed by animals. Most groups of plants show a tendency to peak at moderate levels of urbanization such as small towns, while vertebrate and invertebrate animals tend to have their highest species richness in less urbanized areas (McKinney, 2008). These phenomena are reflected in the intermediate disturbance hypothesis (Blair & Launer, 1997; Germaine & Wakeling, 2001), which asserts that mild or moderate human disturbance promotes the chance of coexistence of species which have different life history strategies (Grime, 1973).

Most research has focused on species richness but has ignored the abundance as well as the complex interactions among different taxa. Our knowledge of urbanization and biodiversity is far from complete. Nonetheless, urban biodiversity conservation is necessary for the rare species that exist in urban green spaces (McKinney, 2002), the health of urban ecosystems, and most importantly for informing the public of the bigger picture of nature and conservation (Miller & Hobbs, 2002). While non-native species may appear undesirable, it is believed that the interaction between people and some non-native species (e.g. Rock Doves *(Columba livia)*) may be helpful for people to obtain knowledge about nature, such as by observing the behaviour of charismatic animals and enjoying the beauty of attractive plants (Grimm et al., 2008).

### 2.2. Birds and Urbanization

Studies of urban effects on avian fauna can be traced back to a work by Pitelka published in 1942 (Pitelka, 1942) and have steadily increased since then. Worldwide, urbanization has changed different ecosystems to varied extents but has resulted in similar ecological structure in city centers (Clergeau et al., 2006; Suhone et al., 2009). Previous studies have also shown some common patterns of bird distribution in and around urban areas (Batten, 1973; Blair, 1996; Marzluff, 2001; Melles, Glenn & Martin, 2003; Clergeau et al., 2006, McKinney, 2006).

In general, a city has more stable artificial food sources, fewer avian predators (Marzluff, 2001), and warmer climates in the winter (Suhonen et al., 2009), all of which favor some bird species over others. However, diminishing habitat quality, decreasing patch sizes, simplified vegetation complexity, spread of non-native vegetation, and increasing edges caused by development are all destructive for interior and ground nesting species as well as those that rely on native vegetation (Marzluff, 2001).

From 1966 through 2005, the abundance of breeding birds recorded in the North American Breeding Bird Survey dropped by up to 18% (Valiela & Martinetto, 2007). The abundance of resident birds decreased by 30% while migrants decreased by 19% (Valiela & Martinetto, 2007). According to several studies (Terborgh, 1989; Böhning-Gaese, Taper & Brown, 1993; Brook, Sodhi & Ng, 2003; Stratford & Robinson, 2005) urbanization has been the primary reason for these population declines by causing significant reductions of breeding habitats in North America, as well as reductions of neotropical wintering habitats. Among the decreasing populations of resident birds, open habitat species, edge species and wetland species suffered most seriously (Valiela & Martinetto, 2007).

Both open habitat and wetland loss have obvious direct connections with urban development. At first it may seem that urban development would improve the conditions for edge species because more edge habitat is created due to habitat fragmentation, but the habitat quality of the edges deteriorates due to frequent human disturbance and ongoing development (Valiela & Martinetto, 2007).

Most urban areas are dominated by a few species with omnivorous diets, such as Rock Dove and European Starling (Marzluff, 2001; Melles, Glenn & Martin, 2003; Rutz, 2008) and this has led to a simplified structure of avian communities in cities. These species are adept at using resources provided by humans, thus their density peaks in city centers. Blair (1996) described such species as “urban-exploiters”. “Urban avoiders” are at the other extreme of the range. They are particularly sensitive to human disturbance and have their maximum densities in natural areas, such as Cetti’s Warbler *(Cettia cetti)*

(Croci, Butet & Clergeau, 2008). Blair (1996) described a third guild lying in between these two cases, which he called "urban adapters" such as Barn Swallow *(Hirundo rustica)* (Croci, Butet & Clergeau, 2008). They are able to exploit the additional resources that accompany intermediate levels of development, but are not as well adapted as urban exploiters or as sensitive as urban avoiders (Blair, 1996).

The overall abundance of birds may peaks in the city center because the population densities of urban species are much higher than the densities of species in the surrounding rural areas (Batten, 1973). The same is true of bird biomass (Melles, Glenn & Martin, 2003). On the other hand, species richness is lowest in the urban center. However, along the urban-rural gradient, neither species richness nor Shannon diversity index increases linearly with distance from the center. For birds, these indices peak where intermediate levels of disturbance are found, such as in the mixed-use largely-agricultural countryside surrounding a city. Typical woodland species are gradually reduced towards urban centers (Blair, 1996; 1999). Blair (1996) found, however, that only using species richness and Shannon diversity indices to examine the impact of urban development on avian communities can be misleading. When closely examined, the additional species in areas subject to intermediate levels of disturbance are usually widespread species (Blair, 1996). The seemingly increased biodiversity is due to more ubiquitous, and sometimes exotic, species being sustained at the expense of fewer locally-adapted native species. Consequently, research focused on different scales is important for differentiating the quality and quantity of species, as well as providing a comprehensive understanding of the relationship between urbanization and birds.

Previous studies on urbanization and birds can be summed into three categories in terms of ecological theories and research methods (Melles, Glenn & Martin, 2003). Different scales are closely related with each approach. The first phase of ecological studies, which are still being carried on, usually focus on a fine-scale, involving stand-level sites. These studies have examined how the types of vegetation structures and their species composition relate with the presence of bird species (e.g. Emlen 1974, Campbell & Dagg 1976, Ambuel & Temple, 1983). For example, the chance of finding native bird

species in a large patch of berry-rich shrubs, or a stand of old trees near a water body, is much higher than in the center of a paved square in a city.

Only taking account of stand-scale a characteristic is insufficient to estimate and explain the presence of birds. Doing so ignores the influence of the landscape background (Miller et al., 2001; Melles, 2003). Though the background influence might be weak when the condition of the site and its matrix are similar (Brawn & Robinson, 1996), it can be strong when the conditions of the two are quite different, especially when a poor local habitat is situated in a favorable landscape for birds (Sewell & Catterall, 1998).

Consequently, in many recent studies (Jokimäki, 1999; Hostetler, 1999; Clergeau, Jokimäki & Savard, 2001; Melles, Glenn & Martin, 2003) stand-scale characteristics have been viewed within a landscape-scale (or even continental-scale) background, and have provided a deeper insight into how birds respond to human activities. For example, Jokimäki (1999) found that species with lower demands for habitat area were found closer to urban centers than those requiring large patches of habitat to breed. Researchers also used the multi-scale analytical approach to determine the scales at which birds respond most effectively (Hostetler & Holling, 2000; Hostetler, 2001), and this has helped decision makers and urban planners to consider wildlife protection in more effective ways. The limitation of this approach lies in the complexity of urbanization itself. Assessing the degree of urbanization is far more intricate than simply measuring distance from the urban center. The distribution patterns of urbanization variables, and other large-scale characteristics such as geographical and hydrological features that influence the habitat, also need to be assessed. Thus, a variety of spatial scales and a comprehensive set of research approaches need to be applied. Besides, Alberti, Botsford and Cohen (2001) have argued that the concept of a rural-urban gradient is inadequate for modeling the rural-urban relationship. Instead, a set of metrics would be more helpful. Thus, another difficulty that multi-scale studies must address is to characterize and quantify urbanization adequately.

In a third research approach, urban habitats have been viewed as isolated islands. In this approach, rates of immigration, extinction, emigration, fecundity, death and other demographic characteristics of bird populations have been examined in relation to habitat characteristics such as size, forest composition and configuration, predator density, and others (Opdam, 1991; Fernandez-Juricic & Jokimäki, 2001; Beckerman, Boots & Gaston, 2007). For example, Beckerman and co-workers (2007) looked at how the density and presence of domestic cats decreased urban bird populations directly by predation, and indirectly by affecting their fecundity and behavior. These island biogeographic approaches have been helpful for understanding the influence of a single environmental factor, or a few factors. However, this needs to be combined with the multi-spatial approach for a thorough understanding of birds and urbanization.

Research methods are constantly evolving as new and more advanced technology is developed, yet there is still a lot to explore in understanding the relationship between urbanization and birds. Melles, Glenn and Martin (2003) considered that there were no well-established ecological theories on the mechanisms underlying the responses of bird communities to landscape variables. Most studies have been quantitative; 60% of them have focused on breeding species, and 70% were conducted in temperate zones. Marzluff (2001) considered that at that time there was still a lack of studies on migration and the influence of the tropical urban environment.

Another challenge facing researchers is how to tailor their research and the presentation of their scientific findings to make them more accessible to policy makers, planners and a diverse audience (Marzluff et al., 2001; McKinney, 2002). The findings of studies in conservation biology have important implications for various aspects of socio-economic and legal policy, but these will not be effective unless the studies address appropriate questions for policy-makers and results are presented in an understandable manner.

### 2.3. Birds as indicators of urban ecological integrity

Parks Canada (2009) describes ecological integrity (EI) as "… a condition that is determined to be characteristic of its natural region and likely to persist, including abiotic components and the composition and abundance of native species and biological communities, rates of change and supporting processes". This concept has been applied to urban, aquatic, and many other ecosystems. It acts as an umbrella idea which embraces values of biodiversity, ecological resilience and naturalness (Noss, 2004).

While very useful in theory, the concept of EI has such broad range and profundity that it is complex to apply in practice. Managers and planners need scientific quantification systems, or accurate ways to measure it, in order to apply this concept in practical work. Various ecological indicators have therefore been developed for measuring and quantifying EI. According to their function, ecological indicators can be categorized into three main kinds (Gregory et al., 2003; Lapaix, Freedman & Patriquin, 2009): status indicators, which describe the current state and predict the future state of variables (Niemi & McDonald, 2004); driving force indicators, which are sensitive to some environmental stressors and can act like early-warning tools (Dale & Beyeler, 2001); and response indicators, which measure rehabilitation processes (Gregory et al., 2003). The three kinds are not mutually exclusive. For example, a particular species or ecological community can serve multi-functionally.

The selection of an ecological indicator, or sets of indicators, is normally based on the knowledge of how their presence or behavior reflects environmental status or changes (Lapaix, Freedman & Partriquin, 2009). At the local scale, urbanization prevails over all other driving factors of environmental change (McKinney, 2002), and has therefore become a focus of researchers who are interested in the influence of anthropogenic disturbances on EI.

As outlined earlier, various taxa (plants, invertebrates, birds, and mammals) have been examined along urban-preserve gradients, that is, from densely urbanized areas to

fully wild areas (Mackin-Rogalska & Nabaglo, 1990; Denys & Schmidt, 1998; McDonnell & Pickett, 1990; Blair, 1999; Germaine & Wakeling, 2001). Taxa that exhibit a unimodal pattern along the gradient are typically very useful indicators for representing anthropogenic stress on an environment (Lapaix, Freedman & Partriquin, 2009). For example, bird species richness been shown to perform such unimodal pattern. It peaks at intermediate levels of disturbance, and decreases gradually as human interference increases towards the urban center; while in the opposite direction from the peak, as the level of disturbance declines, non-native species gradually drop out (Blair, 1996; Blair, 2001; Blair, 2008). Therefore, the pattern of bird species richness is closely related with the shift in habitat structure, and tends to reflect the degree of urbanization along the gradient.

However, birds are not good indicators when EI is examined either on a micro or macro scale. Invertebrates are commonly used as indicators when EI is examined at a fine scale, owing to their stronger association with environmental factors than with biological factors like competition, predation and parasitism (Carignan, 2002). There is a relationship between the scale of the environmental condition and the scale of the characteristics of an organism (Temple and Wiens, 1989; Carignan, 2002). For example, the habitat and food requirements of insect-eating birds are in between those of invertebrates and large carnivorous mammals. Thus the occurrence of individual bird species as well as their species richness may be more dependent on intermediate scale characteristics, such as the vegetation composition in a nature reserve (Pärt and Söderström, 1999; Carignan, 2002), while the presence of large mammals may relate more with landscape-scale features (Noss, 1999), such as the extent of fragmentation and the amount of forest clear-cutting.

Nonetheless, birds are commonly regarded as one of the useful indicators of urban ecology because they can respond to environmental characteristics at various spatial-scales (Temple & Wiens, 1989; Hostetler & Knowles-Yanez, 2003). At the species level, especially with respect to high trophic level birds in urban environments, they may perform as keystones, whose abundance can partly manifest energy and material flow due

to their strong interaction with other species of lower trophic levels. Some species can also be seen as resource-limited, if the resources they rely on (e.g. large habitat) are diminished by environmental stressors. At the landscape level, bird community compositions have been shown to be influenced by the vegetation and structure of their matrix (Blair, 1996; Melles, 2003). Many other characteristics also result in birds being handy indicators of environmental change and stress. Because the taxa are relatively well studied, massive amounts of information are available across both spatial and temporal ranges for better understanding of reference conditions. They can be easily sampled; a set of standardized census methods have been developed and widely used for effective recording and ensuing data analysis (Kendeigh, 1944). Bird indicators are also suitable as communication tools between managers and the general public (Lapaix, Freedman & Partriquin, 2009). In this sense, birds are excellent indicators due to their popularity among people.

Even so birds alone are imperfect indicators and can only be used for initial and coarse measurement of EI. They can be problematic because each species or each guild exhibits different behaviors towards environmental changes. In one study, their coefficient of variation (0.57) was substantially higher than that of vegetation (<0.25) (Gibbs et al., 1998). O'Connell (2000) suggested that the Bird Community Index (BCI) may perform effectively for measuring EI. BCI categorizes birds according to their demand for habitat, food and other elements necessary for survival, and thus resource changes can be reflected in the populations of a specific guild or a few guilds. This method is better than considering the bird community as a whole or using a single bird species as indicators, yet still far from sufficient to measure EI accurately from different organizational levels, such as community, population, ecosystem, and others. Additionally, bird metrics displayed very limited capacity to differentiate mild and moderate levels of human disturbances (Bradford et al., 1998). They need to be coupled with other indicators for a useful gauge of EI.

# CHAPTER 3 – MAPPING TRADITIONAL BIRD KNOWLEDGE

## 3.1. Background

Nova Scotia (NS) is on the migration route of many bird species. Its geographic location and diverse landscape attracts many bird migrants and non-migrants. More than 440 species have been observed in NS (Stevens, 1996). In metropolitan-Halifax, the most urbanized pocket of Nova Scotia, bird species and their distribution are quite different from those of the more natural parts of the province. The profoundly altered urban environment has degraded and diminished the habitats of birds, reduced or altered their food sources by over-management of green spaces, and produced high densities of predatory cats. However, the city's warmer ambient temperature and backyard feeders also provide enriched opportunities for many bird species. Therefore, identifying and prioritizing the important urban habitats is necessary for bird conservation. Planners can use the information and avoid targeting the important bird habitats as potential areas for development, and in this and other ways integrate bird conservation into their planning.

Another driving factor of my project has been to examine the merits of local birders' knowledge. Many research institutions and organizations such as the Cornell Ornithology Laboratory and Bird Studies Canada have realized the value of citizen science and local birders' knowledge. They have successfully gathered knowledge from these amateur observers and applied the knowledge to the study of bird populations, distribution and dynamics at large scales. However, most of the knowledge of local birders is not limited only to location, species and abundance of birds, but is also enriched with personal experiences which contain more detailed information of birds' habitats, threats to their existence, and interaction with other living beings. This knowledge should be recorded for its irreplaceability and local focus. Deep knowledge of this sort could be applied to finer scale studies for diagnosing the local threats and facilitating urban planning to increase urban ecological integrity.

### 3.2. Objectives

The research described here aims to identify the habitats in metropolitan Halifax of conservation value for birds that breed or migrate through the area. Some of these places are important because they provide high quality habitat and are favored by birds. Others might be less important for the avian population itself, but due to the high potential for interaction between humans and birds they have great social and education value, which will in return benefit the conservation of urban birds. Both kinds of values are considered in the research, as are the factors within the habitats that are crucial for bird survival during winter, breeding seasons, and both spring and fall migration periods. By studying the locations and characteristics of each habitat identified, the study tries to make suggestions on how bird conservation might be integrated into urban planning and every city dwellers' daily life. In achieving these goals, several research questions need to be addressed.

### 3.3. Research Questions

Firstly, where do local bird experts go birding in the defined study area and how frequently do they visit these places? The answers to these questions provide geographic baselines (physical and social) for the study.

Secondly, do seasonal and habitat quality factors affect bird distribution? Not all regular birding sites are necessarily of significant conservation value, as seasons change, each habitat changes. The same habitat may support a different group of birds or the same group of birds may look for different things that a habitat can provide. Detailed information on the location of important habitats during breeding season, winter, spring and autumn migration, as well as factors influencing the distribution of birds have been investigated in the study, notably those factors which determine the quality of bird habitat in the urban area.

Thirdly, what is the conservation status of the important habitats identified by the informants? Some of the habitat areas are under various levels of protection already and

these are less vulnerable to habitat loss and other human disturbances; some are in the process of getting protected status; while some are totally exposed and susceptible to habitat alteration. Investigating their status facilitates understanding the current situation of urban bird conservation in Halifax as well as prioritizing current threats. Based on the analysis of status and threats, the research has made it possible to provide suggestions on how bird conservation might be integrated into urban planning, as well as advice on preferable backyard practices of landowners.

### 3.4. Process

To achieve these goals, 14 local bird experts were interviewed formally. Additional birders and urban planners were also consulted less formally, and a focus group was held to obtain the information needed to address the study questions defined above. All interviews and the focus group were audio recorded with the consent of participants. The interviews were transcribed and coded using Nvivo software.

Based on the compiled and analyzed information, habitats that have significant value for bird species that both breed in and travel through metropolitan Halifax, as well as those places that have great social and educational value, were recognized. By comparing the well-known habitat identified by birders with the database of significant habitat, parks and protected areas in HRM, vulnerable sites were identified.

### 3.5. Methods

#### 3.5.1 Selection of study participants

According to standard social science research methods (Bryman & Teevan, 2005), a snowball sampling approach was used to select the potential participants. The researcher initially made contact with three 'key informants' who are familiar with research methods and with the Nova Scotia Bird Society. The initial contacts helped to establish contacts with well-known local birders. After each interview, when the participant had fully understood what the research is about and what the interview process would be like, they

were asked to recommend knowledgeable birders who they thought should be added to the potential contact list. No restrictions from the researcher were applied in finding the interviewees; the credibility and validity of the research is largely based on the traditional knowledge of local bird experts and for this reason it was important to search for interviewees by utilizing the perspective and the social network of local birders. In total, 26 bird experts were contacted and 14 of them agreed to be interviewed face to face.

### 3.5.2 Selection of study area

The study area is located in metropolitan Halifax, N.S., Canada. It is a 21km x 21km square, in the centre of which is Halifax Peninsula and downtown Dartmouth (Fig. 1). It includes various land uses: industrial parks, business parks, residential areas, playgrounds, semi-natural parks, wilderness areas, and both fresh and salt water bodies. The inclusion of extensive land use categories was aimed at lowering the possibility of missing some of the characteristics of urban habitat that influence the survival of avian populations. Most of the interviewees live in or are very familiar with most, or all, parts of the study area. It is worth noting that though the boundary of the study area is somewhat arbitrary, the mental maps in birders minds are not as tangible. The mapped study area was a main reference for them, while in the interview they were encouraged to talk about places beyond the study area when appropriate. However, the data analysis is focused within the scope of the study area.

Since the purpose of the study is to improve urban bird conservation, rather than having a relatively comprehensive collage of different types of land use, the study needed to have a focus on the urbanized core and be detailed enough to not to miss any plot-scale characteristics that might influence the urban bird population. Therefore, an intensive study area was also defined. It is a 7 km * 7km square which is the centre piece (1/9) of the whole study area. It is comprised of the whole Halifax Peninsula, downtown Dartmouth, Purcell's Cove and part of McNabs Island (Fig. 2).


Figure 1 – Whole Study Area


Figure 2 – Intensive Study Area

### 3.5.3. Preparation of the maps and questionnaire

Both the whole study area and the intensive study area were made into maps and printed on 60 cm by 90 cm paper before each interview. The spatial data were obtained from the Department of Natural Resources, Nova Scotia, and the aerial photography was flown in October and November, 2003 after Hurricane Juan hit the east coast of Canada (Natural Resources Nova Scotia, 2004). Due to data limitation, a small part of the bottom-right corner of the whole study area is blank. This deficiency involves open-water marine habitat had no notable influence on the study.

Each participant was given a set of un-marked maps to work on, so as to avoid the influence of other birder's ideas. Most participants worked with both maps while some individuals marked only one map (whole study area or intensive study area). However, both maps proved to be similarly effective, scale being the only difference, so participant choices regarding map-marking did not sacrifice data quality.

The questionnaire was designed beforehand as guidance for semi-structured interviews. As urban bird conservation is a broad topic and traditional bird knowledge is not as organized as documented scientific data, the questionnaire needed to be coherently framed while also open enough for different types of information to be obtained. In addition, the questionnaire needed to be easily followed by each birder and be helpful for them to organize and logically present their bird study experiences. Following the instructions, there are two sections of the questionnaire: section one is about geographic information and section two is about characteristics and general comments (see Appendix One).

### 3.5.4. Semi-structured interviews

When the maps and questionnaires were ready, potential participants were contacted by phone or email with a brief introduction to the study as well as the interview process. Once a birder confirmed the time and place to meet, more information was sent to

him/her if so requested. Since birders were required to draw on maps to show areas of conservation value during each season, different colors were applied for the seasons. In order to remind the birder and reduce the chance of misuse of the color, at the top of each map were written the seasons in symbolic colors.

At the beginning of the interview, interviewees were required to read through the instructions describing the content and process of the interview as well as the information the researcher intended to gain from them. Participants were also asked to put bird stickers on the actual map to show where they often go birding. This initial phase of the interview not only familiarized birders with the maps but also helped them to recall their experiences.

Not all interviewees went through the questionnaire in the same order as planned; each has knowledge organized in their own way. In such cases, the researcher did not interrupt the flow of the conversation; instead, unanswered questions were asked at the end of the interview and interesting topics that emerged from the interview were discussed.

### 3.5.5 Data Verification

Inaccuracy in the data mainly comes from the unfamiliarity of birders with the map. Though they are quite familiar with the study area when they drive to their regular birding spots, their sense of direction did not automatically transform itself onto the maps. Some interviewees could easily find the area they talked about, while some were doubtful in spotting the right places. In these cases, the circled areas were double-checked by the researcher using Google Map, Street View Function, field trips and the tape recorded interview. During the interview, some participants noted that there were some places they recommend but were not sure about the location; when possible these places were discovered by using Google Map and were added after the interview by the researcher. Some data verification was done by comparing the coded transcript with the marked

maps, if there were inconsistencies between the two. The map was corrected in accordance with the audio-record.

Another aspect of data verification was trying to avoid incomplete information. The interview process, which was typically about 40-60 minutes in length, was limited relative to the birding experience of a birder. Interviewees may have missed some important points during the interview process, or the spatial information they had provided might be misleading due to subsequent changes in land use, or misidentification of precise locations by the interviewees. Similarly, the non-spatial information from different experts may have been contradictory. For these reasons, the focus group was useful for checking precision and validity of the data.

### 3.5.6. Focus group

All interviewees were notified and contacted two weeks ahead of the focus group meeting. Seven of them attended. One focus group participant did not go through the interview process but had received all the interview materials and was provided with a detailed explanation of the study purpose.

The focus group was held several months after most of the interviews had been completed and was composed of five sections. Firstly, the project, especially the research questions and objectives were explained again to the focus group participants. The second phase was to adjust the maps. Interview data were compiled and mapped out in advance. The important conservation area maps in each season and at each scale were projected on a big screen one after another. In total, 8 maps were shown and enough time was given to the expert group to complete, correct and adjust the mapped data. All decisions were made by the group and agreed unanimously.

After compiling the spatial data following the initial interview phase, some non-spatial data had been integrated and preliminary conclusions drawn by the researcher. In focus group phase three, these preliminary results were discussed with the focus group

participants and more detailed information was acquired. Phase four consisted of a discussion about three special conservation areas that the researcher had identified based on the interviews, as well as addressing general questions regarding the variation of bird distribution with time, bird conservation strategies, and habitat preservation. The last part of the focus group was opened up for free discussion.

The focus group was effective in data verification and in-depth discussion. By this means, five areas of conservation value were added to the original map. The focus group also provided insights into three examples of urban bird habitat and their conservation, as well as better understanding of the threats and opportunities for birds in general.

### 3.5.7. Transcribing

Each interview and the focus group were audio-recorded with the consent of the participants. Afterwards, the audio-records were transcribed into text. Transcribing is not purely the conversion of audio file to text; instead, it entails the first phase of data analysis (Green, Franquiz, & Dixon, 1997). The transcribed information did not contain tone, pitch or extra words (e.g.: um, ah,). Because no questions involved attitudes and the study only dealt with traditional knowledge and field trip experiences, no investment was made in transcribing the emotion of interviewees, which had little influence on the quality of the data.

### 3.5.8. Coding process and Nvivo

Coding was employed to dissect each interview transcript into series sets of data and combine each interviewee's information according for further analysis. In this way, information was broken down into sub-categories, which are called free nodes. Free nodes were generated gradually through the process of transcribing and reading each transcript. They were revised and adjusted during all subsequent analytical processes. In total, seventy five free codes were used to categorize the transcript. "Characteristics of Sullivan's Pond", "social value", "winter spots" are examples of free codes. In addition, a

node named “Random” was generated to gather all the distinctive information mentioned by each birder which could not be categorized into other free nodes but are related to the research topic. In this way, the researcher tried to reduce the possibility of information loss in the coding process. After the coding process, all seventy five free nodes were categorized under eight Tree codes (Appendix Two) for speedier searching of information in the writing process.

NVivo was applied to facilitate the coding process in the study. It is one of the Computer-Assisted Qualitative Data Analysis Softwares (CAQDAS). CAQDAS has been a notable development in recent qualitative studies and is applied frequently (Bryman & Teevan, 2005; Welsh, 2002). NVivo does not and cannot make decisions on coding, it acts like an index. Any information, such as a quote from a birder that is stored under a free node or tree node can be found quickly along with the identity of the provider of the information, the frequency of its appearance in the conversation, and so on. Nvivo smoothed the process of precise and transparent data analysis (Morison & Moir, 1998; Richards & Richards, 1994). Additionally, the prompt about ‘trees’ of interrelated ideas invited by NVivo encourages researchers to consider possible connections between variables in-depth (Bryman and Teevan, 2005).

Due to a limitation of access to the software, the study analyzed the relationship between free nodes and organized them into a hierarchy of tree nodes using Microsoft Excel, Word and the output information from Nvivo. Due to the small number of codes and the relatively straightforward content, the application of other software (Excel and Word) proved to be feasible and convenient.

### 3.5.9. Map digitization

GIS (Geographic Information Systems) was employed to create the study area maps as well as to represent spatially-related traditional bird knowledge. After maps had been marked by each interviewee and the whole focus group, their notes on the map were digitized and translated into digital maps, in which the information can be easily updated,

revised and integrated with others. Because the research was founded on the idea that the mental maps of local bird experts (birders) will reflect both their research and their life experience, it is expected that an assemblage of these maps will highlight the common places and features that are important for urban birds, as well as birders. Therefore all the knowledge of bird experts was incorporated and final maps showed the regular birding spots, important habitat in each season, protected and unprotected habitat. Information from each individual birder were treated equally; the final maps are the accumulative results of each map marked by birders. When the similar area was mentioned by different interviewees, the biggest outline of each set was applied on the final map. The information on each place was stored as shapefiles, which documented their location, size, name and seasonal effect. This form of the data not only visualized the traditional bird knowledge but also can be circulated and therefore is convenient for future ecological studies and urban planning.

The study took methodological components from both Participatory GIS (PGIS) and Green Mapping. It merged people's spatial knowledge in virtual or physical forms using GIS-based maps as the major conduit. The ability of GIS to communicate information visually in ways that can be easily understood by the public is vital to preserve traditional knowledge and engage high degrees of public participation (Maantay and Ziegler, 2006).

Birders' knowledge is quoted and paraphrased all throughout the thesis. In order to differentiate their knowledge from the other findings of the study, each birder as well as their information is acknowledged by citing the date on which the interview was conducted. Because multiple interviews were not carried out on the same day, each date correspond with only one birder.

### 3.6. Location and characteristics of regular birding spots

Birding spots are places that local birders go to see birds; they can be different from places of important conservation value. Normally, birders visit places on a regular basis due to the accessibility, the likelihood of rare species and the aesthetics of the overall

environment; while their evaluation system for habitat of conservation value is quite different. The identification of the regular birding spots provides a baseline revealing those places that have been birded and studied. For beginner bird watchers and naturalists, it also presents the must-visit places. Fig. 3 identifies the most popular birding spots in red, less popular but well-known spots in orange; places marked with yellow were mentioned but less intensively visited by birders.

### 3.6.1. Popular birding spots

Eight places were frequently mentioned as regular birding spots, some of which were mentioned by 11 interviewees. Point Pleasant Park and the south end residential area were listed as the most regularly birded places. The geographic location of Point Pleasant and the mixture of forest attract a considerable number of migrants, breeding and wintering birds. Bird feeders provided by local residents together with mature urban forest in the south end of Halifax provided both food and shelter for vagrants in the winter. Moreover, these two places are heavily used and accessible to Halifax urban residents. Hartlen Point is the favorite of many birders, it is renowned as "one of the best birding sites in the province" (Stevens, 1996). Hundreds of species congregate there every year and the bird list of Hartlen Point keeps growing. In addition, Seaview Park, Sullivan's Pond, Frog Pond, Chebucto Head and MacCormacks Beach are all beloved birding spots of local birders. Some of them are quite urban. For example, Sullivan's Pond is a man-made lake in downtown Dartmouth which has a high concentration of wintering waterfowls; Seaview Park used to be the city dump, yet rarities are drawn to there in both migration seasons. Some of the most popular birding spots are more natural, MacCormacks Beach is a provincial park; Frog Pond is surrounded by mature forest and thick growths. Chebucto Head is slightly out of the scope of the study area but has been included here because it was popular among the interviewees.

In addition to the most popular birding places mentioned above, another 17 places were visited on a regular base by most of the local birders (Table 1).

### 3.6.2. Less well-known sites

There are birding spots that were identified only by individual birders as their regular visit sites; they were not fully recognized by the whole birder group. According to the yellow marks on Fig. 3, these places spread to the city's outskirts and thus accessibility tends to become a barrier for bird watching. Most bird experts that are familiar with these spots live close to these areas, or worked/volunteered in the area.

The spots marked in yellow are not necessarily inferior to the well-known birding spots for either bird watching or conservation; some of them might even be better for they have less interference from human beings. For example, Nichols Lake is located in the semi-natural zone and is almost outside of the study area. It was highly recommended by a birder as "a great habitat, it's very diverse" and "the bird diversity in that Nichol's Lake area is really tremendous" (personal interview, October 5, 2009). At the end of Crown Drive, near the Halifax Water Commission reservoir, is a spot favored by vireos and it might also appeal to other birders if they knew about it. Some of the less-known spots, such as the Mainland Common and Belcher's Marsh appear to have less diversity of species and are not as important to the urban birds. However, they are accessible for local communities and so promotion of these places might engage more beginners into bird watching and consequently raise awareness about conservation.

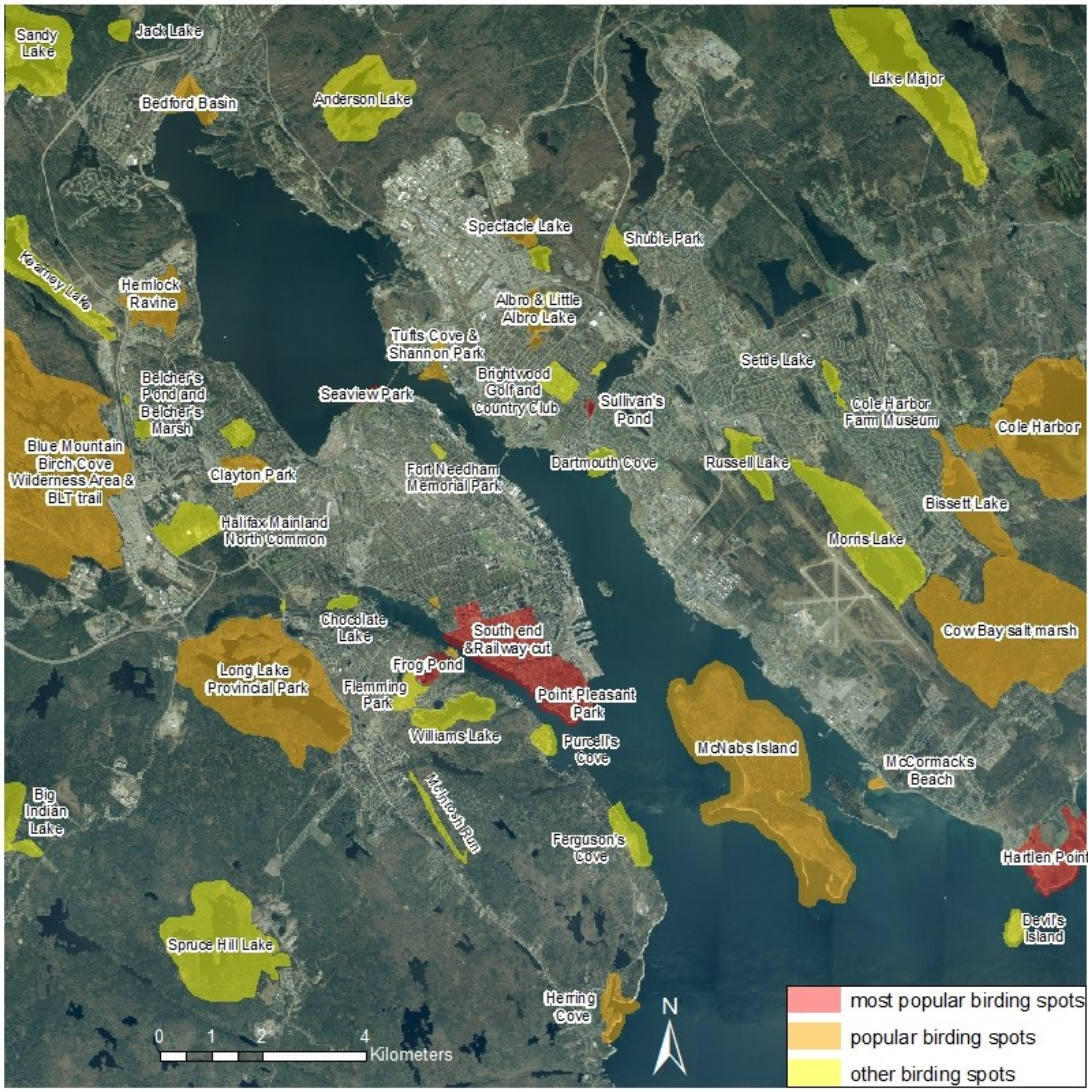


Figure 3 – Regular Birding Places

Table 1- Regular Birding Places

| Popularity | Birding Places | Popularity | Birding Places |
|---|---|---|---|
| Most Popular | Chebucto Head | Known | Cole Harbor Farm Museum |
| | Frog Pond | | Cow Bay |
| | Hartlen Point | | Dartmouth Cove |
| | MacCormacks Beach | | Devil's Island |
| | Point Pleasant Park | | Fairview Cemetery |
| | Seaview Park | | Ferguson's Cove |
| | South End | | Flemming Park |
| | Sullivan's Pond | | Findley Park |
| Well-known | Albro and little Albro Lake | | Fort Needham |
| | Bedford Basin | | Frenchman Lake |
| | Bissett Lake | | Jack Lake |
| | BLT Trail | | Kearney Lake |
| | Blue Mountain Bird Cove Wilderness Area | | Lake Major |
| | Clayton Park | | Lake Nichols |
| | Cole Harbor | | Mainland North Common |
| | Conrose Field | | Martin Lake |
| | Cow Bay Salt Marsh | | McIntosh Run Trail |
| | Dingle Park | | Morris Lake |
| | Duncane's Cove | | Mount Saint Vincent University |
| | Hemlock Ravien | | Old Coach Road Trail |
| | Herring Cove | | Purcell's Cove |
| | Long Lake Provincial Park | | Rainbow Haven |
| | McNab's Island | | Rockingham |
| | Spectacle Lake | | Russell Lake Marsh |
| | Tuft's Cove | | Sandy Cove Road |
| Known | Anderson Lake | | Sandy Lake |
| | Belcher's Marsh & Pond | | Sambro Harbor |
| | Big Indian Lake | | Settle Lake |
| | Birch Cove Park | | Shubie Park |
| | Brightwood Golf Course | | Spruce Hill Lake |
| | Chocolate Lake | | The end of Crown Dr. |
| | | | Williams Lake |
| | | | Woodlawn |

### 3.7. Location of urban bird conservation hotspots

#### 3.7.1. Seasonal Effects on Location

##### 3.7.1.1. Spring Migration

The important habitats for spring migrants are either similar to those of fall migrants or are breeding habitat. During spring migration, birds travel by different routes than in fall. Inland areas get warmer first, and insects and other food resources become available earlier than in coastal areas, thus fewer birds tend to follow the coastlines and some can finish their migration in 20 days with little stopping to reach their breeding area and start breeding immediately (Stutchbury, 2007). For these migrants, if Halifax provided the right breeding habitat, it should be those large areas with good cover of natural vegetation and relatively isolated from human interference, such as Blue Mountain Birch Cove Wilderness Area, Long Lake Provincial Park and both McNabs and Lawlor Island (personal interview, July 22, 2009). Some species, however, take a detour to get to their breeding habitat; they need to fuel up along the way. For them, important habitats are good stopover sites (personal interview, July 15, 2009; personal interview, July 27, 2009). After they had a long flight and burnt a lot of fat, they arrive at the city craving food, any habitat providing an adequate food source can be their stopover. Birder feeders in early spring play an important role in supplying the early-comers when the weather is still harsh and few insects or fruits are available (personal interview, July 15, 2009). The length of their stay depends on their deposition of fat, weather condition, predators and competition with resident birds (Moore & Kerlinger, 1987), thus suitable cover near food sources is important for their survival when they have to linger for a longer time. Birders found that though the migration pattern between spring and fall are not exactly the same, spring and fall migrants seem to be attracted to similar places in the study area. All marked areas in Figure 4 are closely associated with water bodies, 7 of them contain or lie beside lakes, while the remainder are along the coastline.

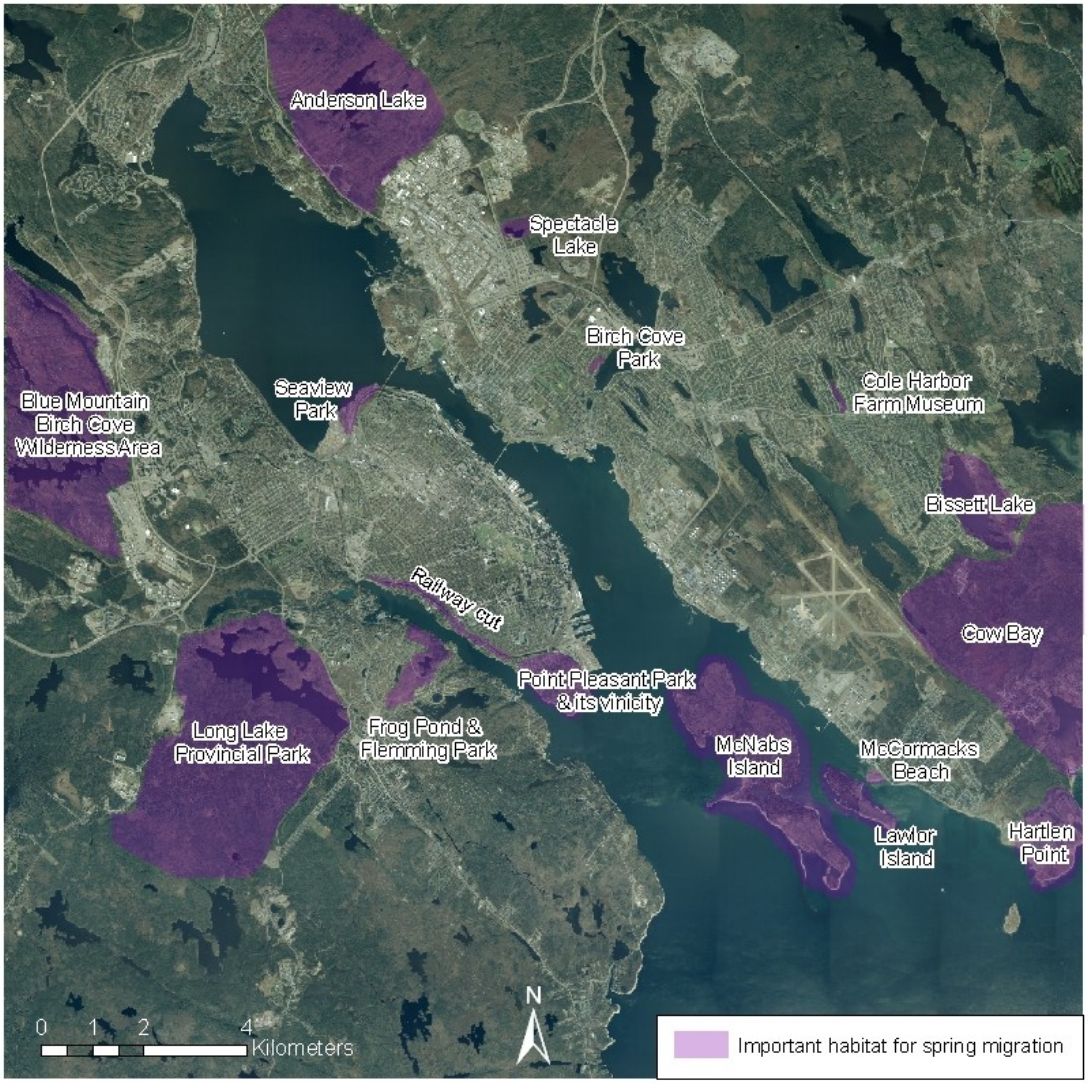


Figure 4 – Important Spring Migration Habitat

#### 3.7.1.2. Breeding Season

The breeding season starts once spring migrants have landed and found the right habitat; during the breeding season bird populations grow tremendously in a short period of time. Substantial amounts of food sources and large breeding habitat are the keys for successful breeding (personal interview, August 19, 2009; personal interview, August 20, 2009). Although overall bird conservation should make sure there is no weak link, breeding is where recruits come into the avian population and is the pump that keeps the whole system working. One local birder deemed breeding season as "the important time, absolutely the most important time" (personal interview, August 20, 2009).

During breeding season, fewer birds utilize the resources provided by the urban aspects of the city. Most of the important habitats picked out by bird experts are big patches of natural areas away from the city center. Large intact forests with thick undergrowth support a lot of breeding woodland birds; while wetlands and marshes are vital for aquatic birds (personal interview, July 22, 2009). Not surprisingly, local birders have different ideas on the most important breeding habitat. McNabs and Lawlor Island were given a lot of attention as a result of their relatively isolated environment. Hartlen Point, identified as one of the favorite birding places, was believed to be "obviously a very significant area" (personal interview, September 22, 2009). Down to the scale of intensive study area, Point Pleasant Park was titled as the "single most important urban breeding habitat" (personal interview, August 13, 2009).

Among all the marked important breeding habitats, some of them were picked due to the uniqueness of the habitat they provide, such as the Cow Bay estuarine habitat. Some were pointed out because they contain different kinds of habitat and support diverse groups of birds, like Blue Mountain Birch Cove Wilderness Area, Spruce Hill Lake and Long Lake Provincial Park; other places were identified owing to specific species they sustain. Lawlor Island is conceived to be "extremely important" (personal interview, July 27, 2009) for Osprey *(Pandion haliaetus)* and Great Blue Heron *(Ardea Herodias)* breeding. Part of Williams Lake is the home of breeding Chuck-Will's-Widow

*(Caprimulgus carolinensis)*, and is currently the only place the bird breeds in metropolitan Halifax (personal interview, August 7, 2009). The northern part of Russell Lake and the areas around it has tern colonies (personal interview, July 27, 2009). In Point Pleasant Park, there are breeding Merlin, *(Falco columbarius)* (personal interview, September 22, 2009) and in Birch Cove Park, Red-bellied Woodpeckers *(Melanerpes carolinus)* are breeding (personal interview, August 7, 2009). These places are critical and should be preserved for philopatric individuals that return to the same place to breed year after year (personal interview, July 23, 2009).

Pockets of relatively urbanized areas were also identified for some breeding species. The city's south end, especially grounds of Saint Mary's University and Dalhousie University have breeding House Finches *(Carpodacus mexicanus)*, the population of which in the city center has declined in the past few years (personal interview, October 5, 2009). Another red finch, Northern Cardinal *(Cardinalis cardinalis)*, drew a lot attention from birders and people who have backyard feeders due to their bright red color. Urbanization along the east coast of America has helped them expand their range (The Cornell Lab of Ornithology, 2009), all the way from Massachusetts. Northern Cardinals have nested in Woodlawn, Dartmouth, for decades and their population has kept growing as more people have fed them. Although metropolitan Halifax is visited by breeding warblers and sparrows, bird experts reported no particular pattern of their distribution in breeding season, "they show up where there is source of food" said one birder. Birders also believe that, although birds like House Sparrow *(Passer domesticus)*, House Finch and Northern Cardinal breed in the city center and residential areas, compared with large pieces of natural area both within and out the study area, city breeding habitats are too localized and shouldn't be considered as important (personal interview, July 23, 2009). Undisturbed and diverse habitat should be the focus of breeding-habitat conservation, which is also the reason that birders tend to go outside of the urbanized city core for birding in the summer.

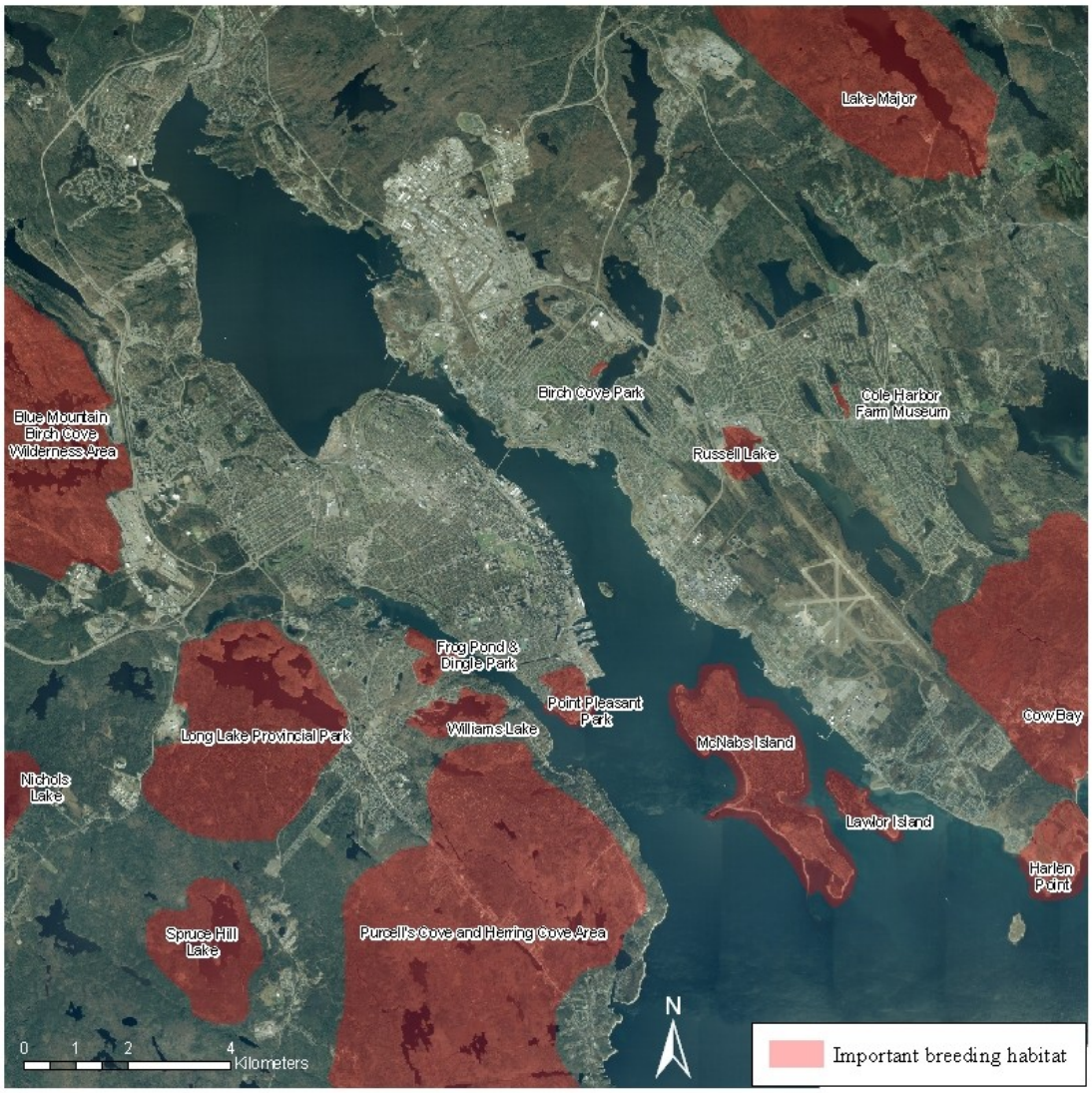


Figure 5 – Important Breeding Habitat

#### 3.7.1.3. Fall Migration

Fall migration is the favorite season for many local birders because Halifax is on the migration flyway, so that spectacular migration movements can be seen without going too far from the city. Another aspect is that autumn is usually accompanied by hurricane season, when some vagrant species that normally could not normally be seen in Nova Scotia are brought in by the wind. Headlands like Chebucto Head, Duncan's Cove and in recent years Seaview Park are where local birders have gone to see rare species. Sadly, despite the excitement and interests of local birders, most of the vagrants cannot find their way back and will eventually die out as a result of the wrong habitat and lack of suitable food sources.

Influenced by the micro-climate of the Atlantic, Halifax gets cool more slowly than inland places of the same latitude, such as Montreal and Ottawa. The warmer weather provides more opportunities to find insects and fruit and other sources of food for birds to build up fat. Therefore, birds tend to travel and congregate along the coast to fuel up for the long journey over the ocean. Coastlines and the entire water body were indicated frequently in the interviews. Figure 6 shows that most of the coastal areas, Northwest Arm, Purcell's Cove, Herring Cove and sites in Dartmouth are listed as important habitat for fall migration. The entire ocean water body has not been circled for the overall presentation of the map, but is important for aquatic migrants.

Hartlen Point is the most celebrated place in the fall; all birders mentioned and referred to it as habitat of great conservation value. It stretches out to the Atlantic Ocean and might be the last stop before the journey over the ocean for members of some species. Complex environments consisting of both land and ocean are utilized by substantial populations of hundreds of species, such as the terrestrial and marine components of Bedford Basin, Herring Cove and both McNabs and Lawlor Islands. In more urbanized environments, Halifax's south end and Point Pleasant Park were commonly noted as usual; especially the railway cut and some urban pockets linked with it, such as Conrose Field, Flyn Park, and the area behind Armbrae Academy. These places have bushes and shrubby-tangles loaded with berries, which provide excellent food and cover for the

migrants. Furthermore, gardens with bird-feeders in the old neighborhoods are appreciated by the birds, and therefore also by the birders.

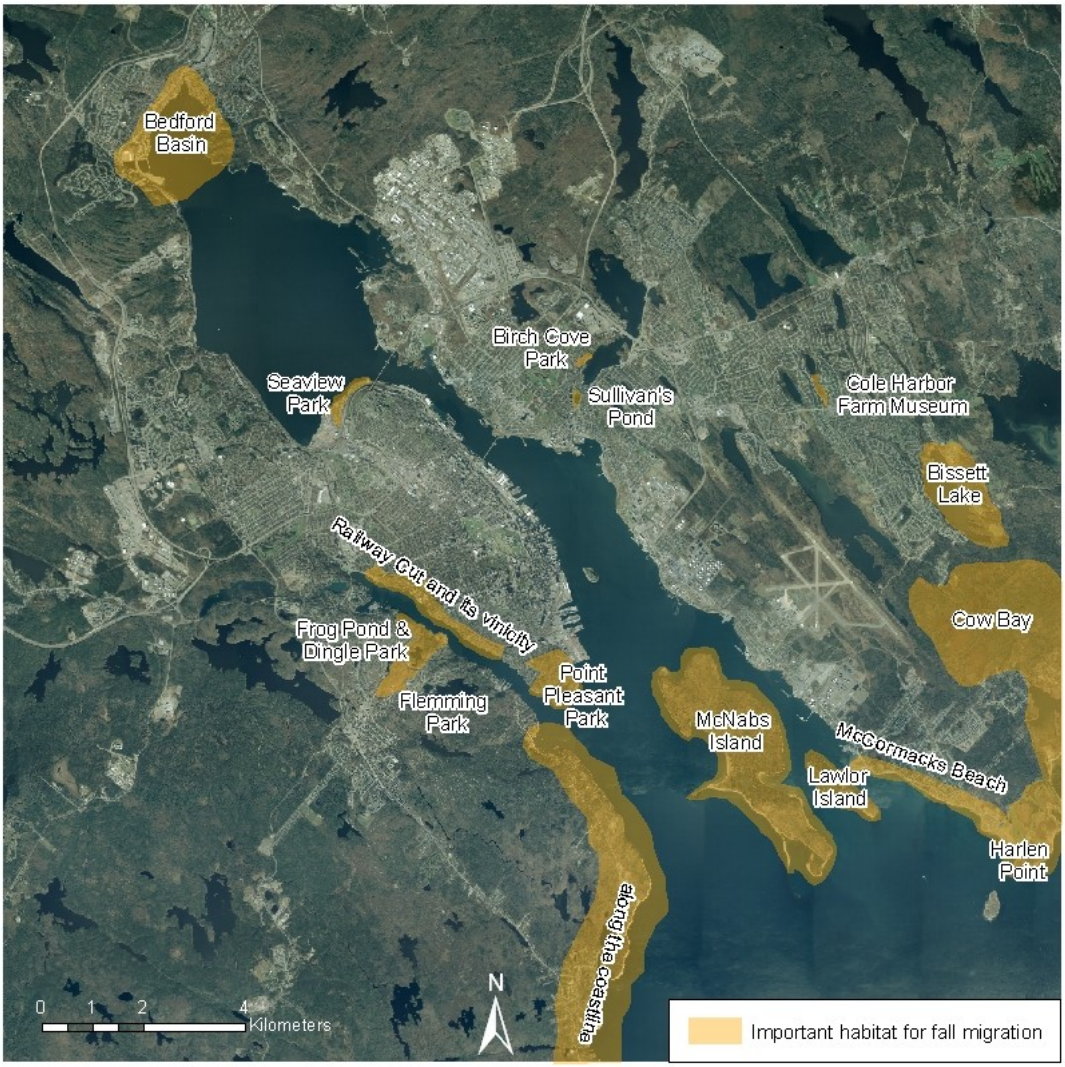


Figure 6 – Important Fall Migration Habitat

#### 3.7.1.4. Winter

Winter birding happens mostly along the coast and is focused on waterfowl. Most song birds have migrated to the south and spend winter in the tropical areas. Large flocks of waterfowl which breed further north migrate to Nova Scotia to spend winter. They congregate along the coastline where rich nutrients are brought up by tides and currents, such as near Fergusons Cove (personal interview, September 22, 2009). Coves are visited more than exposed beach areas for they are more sheltered from wind and cold weather. Also, places like Bedford Basin, where river and small streams meet the salt water turn out to be favored by waterfowl. Essentially, because of both the natural features and human interference, the entire harbor attracts many wintering birds. Some effluent from sewers that enters the harbor makes the water warmer than the normal temperature; and untreated human wastes have been enjoyed by thousands of gulls and some ducks (personal interview, August 18, 2009). Places like Tuft's Cove, Dartmouth Cove, and the coastline along the west side of Point Pleasant Park are in this category. Birders like to go there with the purpose of spotting one member of a rare species among hundreds of common ones. However, the importance of the sewer outflow to these places for wintering birds is in debate.

Human interference not only affects the aquatic environment; effects in residential areas are very significant. Good bird-feeder systems along with multi-flora roses and bird-friendly backyards support many birds through winter when food becomes very scarce and all deciduous leaves are gone (personal interview, August 13, 2009). The south-end railway cut is very important in that the bush tangles and interlaced undergrowth shelter birds from cats, coyotes and hawks. It is also near the neighborhood in which many people feed birds. Sullivan's Pond is another winter hotspot and the only fresh water body in Dartmouth that stays open even on the coldest days. In recent years, removal of trees and shrubs, and over management of the rose bushes around the pond, have deprived wintering birds of some important shelter.

Generally, in winter, more birds are drawn to the city because cities produce heat and the micro-climate is milder than in the surrounding country (Jones & Reynolds, 2008). When natural food sources become insufficient, backyard feeders, feeding stations and even garbage bins are important resources for the survival of wintering birds. The structure of natural habitat is extremely important in winter; deciduous forests provide relatively poor cover. Instead, coniferous trees and weedy, bushy undergrowth are critical for birds to hide from harsh weather and predators.

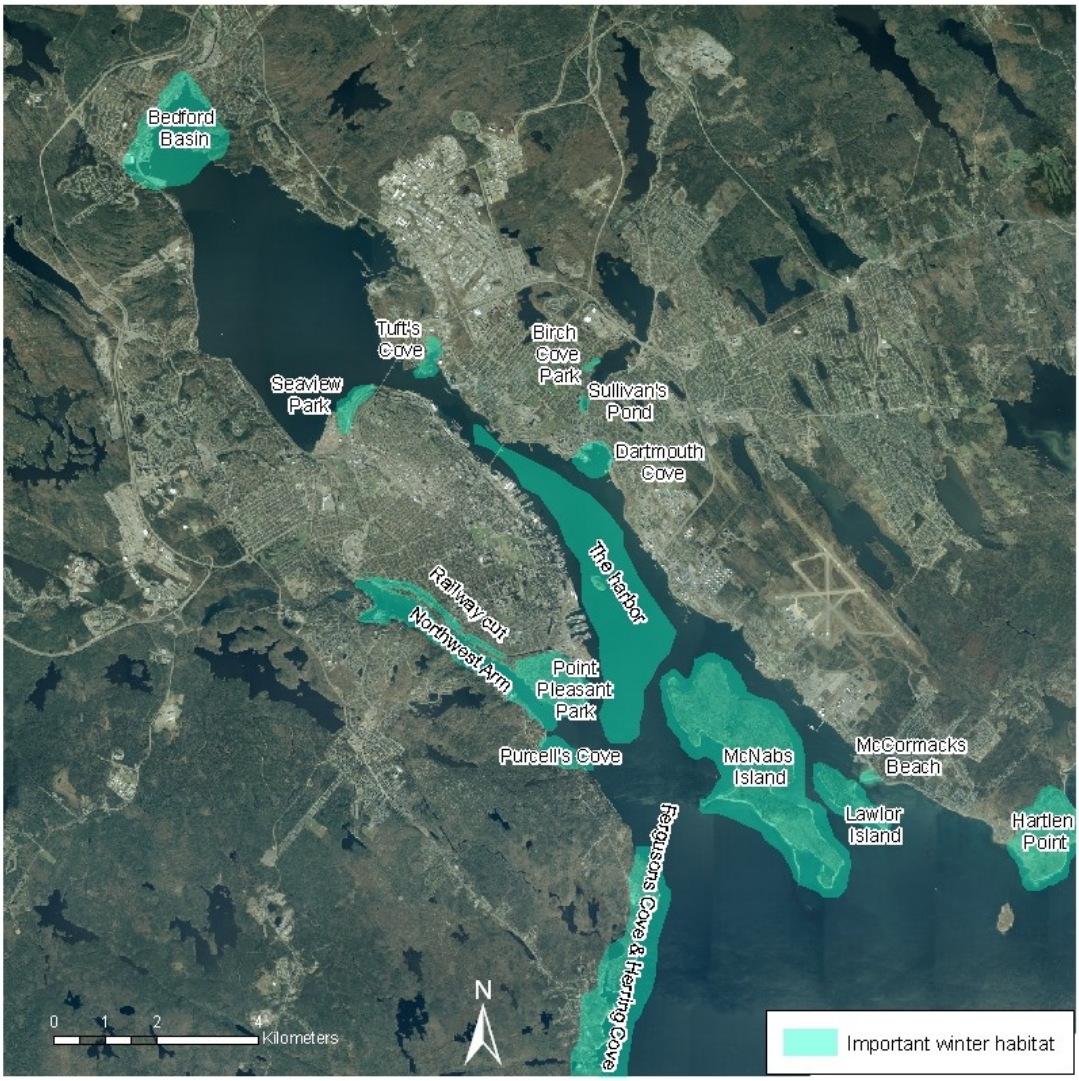


Figure 7 – Important Winter Habitat

#### 3.7.1.5. List of Locations

After integrating the information of important habitats in each season obtained from local bird experts, the places described below were found to be of high conservation value. These places can be divided into three groups: coastal areas, the most important zones that have concentrations of migrants in both spring and fall; inland natural and semi-natural areas, patches of natural forest and left-alone vegetations with various degrees of anthropogenic use but in which birds breed; and urban pockets, places heavily used by people on daily basis or located in the urban core. The classification of these important habitats is not exclusive; some sites are along the coast, have natural vegetation and are heavily used by humans at the same time, such as Point Pleasant Park. Some are surrounded by residential areas but have been left alone due to inaccessibility, like the railway cut. The following table is a general organization of the most important habitats perceived by birders. It should be noted that many more areas were pointed out during the interview and consulting process, some of which are known by a single birder and were not recognized by the whole group. Areas at the right top corner of the study area are scarcely visited by birders and the importance of the habitat is unknown. Many other places that have important roles in urban bird conservation, like playgrounds, graveyards, small gardens, and small Dartmouth lakes are scattered in the study area. It would be redundant to list all their names. Therefore, the table does not list all the habitats that need attention, but lists the focal areas that have been identified.

Table 2 - Important Habitat in Metro Halifax

| Type | Name | Type | Name |
|---|---|---|---|
| Coastal Areas | Bedford Basin | Natural & Semi-natural Areas | Cole Harbor Farm Museum |
| | Chebucto Head (outside) | | Cole Harbor Place |
| | Duncane's Cove (outside) | | Cow Bay Salt Marsh |
| | Eastern Passage | | Frog Pond & Dingle Park |
| | Ferguson's Cove | | Long Lake Provincial Park |
| | Hartlen Point | | Point Pleasant Park |
| | Herring Cove | | Russell Lake |
| | Lawlor Island | | Williams Lake |
| | MacCormacks Beach | | |
| | McNabs Island | | |
| | Northwest Arm | Urban Pockets | Birch Cove Park |
| | Purcell's Cove | | Conrose Field |
| | The entire harbor | | Fairview Cemetery |
| | | | Seaview Park |
| Natural & Semi-natural Areas | BLT Trail | | Sullivan's Pond |
| | Blue Mountain Birch Cove Wilderness Area | | The Railway Cut |

### 3.7.2. Scale of urban bird conservation hotspots

Urbanization is not only growing in quantity but also in scale. Urban biodiversity conservation transfers attention from the approach of preserving remnant forest patches to integrating different scales of urban habitat into planning. The relationship between the scale of urban habitat and avian populations and its interaction with human activities has been investigated in different ways (Hostetler, 2000; McKinney, 2002; Melles, 2003). The importance of a specific habitat depends not only on site factors such as canopy, proportion of coniferous forest or the presence of fresh water, but it is also influenced by the characteristics of a larger landscape. Additionally, birds react to different scales of habitat in various ways; some birds are more associated with site-scale factors, while the presence of others is determined by landscape-scale factors (Melles, 2003). Therefore, conservation goals as well as strategies may differ due to the differences of scale of urban habitats. The characteristics of different scales of urban habitat deserve more investigation in order to prioritize and differentiate conservation activities.

The identified important urban habitats in metro Halifax were divided into three categories: large forest/mixed vegetated patches, which are more than 1$km^2$; small parks and urban pockets, which can be as small as a backyard or as large as 0.2 $km^2$; and medium-scale habitats, which is everything in between.

Table 3 - the scale of important urban habitat

| Large Scale Habitat | Medium Scale Habitat | Small Scale Habitat |
|---|---|---|
| Blue Mountain Birch Cove Wilderness Area | Bedford Basin | Birch Cove Park |
| Cole Harbour | BLT trail | Cole Harbour Farm Museum |
| Cow Bay salt marsh | Frog Pond & Dingle Park | Conrose Field |
| Eastern Passage | Hartlen Point | MacCormacks Beach |
| Ferguson's Cove& inland | Lawlor Island | Seaview park |
| Herring Cove& inland | Point Pleasant Park | Sullivan's Pond |
| Long Lake Provincial Park | Russell Lake | the railway cut |
| McNabs Island | the Northwest Arm | |
| Purcell's Cove & inland | Williams Lake | |
| The entire harbour | | |

#### 3.7.2.1. Large habitat

The inland large habitats are mostly credited for their capacity to hold diverse and abundant breeding species. These large habitats become sanctuaries for urban birds to get away from human interference. The thick and older growth in these habitats shelters birds from predators and harsh weather. In most cases, because of the extensive areas they cover, these habitats are heterogeneous. The various micro-environments attract different types of birds to feed and breed, and the interaction between the micro-environments makes them more interesting. In winter, when big lakes and ponds freeze up, the small streams and puddles become precious fresh water sources for wintering birds despite the fact that most birds that breed in them migrate to the south before winter.

Unlike inland large habitats, coastal habitats like Purcell's Cove, Ferguson's Cove and Herring Cove are good for aquatic birds during fall migration and winter. The biggest attraction is what is available under the water. Some sections of the coastal shelf are very shallow, so that diving ducks can get under the water and catch food. In some places, as a result of current and other fluxes, nutrients are brought up near the surface such that grebes, ducks and gulls can feed on them. Habitats of the entire coast are recognized by the large numbers of birds and the richness of the species that are supported during migration and winter.

Despite the many common characteristics the large habitats in metro-Halifax share, they are distinct. Multiple criteria were applied when bird experts identified places of great conservation value. Other than diversity and abundance, some specific species received more attention for various reasons and the occurrence of these species makes the habitat more valuable for protection. For example, the breeding Ospreys on McNabs Island, Barrow's Goldeneye *(Bucephala islandica)* in Purcell's Cove, Sandpipers in Cow Bay, Black-backed Woodpeckers *(Picoides arcticus)* and owls in Long Lake Provincial Park, were all viewed as flagship species for each habitat. For urban bird conservation, not only the species and number of birds need to be taken into consideration, but also the uniqueness of the habitat and landscape. The salt marsh in Cow Bay is extremely nutrient rich and comprised of mixed habitats; Long Lake Park has typical upland forest and

oligotrophic lakes; Purcell's Cove is well sheltered and behaves as a good conduit for birds to travel into the Northwest Arm.

#### 3.7.2.2. Medium scale Habitats

In medium-scale spots, the level of human interaction is much higher than those of the large habitat patches. Point Pleasant Park is the busiest park in Halifax, a handy place for jogging, dog-walking, picnics and various activities. Hartlen Point is backed with a golf course, and BLT trail is designed for bikers and runners. Bedford Basin backlands and Russell Lake are surrounded by residential areas. Lawlor Island and Williams Lake, though less visited, are still more accessible than some of the large habitats mentioned above.

Medium-scale spots as a group have fewer consistent patterns in terms of both habitat type and seasonal effects. Hartlen Point and Lawlor Island are out in the ocean, their locations attract numerous migrants, and their inland spaces also provide excellent environments for breeding birds. Lawlor Island is special for Ospreys and Great Blue Herons that nest on it, and also for wintering Purple Sandpipers *(Calidris maritime)*. Both areas are mentioned as "the most important to conserve" by bird experts (personal interview, July 23, 2009; personal interview, July 27, 2009). Geographically, the Northwest Arm and Bedford Basin are sheltered by the harbor. Fresh water comes to meet the salt water and parts of both places stay open in the winter time. They are good for wintering waterfowl: Barrow's Goldeneyes can be found at Bedford Basin and Red-breasted Mergansers *(Mergus serrator)* always show up in the Northwest Arm. Because of the mature neighborhoods and urban forest around Bedford Basin, it is preferred by woodland species as well. Point Pleasant Park and BLT Trail are similar in that both areas are used intensively and have new growths of bushes and small trees, which favor some species. Frog Pond and Williams Lake by contrast are not heavily used and have some patches of very old vegetation. Diverse groups of woodland birds perch in them but not a lot of waterfowl. Around Russell Lake, there is a big cattail marsh, which contributes to the diversity of bird habitat in urban Halifax.

#### 3.7.2.3. Small parks and urban pockets

Except Cole Harbor Farm Museum and the railway cut, which were evaluated by birders as important habitat all year round, most other small parks and urban pockets are more interesting during migration seasons and winter. The diversity of species and numbers of the birds they support are less than those of big wilderness areas and medium-scale parks. More city birds are seen in these spots, which is a result of more human inference and alteration of the environment. However, rarities are still regularly spotted among the groups of waterfowl in Sullivan's Pond in the winter, or in the weeds of Seaview Park in spring, or in tangled bushes beside feeders anywhere in the city.

On the whole, small parks and urban pockets have the highest level of human interference among all. Apart from MacCormacks Beach, which is a provincial park and Cole Harbor Farm Museum, which is left alone, other small habitat patches are either surrounded by residential development or altered by people to some degree. Rose tangles, berry-rich bushes and thick undergrowth vegetation with adequate forest cover are the main characteristics of value in all small city parks. They provide cover and food when birds come into the city center. In addition, the precious unfrozen open water from Sullivan's Pond and cattail marsh in Cole harbor museum provide habitat for waterfowl.

The conservation of the small city parks and urban pockets may be less meaningful for the avian population but it is important for keeping the species richness in the city. Better ground cover and bird feeding stations can lead to a more diverse and abundant bird community. More importantly, the conservation of the small parks is profound for environmental education and improving life quality. They are the closest to the daily life of city dwellers; some of these spots are behind schools and playgrounds, which are good for children to get in touch with birds and nature. In recent research about the relationship between different urban landscapes and people's feelings, the majority of participants perceived birds and bird singing as important components and can connect them with love of nature (personal interview, October 15, 2010).

### 3.8. Characteristics of urban bird conservation hotspots

The research project assumed that regardless of scale, there are intrinsic elements of each habitat that draw urban birds to them. In order to answer what to protect in each habitat class and how to preserve them more effectively, the essential characteristics need to be distilled from single places and integrated together. Therefore, local bird experts were asked about their evaluation standards with respect to conservation hotspots - the criteria they used to measure the importance of each urban habitat in Halifax. Though individual opinion varied, two themes were discussed and stressed by every birder: the availability of food and shelter. All the conservation hotspots are excellent for providing both food and shelter.

#### 3.8.1. Food and Shelter

##### 3.8.1.1. Food sources

"Food is number one. Even if there is no cover, they will take a risk when they are hungry" said one local birder (personal interview, August 7, 2009). Though for most birders, it is difficult to compare the importance of food and shelter and unwise to separate them from each other, this birder's statement emphasizes the prominent role of food sources in each habitat marked on the map.

Generally speaking, birders evaluate a place as important habitat because of the abundance and the richness of the birds the area holds, or sometimes rare species. When an area attracts a large bird group or a diverse bird group, it must be able to provide sufficient quantity and variety of food sources. All the marked habitats have this ability to offer sufficient food sources in the various seasons. For aquatic birds, the food is usually related with the current, tide, and the creatures living in the ocean, marsh or a fresh water body. Woodland birds are looking for insects and berries, both of which are more common in natural or unmanaged parks than the sidewalk trees and neat garden areas. In the winter, when many natural food sources are diminishing for woodland birds, backyard feeders and feeding stations become a good substitute for foraging in the city, even though the artificial food sources cannot totally replace natural food sources. The

quantity of artificial food is very limited compared with that of natural food and feeders cannot provide all the kinds of food that are needed by birds.

Therefore, to conserve the bird habitats we must first guarantee the food sources in them. For aquatic birds, this means keeping where they congregate free from pollution and reducing interference by human activities. This is especially important in the winter, when many fresh water bodies freeze up; at that time birds have fewer choices to rest and feed. For woodland species, it means keeping the diversity of berry bushes and shrub tangles, marshes, dead tree trunks, and any other places they can find fruits and insects.

#### 3.8.1.2. Well mixed vegetation

Shelter is another elementary factor that birders use to evaluate the importance of an urban habitat. Places like a front yard with a big lawn and a single bird feeder could occasionally attract some urban species like European Starling or Song Sparrow *(Melospiza melodia)* to feed, but they are much less popular than a backyard covered by raspberry bushes and a mixture of coniferous plants. The mixed vegetation provides better cover for birds than a lawn, so that birds are less exposed to their predators, which could be a raptor, or more often cats in the urban area. They also need the shelter to hide from strong wind so they spend less energy in keeping their body temperature. The shelter created by thick growths can create micro-climate conditions that mitigate the cold. This extra warmth is crucial for bird survival in strongly adverse weather, such as freeze-thaw cycles involving intense precipitation.

The shelter in a good habitat needs to have dimension and structure. Not only a mixture of types of forest is desired but the significance of having suitable ground cover was stressed many times by local birders. The shrubby and weedy places often provide berries and a variety of foods for birds. Because of the intertwined twigs with thorns, small birds can easily hide in them but other bigger animals including people find it hard to get close. For cavity nesters, dead trunks are their homes; they also forage under the bark of the dead trunk. One local birder found more than four species of cavity nesters

living in a single dead tree at Frog Pond. Dense conifers are important shelter in the winter.

Both food and shelter must exist at the same time and location. In most conditions, they are closely related, for example, berry bushes generally provide both shelter and food for birds. When the shelter and food sources are located apart, both of the areas and the region between them need to be conserved. Missing either of the elements will make the habitat unattractive for a large and diverse group of birds.

### 3.8.2. Other important characteristics

Other features might not be as important as food and shelter, but their existence increases the attractiveness of habitat areas for urban birds. The following two were brought up as prominent examples.

#### 3.8.2.1. Terrain feature

The effect of terrain feature is not so noticeable except in the winter. When the temperature drops below zero and the city is swept by strong winds, the time for birds to find food is very limited. Most winter winds in Halifax are from th north or northwest (Nova Scotia Museum of Natural History, 1996; Environment Canada, 2010), so in places sloped towards the north, especially with little cover and that are very exposed to the wind, the temperature will be lower than other parts of the peninsula. The aspect also influences the timing of sunshine. South-facing slopes get more afternoon sunshine, which means that insects and other invertebrates will be active for a longer time, and birds will have a better chance to feed and store enough fat to maintain their body temperature.

The Frog Pond and Dingle complex, which is sloped towards the north, gets dark earlier in the afternoon. The area has many migrants and provides habitat for several species of breeding birds, but in the winter fewer birds were found there than in the railway cut on the other side of the Northwest Arm, which faces south. Fort Needham

Memorial Park has a similar situation to Frog Pond, it is up on a hill and has less cover than Frog Pond, so it is too exposed for birds to stay.

#### 3.8.2.2. Less human interference

Urban habitats are more or less interrupted by people and breeding birds do better in habitat with little human interference. McNabs Island and Lawlor Island, for example, provide important breeding habitats. Though both of them are in the scope of the study area, they are not urbanized, and being isolated from the mainland much less human activity happens there. Blue Mountain Birch Cove is wild as well; more breeding birds were reported to be found there than in Point Pleasant Park. The birds that breed at Point Pleasant are mostly those that are well adapted to the urban environment, such as Song Sparrow and American Goldfinch *(Spinus tristis)*. In Blue Mountain Birch Cove and other wilder places that lie on the city outskirts, birders reported that a wider diversity of species breed there.

Interviewees pointed out that for the purpose of conservation, people should not approach the nests of breeding birds. Predators like coyotes and cats can recognize the smell of humans and will follow the paths of people to find the nests of breeding birds. Birders suggested that people should not to touch the vegetation around the nest with their hands, but with a cane, and should try to obscure their trail as they leave.

## 3.9. Case studies

During the interviews and focus group, a number of places were discussed intensively by local birders. These places are the most well-known of all the important habitats, and of great interest to local residents. Because the present study focuses on the urban environment, three relatively urbanized sites were chosen to obtain further insights into the relationship between the urban environment and the avian community.

### 3.9.1. Point Pleasant Park

Point Pleasant Park is located at the tip of the Halifax peninsula, with three quarters of its edge bordered by Atlantic waters. The forest is a mixture of coniferous and deciduous trees. In total, over 90 species of plants have been documented in Point Pleasant Park (Halifax Regional Municipality, 2008b). It is about 0.75km$^2$ in area and has been used as a recreational park since the founding of the city in 1749 (Halifax Regional Municipality, 2008c). Along the south and east sections the coast is relatively open land with lawn cover and a few standing trees. Towards the park center, there are rocky hills and low cliffs covered mostly with forest and lower-growth vegetation. The habitat was greatly altered by Hurricane Juan in October 2003, when almost three quarters of the forest trees were knocked down, most of which were conifer species. The thick canopy and older forest is now mostly gone, leaving dead trunks and upturned roots.

For avian species, Hurricane Juan tended to be advantageous rather than disastrous (personal interview, August 13, 2009; personal interview, September 22, 2009; personal interview, October 5, 2009). Most bird experts found the park has more opportunities than existed before the hurricane. Both avian diversity and abundance have improved. The dead trees provide more shelter as well as food for cavity nesters like woodpeckers and nuthatches (personal interview, August 12, 2009; personal interview, October 5, 2009). Bigger flocks of crossbills, Pine Grosbeak *(Pinicola enucleator)*, Evening Grosbeak *(Coccothraustes vespertinus)* and Boreal Chickadee *(Poecile hudsonicus)*, which fly in from similar natural habitat outside of the city, are now found in Point Pleasant Park (focus group, October 25, 2009). The forest regeneration process has started. Many shrubs and small trees, such as maple, birch, poplar and aspens have replaced the previous mature forest and these are favored by some avian species such as White-throated Sparrow (focus group, October 25, 2009). These bushes and tangles are hard for big animals to get in, and they protect birds from hawks and cats. There are now more places that people don't walk because of the tangles and bushes, leaving more habitat for the plants, insects and birds. This may also be another factor for the growing number of birds. Though the presence of a more-open canopy allows more undergrowth

and a diverse plant community to develop, some species have suffered from less forest cover, such as Golden-crowned Kinglet *(Regulus satrapa)*, Bay-breasted Warbler *(Dendroica castanea)* and Blackburnian Warbler *(Dendroica fusca)*.

Other than the opportunity brought by Hurricane Juan, Point Pleasant Park is the largest park on the peninsula, and its diverse habitat and the feeding stations and nearby bird feeders sustain several species. Along the east coast of the park, there is a fringe of pines, in which rarities blown from the west and south are usually spotted (personal interview, July 15, 2009; personal interview, September 22, 2009). The shoreline is magnificent for viewing waterfowl in fall and winter and becomes a vital component of the park.

Bird experts came to consensus that Point Pleasant Park isn't fundamentally important on the provincial scale (focus group, October 25, 2009). It is too disturbed to be good breeding habitat; many people and dogs visit, and there is active management of the park. However, in the urban context, it is very important as the public can get close to birds, see some rarities and sustain the vagrants that come to the city. The social benefits of conserving the habitat in Point Pleasant Park outweigh the benefits to natural values such as biodiversity.

### 3.9.2. Sullivan's Pond

Sullivan's Pond is a small artificial pond about a half kilometer from the harbour. It is the last piece of the water corridor from Grand Lake, that connects a canoe route between the Bay of Fundy and Halifax Harbor. After the canal was abandoned in the 1860s, houses and subdivisions started to surround the lake. In the 20$^{th}$ Century, Sullivan's Pond became a city park and is well-known for the diversity and abundance of waterfowl it holds in the fall and winter (SWCSMH, 2008).

Sullivan's Pond is the most urbanized site among the three cases and one of the most urbanized among all the spots that were mentioned by local birders. It is surrounded by

large lawns, some bushes, and ringed by a busy road and residences. However, the bird experts rated it top on the list of places of great conservation value in the urban study area. They thought the pond is a place for waterfowl to collect and provides them a place to rest in storms. Because Sullivan's Pond is one of only a few fresh water bodies in the city that stays open in the winter, waterfowl congregate there for this open-water habitat. Additionally, the feeding stations that are put up by the city administration, as well as nearby mature backyards with bird feeders, help to provide birds with fuel for their long migration in the fall, or to survive through winter. Besides, berry bushes and multi-flora roses near the pond, and Birch Cove Park which sits about half a kilometer away from the pond, have good covers for woodland birds. Two other reasons might add to its popularity: as it is one part of the water corridor, birds that migrate along the corridor naturally come to Sullivan's Pond, and because it is quite urbanized and many waterfowl stir the water, the micro-climate is warmer than that of the harbor (focus group, October 25, 2009). The pond is also a place of concern due to the recent clearing of rose tangles around it (focus group, October 25, 2009). These tangles are helpful for birds to hide from predators, and rose hips are valuable food sources for birds.

### 3.9.3. The Railway Cut

The railway cut lies along the southern edge of the Halifax Peninsula. It goes through several residential areas, small urban parks like Flyn Park and Conrose Field, and links two relatively forested areas: Point Pleasant Park and the region around Clayton Park. Because of the topography, the railway itself is down in the cut and both edges of the cutting are covered with second or third growths, most of which are young deciduous trees, shrubs and understory (personal interview, October 8, 2009).

The railway cut is the only linear feature in metropolitan Halifax that was evaluated as important habitat. It is mostly important for migrants and wintering birds. It is a tongue of nature that extends into the more urban part of the city, and because it is hard for people to go down to the railway, the tangles and bushes on both edges are left alone. The intertwined twigs and branches keep many migrants and wintering birds from cats and

other predators, while the fruit that Mountain Ash trees provide, along with seeds from bird feeders all along the railway, sustain the avian population (personal interview, October 8, 2009). It is also characteristic of a larger part of the peninsula's south shore, which slopes a bit south towards the northwest arm. The topography determines that it gets more afternoon sun. With the natural vegetation and extra warmth, the railway cutting becomes attractive for migrants in late fall, and for wintering birds. Additionally, its long and narrow feature explains the higher concentration of urban birds; they travel through it, use it for feeding, and shelter at night in it. Along the railway cut, the small parks provide more types of habitat including open spaces, wet areas, and patches of trees which helps to attract a greater diversity of bird species.

## 3.10. Threats to urban birds in Halifax

### 3.10.1. Habitat Loss

The loss of habitat for migration and breeding birds was deemed as the biggest threat in the study area. This is mainly due to two causes: the conversion of natural areas to residential houses or industrial parks and the poor management strategy and policies for the current parks, green spaces and residential areas.

#### 3.10.1.1. Development

From 1996 to 2006, more than 20,000 new households were built in metropolitan Halifax (Statistics Canada, 2010). The development almost entirely converted natural habitats to residential areas. For example, the land between Bedford Highway and the east shore of Kearney Lake is green and wild on the basic map which was created shortly after Hurricane Juan in 2003. Since then, this piece of land has been converted for the development of residential subdivisions. Many other pieces of land had the same experience. All the area between Russell Lake and Morris Lake has been urbanized for houses. House building is also encroaching on the Spectacle Lake area, Big Indian Lake area, and there is a plan to shrink the Shearwater airport for residential development.

These conversions resulted in natural vegetation being destroyed and replaced by horticultural and exotic species. One birder said: "I'm very much against people who dig up trees and bushes even if they are older bushes and plant lawn, because Kentucky blue grass is not a wild space. It's a lawn that's based on an imported grass seed and it's not healthy. To my mind, it's a very sterile environment. You might find a robin pick a worm out of it, and that's about it" (personal interview, July 5, 2009). Another example was when a weedy, left-alone place near a nursing home named Glades was taken away to put up a condominium and the Northern Cardinals that used to nest there, and stayed there for the winter for more than 10 years, abandoned it. Now that their habitat is gone, they have to go to the backyards of the neighborhood to feed and shelter (personal interview, October 5, 2009). Northern Cardinals are a well-adapted urban species, and their range has expanded along with the urbanization of North America. However, other shyer species have a much more difficult time when their habitats are destroyed. For example, the bird experts reported that the number of breeding warblers and finches they find in HRM are in decline.

#### 3.10.1.2. Management Strategy

Another aspect of habitat loss is the poor management of urban parks, cemeteries, playgrounds, and residential yards. One birder said: "I think it is that people like to clean out, get rid of. There are lots and lots of backyard, little parks and so on in Dartmouth and Halifax, I mean, right in downtown Dartmouth and downtown Halifax and just out the urban areas around them that are lovely weedy overgrown places that birds love. They breed there, they nest, they winter there, and that's maybe most important of all, they get shelter and food in the winter time when shelter and food are hard to come by" (personal interview, September 22, 2009). Removing the tangles and bushes is happening in many parks: Sullivan's Pond and Camp Hill Cemetery are two outstanding examples. The more organized vegetation provides less shelter and food sources for birds; fewer early winter stragglers have been seen around Sullivan's Pond since the clean up. Therefore, preserving the existing habitat is not adequate for conserving urban birds; maintaining the dimensional complexity of the growths along with sufficient ground cover is important as well.

### 3.10.2. Predators

Urban predators in most cases are cats. One of the birders viewed cats as the biggest threat to urban birds. Free range cats became a bigger threat to urban birds as more birds started to come to the backyard feeders. No statistics have been collected on the number and species of birds that are killed by domestic cats in Halifax yet, but several local birders indicated it is a serious problem. Other researchers found that the level of absolute mortality caused by domestic cats may not be the most important problem, but rather the sub-lethal effects of predators. This means that the presence of predators may reduce bird fecundity and interfere with other life-history traits, and thus even in the absence of direct mortality may potentially depress bird populations severely (Beckerman, Boots & Gaston, 2007). It was suggested that keeping the cat on a leash when they are outside can substantially reduce the chance for them to prey on birds, as well as reducing their sub-lethal stress on the avian population.

### 3.10.3. Pollution

Pollution was seldom mentioned as a threat to urban birds in Halifax. Only one birder expressed his concern about the effects of residues of pesticides on the reproduction of insects. By contrast, a more common pollution phenomenon raised no strong objections from local birders. Until recently, Halifax Harbor received about 170 million liters of untreated sewage from 50 outfalls, and the effluent has contaminated the water (Natural Resources Canada, 2007). However, big flocks of gulls and some ducks congregated near the outflows of sewage where they feed on the waste. Rare species sometimes can be spotted among the big groups of common birds. Therefore, some birders have enjoyed birding near the sewage outflows in the winter. From 2007, three wastewater treatment plants have been constructed and the harbor will be cleaner in the future. Most birders foresee that a cleaner harbor will support a different bird community, and the ecosystem may be healthier but perhaps less interesting to birders.

# CHAPTER 4 – BIRD CONSERVATION IN HALIFAX

## 4.1. Protected areas and other land that has been conserved

For the purpose of conserving the biodiversity and natural heritage of Nova Scotia, the provincial Department of Environment has developed a protected areas program based on the 80 Natural Landscapes Framework (Government of Nova Scotia, 2009a). 37 Wilderness Areas, 21 Nature Reserves and 2 Heritage Rivers have been set aside as provincial protected areas (Government of Nova Scotia, 2009b). They serve differently in terms of their purpose. Wilderness areas were set up as examples of representative natural landscapes and features; they are protected by the Wilderness Areas Protection Act. Scientific research, environmental education and nature-tourism, such as hiking, canoeing, kayaking, sport fishing and hunting are allowed in protected wilderness areas. In nature reserves, however, scientific research and education are the primary use, recreation is generally restricted. They are high conservation value lands which were previously in government ownership, or have been purchased by the government for conservation reasons, or are private lands set aside from development with the land-owner's consent. The Special Places Protection Act, R.S.N.S., 2205, c.28 enables the establishment and protection of Nature Reserves in NS. The two Heritage Rivers in the province are part of the Canadian Heritage Rivers System (CHRS), which was established by the federal government in 1984. CHRS encourages the appreciation of rivers by the public and permits recreation.

In addition to working with these three categories of protected areas, the Department of Environment of Nova Scotia supports private land conservation by working with landowners as well as with environmental NGOs like the Nature Conservancy of Canada and the Nova Scotia Nature Trust. Almost 70% of the province's lands are privately owned (Government of Nova Scotia, 2010a), and some of them are habitat of endangered species or places of high conservation value for other reasons. The existence of so much private land therefore brings both challenges and opportunities for reaching the provincial goal to protect 12% of its landmass by 2015, as required in the Environmental Goals and Sustainable Prosperity Act, S.N.S., 2007, c.7. Provincial Statutes exempt beaches,

provincial parks, trails and some special places for natural habitats or rare species on private lands from development, but establishing protected areas on private property is challenging. This usually requires long-term negotiating with various stakeholders and may require expenditure of substantial public or private NGO funds to purchase the land.

In the current study, the whole area examined is 441km$^2$, 31.6% of which is protected to some extent as marked out with green, orange, and pink in Figure 8. Parts of three provincial Wilderness Areas lie within the scope of the study area: Blue Mountain Birch Cove Lakes, Waverley-Salmon River Long Lake, and Terence Bay. Three areas are protected by Parks Canada as parts of the Halifax Defense Complex, which is a National Historic Site. Additional areas, large or small, are restricted from development by various statutes such as the Provincial Parks Act, Environment Act, Wildlife Act and Beaches Protection Act. The largest of these is Long Lake Provincial Park which lies entirely within the study area and is 21 km$^2$ in area. These lands are marked in orange and together with the protected Wilderness Areas and Parks Canada lands make up about 114 km$^2$ in area; or 26% of the whole study area (Table 1). They consist of heritage and historic parks, provincial parks, canal, beaches and marshes. As is shown on Fig. 8, most of these areas are away from the city center, they are wild but fragmented by the cobweb-like urban development.

Areas marked in green are parks and open spaces in NS identified within a GIS database provided by Dalhousie University (Fritz, 2010). They include regional, community, neighborhood, district parks and parks that have no name. Most of these parks are regulated as part of municipal planning and are less well protected than provincial parks and protected areas. Point Pleasant Park is an exception in this regard because it has been leased by HRM from the Government of Canada for 999 years and the terms of the lease only permit the lands to be used as park, but compared with areas protected under legislation, most of the other municipal parks and playgrounds are not securely restricted from urban expansion. The number of these municipal parks found in the study area hugely outweighs that of the provincial and federal restricted land use areas, but the sizes are much smaller. With the exceptions of the Western Commons

Regional Park and Sandy Lake Park, which are relatively large and undeveloped areas, most parks are medium to small size, close to the urban core of the city and highly fragmented. Children's playgrounds, adult sports fields, and other recreational areas are included in Fig. 8 as part of the park layer. However, as a result of excessive human activity and little productive vegetation on these open spaces, they are not suitable for wild animals. Some other city parks, such as Frog Pond and Fleming Park, are small remnant patches of natural habitat that are valuable for wildlife. Due to their accessibility they have become good places for urban residents to appreciate nature and benefit from environmental education.

The single pink area consists of two pieces of land acquired and conserved by the Nova Scotia Nature Trust: Captain Arnell Conservation Lands and the Napier Family Conservation Lands. They are adjacent to each other in the region known locally as the Purcell's Cove backlands (Nature Trust NS, n.d.). The total area is about 0.34km2 and takes up 0.08% of the study area (Table 1). Although these conserved lands are not substantial in terms of area, they provide an important example of private land conservation in HRM by means of a private land trust.

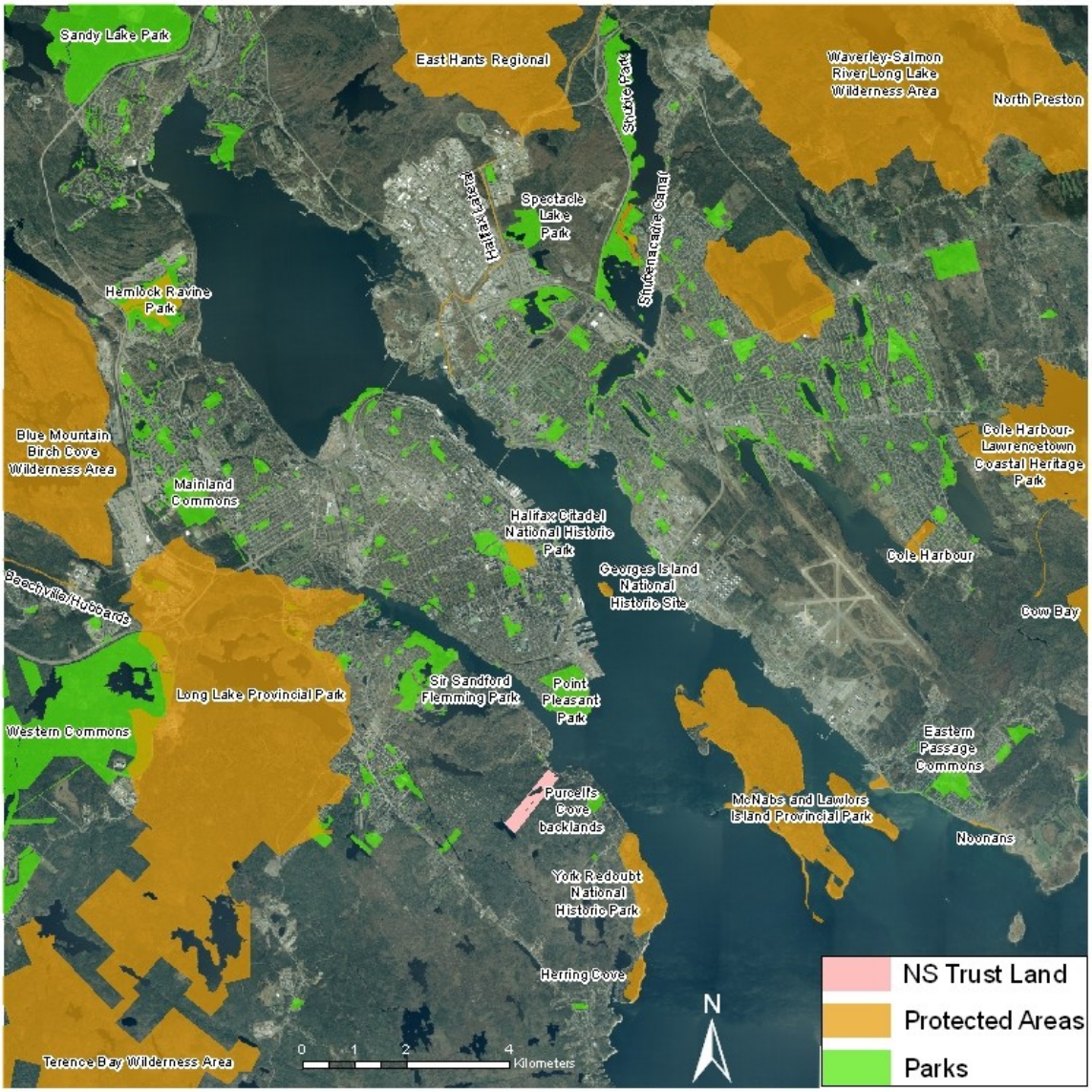


Figure 8 – Areas of Restricted Land Use

Table 4 - Land of Restricted Use in the Study

| | Areas protected under legislations | Parks | Nature Trust's Land | Total protected area |
|---|---|---|---|---|
| Area/$km^2$ | 114.7 | 24.5 | 0.3 | 139.5 |
| % of whole study area | 26.0 | 5.6 | 0.1 | 31.6 |

### 4.2. Unprotected urban bird conservation hotspots

According to the information collected from local bird experts, 128 $km^2$ of the study area are considered as important bird habitat, consisting of about 29% of the total area, as shown in Figure 9. Habitat judged to be important year round is shown in Figure 10. Compared with the land that is set aside for parks and conservation, the total area of identified bird habitat is smaller but much less fragmented. Not only terrestrial habitats were considered, but coastal marine habitat was also given much attention by local birders. "In winter, you see most of the good for winter spots are all, they're not inland, they are all coastal…. they're all places where birds collect up along the water here", one local bird expert said during the interview, "it's significant in my opinion. … Purcell's Cove and the whole Northwest Arm" (personal interview, June 22, 2009). Another birder said: "in the winter they [birds] migrate here from further north and they winter here, they spend their winters in these coastal waters and they spend where they can feed … and once again that's water habitat but that's important. And part of the reason of birds being there is the water there is very shallow, so diving birds can get food from the bottom" (personal interview, September 22, 2009). At the same time, coastal areas were identified as susceptible targets for development: "We are finding that there is more development going on along the coast for residential area, so some of that habitat was never accessible before because there are no pathways going down, but now they've cleared it and had these little bands of woodland" (personal interview, August 13, 2009).

There is a lack of protection of marine habitat in general in the study area as well as across Nova Scotia. Figure 8 shows that there are only four coastal areas protected under statute: MacCormacks Beach, Lawlor Island, McNab's Island and a strip of land at Ferguson's Cove, none of which includes protection of marine habitat. Birders identified the entire Halifax Harbour, the Northwest Arm, Bedford Basin, coves along the shoreline, water around islands as important habitat for wintering birds. "They're all places where birds collect up along the water" mentioned one birder (personal interview, July 22, 2009). Among 195 bird species found during December and January in Nova Scotia in the Christmas Bird Counts (Bird Studies Canada, 2010), 90 of them are waterfowl, shorebirds and seabirds, which require sheltered and productive coastal marine habitat to

feed and rest. None of the shorelines in the region of Purcell's Cove or Hartlen Point are protected, nor are any coves or harbor area.

Unprotected important bird habitats are shown in Figure 11. These are areas that have not been protected by any means but were identified as important bird habitat by the bird experts in interviews. Compared with the habitat identified as important ones all year round (Figure 10), several of them have not been protected at all. Among these habitats, Hartlen Point is the favorite birding spot of many local birders (personal interview, July 22, 2009; August 13, 2009; August 18, 2009) and one of the most important habitats for various bird species in the scope of the study area (Stevens, 1996; personal interview, July 27, 2009; August 13, 2009; September 22, 2009). One birder said during the interview: "there seems to be a trap for birds and I wouldn't want to see anything happen in that area" (personal interview, June 22, 2009). Hundreds of species have been found at this spot and the number keeps growing (Stevens, 1996). The Cow Bay area is similarly marked as important bird habitat for every season around the year. The salt marsh, intertidal flats and wooded shores there provide a mixture habitat for both shorebirds and open-habitat species. This kind of habitat is not common in the study area and at Cow Bay there is a relatively large, intact but isolated piece of natural land. In order to provide the natural services needed by millions of migrants and breeding species each year, as well as other animals and plants, it needs to be preserved and protected from development.

Across the harbor, the entire piece of land marked as "Purcell's Cove & Herring Cove Area" in Figure 9 was identified as important breeding habitat. Although there are several parks and reserves located in this area, breeding birds, even those that breed near the city, require "big patches of natural areas" (personal interview, August 19, 2009) and "intact forest" (personal interview, July 22, 2009). In the Halifax 2006 Regional Plan most of the land in this area is not planned for development except for the Herring Cove Suburban District Center located at the right-hand bottom corner of the marked area, which is planned as a district center (Halifax Regional Municipality, 2010a). However, the area is still stressed by ongoing housing development.

In the city center, beside Point Pleasant Park, the railway cut is another all year-round bird habitat indicated by birders. It is embedded in old residential areas of south end Halifax peninsula. The deeply canalized track and thick bush covers entitled it to be described as "an important and attractive corridor for birds to travel along" (personal interview, October 8, 2009). It is still utilized for railway transportation, and the bird community seems to have adapted to the noise and vibration caused by the trains. Clear cuts associated with housing development have destroyed some of the habitat (personal interview, October 8, 2009). Examples of the clearing of semi-wild habitats like this are not uncommon in the city. Between Russell Lake and Morris Lake, there used to be a little marsh that was home to Wood Ducks, Ring Neck Ducks, Redwing Blackbirds and occasionally Rails, but now all of it has been developed (personal interview, August 13, 2009).

Above are just five prominent examples of areas that are important for birds yet are fully exposed to development. Many more are shown in Fig. 11. The biggest threat to terrestrial habitat is shrinking habitat and less natural service due to residential development, as well as the clearing of dense shrubs such as tangles of multi-flora roses. Regarding the marine environment, birders have mixed feelings about the untreated sewage in the harbor. "Because in the winter when things freeze up, and then you have the sewer outlets and it would accumulate gulls and ducks and things like that" (personal interview, August 18, 2009) and birders "look through those flocks of birds for rare arctic or western or southern gulls that belong somewhere else" (personal interview, September 22, 2009). Therefore, sewer outflow spots are usually birding hotspots in the winter, however, "winter is all the water, the entire harbor, that's why it's important to clean it up" (personal interview, August 7, 2009). It is believed that when the raw sewage in the harbor is cleaned up, a healthier marine ecosystem will eventually benefit the bird community (personal interview, August 7, 2009; focus group, October 25, 2009).

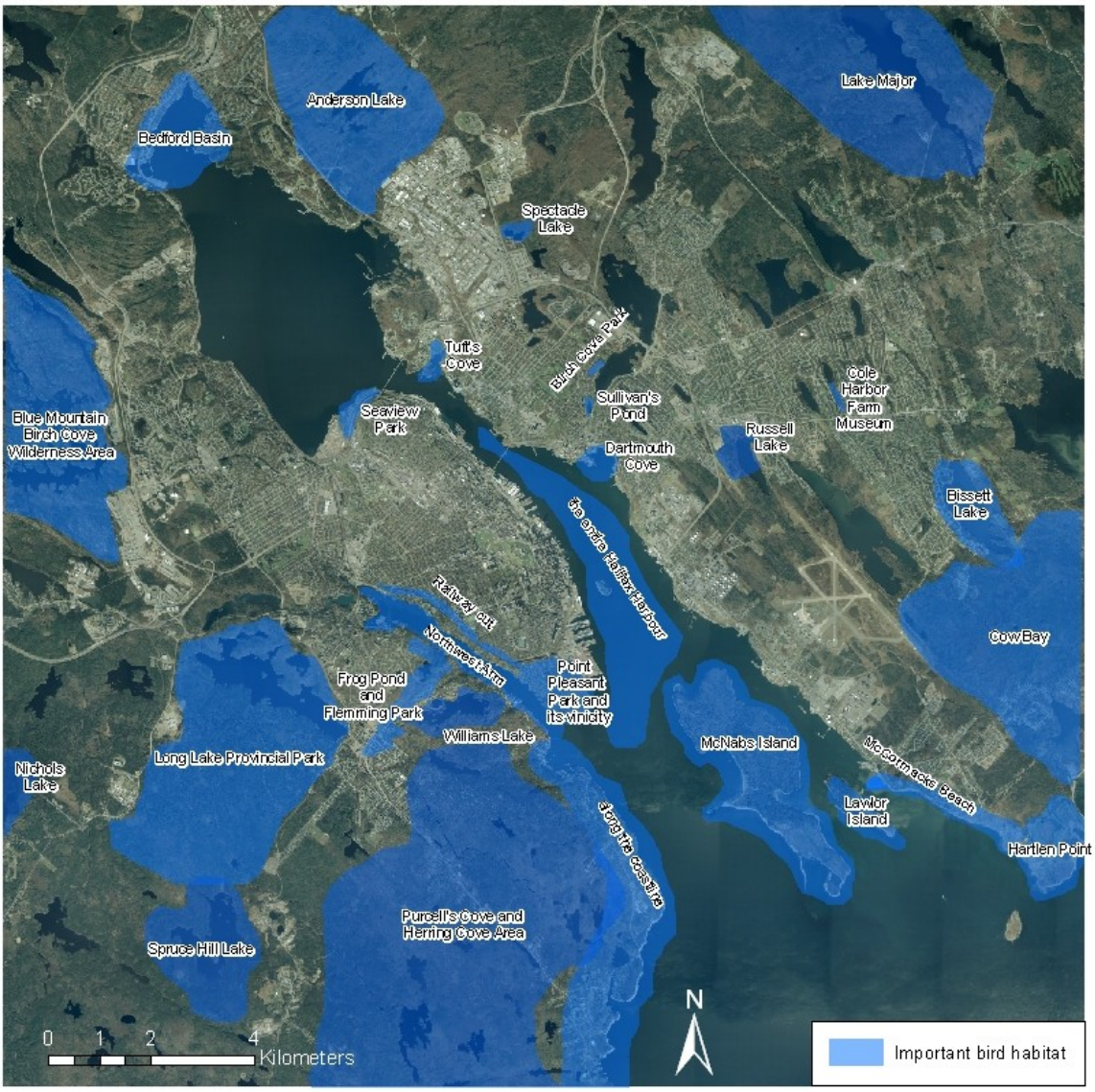


Figure 9 – Important Bird Habitat

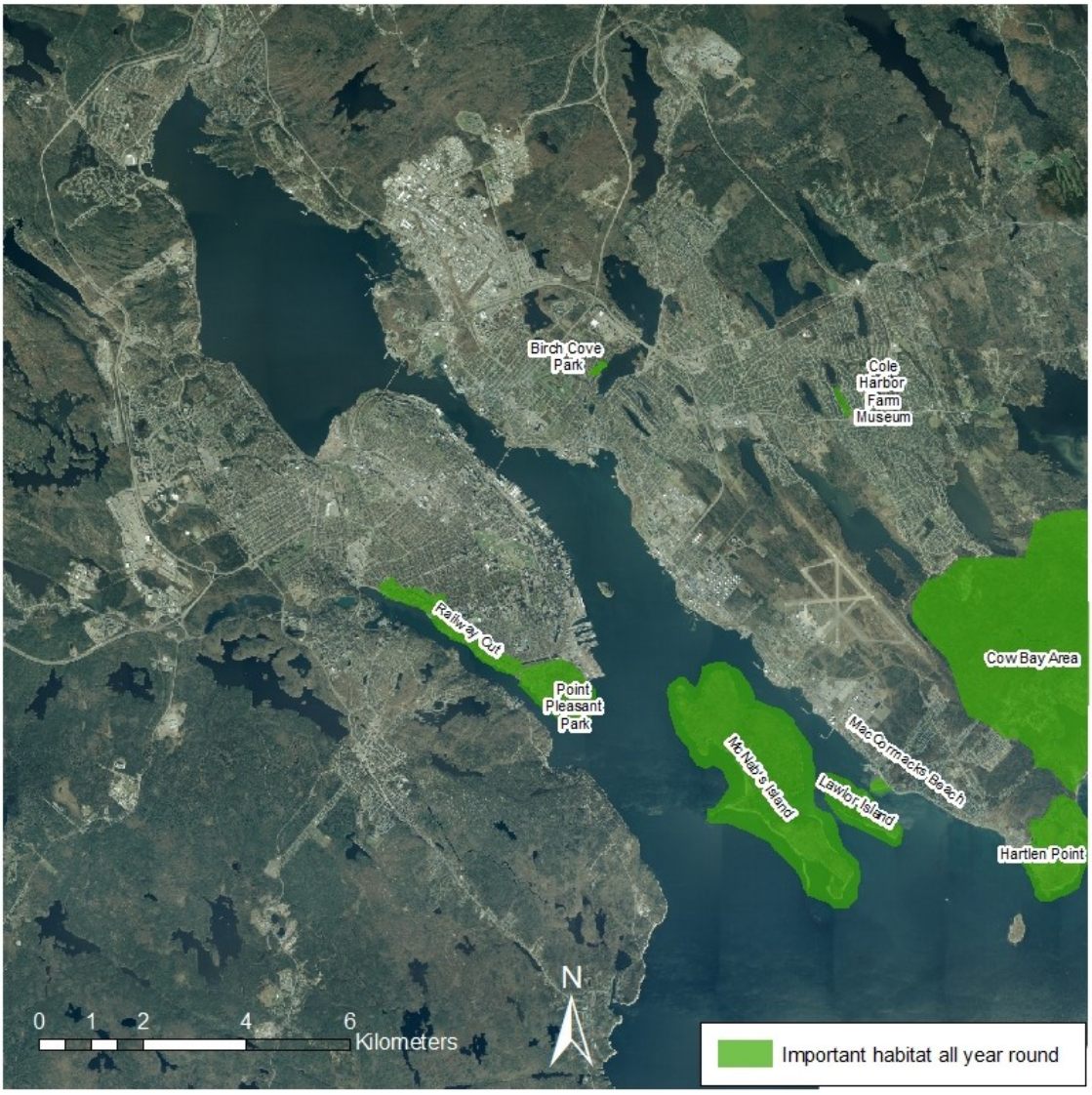


Figure 10 – Important Bird Habitat All Year Round

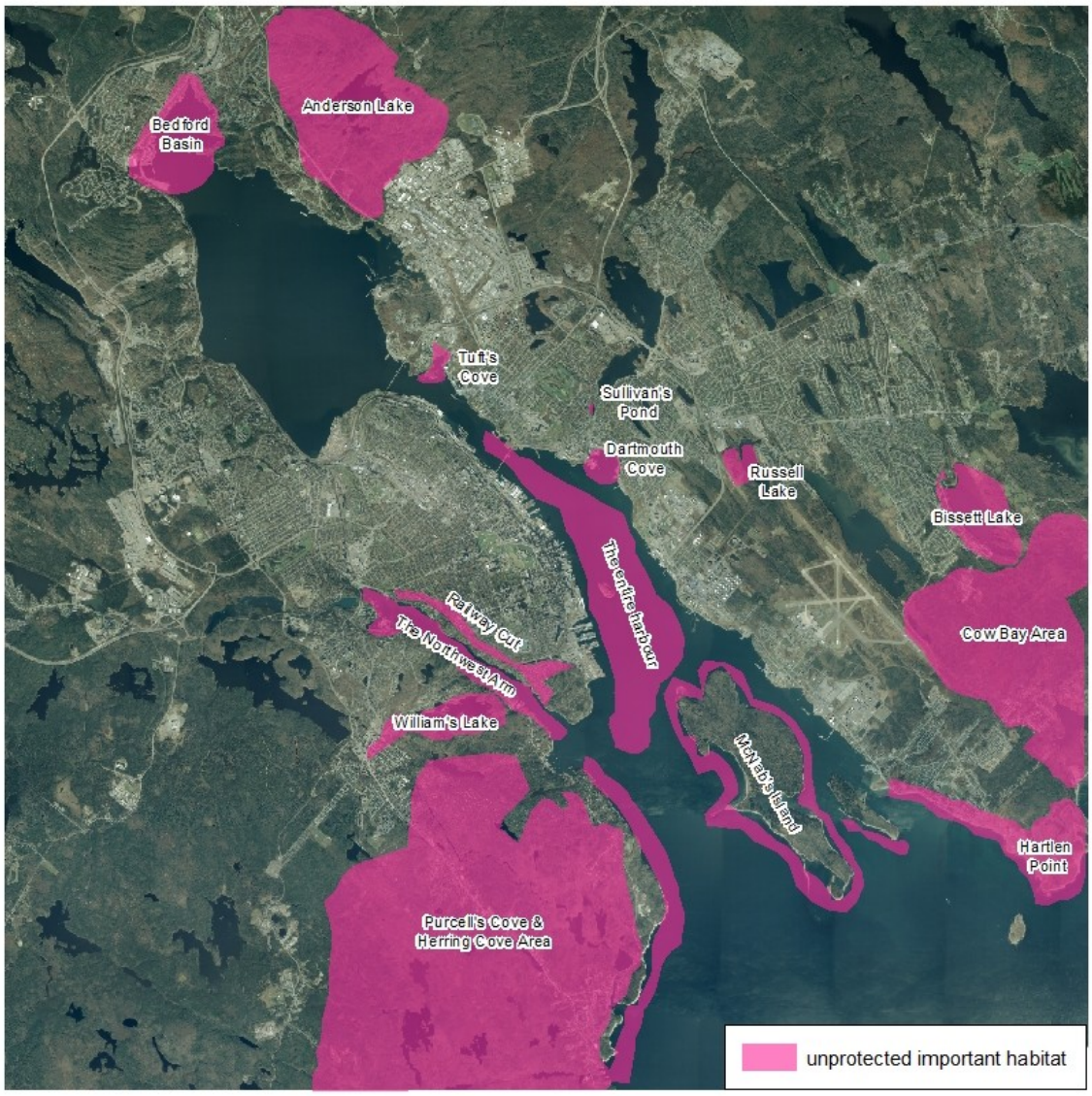


Figure 11 – Unprotected Important Bird Habitat

### 4.3. Management of medium and small scale hotspots

Near the urban center, where there are no chances for establishing additional large protected areas, effective management of medium and small scale bird habitat is necessary for maintaining and increasing both the species diversity and abundances of birds.

Because of the scale of forest and green areas in the urban center, it "actually gets more interesting things during the migrations and during the winter" (personal interview, July 23, 2009). Especially in the winter, "city area is producing heat and there's a lot of heat produced by buildings and city and as birds move over and they seek a warmer area, and they will come in" (personal interview, August 13, 2009). So most urban birds in metro Halifax rely on the resources provided by the city during migration seasons and winter. Migrants and wintering birds are "not very discriminating with regard to habitat preferences, … habitat preferences presumably it has to do with food supply" (personal interview, July 22, 2009). They could appear in bushes, urban forests, backyards, and wherever green land and vegetation exist in the city.

#### 4.3.1. Effective management of parks, schools, playgrounds for birds

Community parks, schools, cemeteries, sport clubs and shopping malls in metropolitan Halifax usually have a green belt or a piece of left-alone land on which plants are allowed to grow relatively naturally. Hardy thorn bushes, cattail marshes or little brooks can be found in these so called "waste lands" (personal interview, August 13, 2009), which provide both food supply and shelter to birds. There are "fairly significant numbers of birds" found in these green pockets of the urban area. Even species that would not normally be found in the city will survive "quite a bit longer" in these green pockets before the harsh weather comes. An example is a piece of land between Armbrae Academy and the railway cutting. It is covered with intertwined bushes; birds like American Robin, Song Sparrow and Yellow Warbler *(Dendroica petechia)* nest in it (personal interview, September 22, 2009).

Some local birders have found particularly that multi-flora rose bushes (*Rosa multiflora*, an alien species) are one of the biggest attractants for birds in the city (personal interview, August 13, 2009). Birders pointed out that the tendency to clear cut and manicure these multi-flora rose bushes is devastating for both the urban avian diversity and survival of urban birds (personal interview, July 15, 2009; personal interview, July 22, 2009; personal interview, August 13, 2009; personal interview, August 20, 2009). Clean-up of this sort has happened in many cemeteries (personal interview, July 15, 2009) and community parks: "across the Hawthorne Street off the trail leading to Lake Banook that there's been tidying up, and in fact fewer early winter stragglers have been seen there since the clean-up" (personal interview, July 22, 2009). The solution is "leaving it alone, no interference, left it alone naturally, left the insects and all" (personal interview, August 20, 2009), so that nature will do its own thing.

Another aspect of managing the green belts in the urban core is regulation of free-range cats. Though there is no statistic on the number of bird deaths caused by domestic cats in Halifax, several birders indicated that cats are one of the main urban threats (personal interview, July 15, 2009; personal interview, August 12, 2009) and have the potential to become a more serious problem if no regulations will be implemented.

*Cats are very very very bad for birds. And I can't say that enough. People, if they are going to have a cat for a pet, they should have it for a pet, and keep it in the house or take it for a walk on the leash. I really think it's irresponsible to open the door and let your cat out. …That has nothing to do with how well fed it is, cats are hunters. It's her instinct, not the cat's fault.* (personal interview, July 15, 2009).

Additionally, interviewees said that keeping fresh water bodies like little ponds and brooks pollution free is very important for urban birds. Especially when most of the fresh water bodies freeze up and large flocks of waterfowls are drawn to remaining open ponds and lakes, pollution may be fatal.

### 4.3.2. Potential restoration projects

Small restoration projects could improve the availability and quality of urban bird habitat, thus attracting more species to the urban core. One birder mentioned that Conrose Field, a small community park in the south end of Halifax, used to have a pond with tree frogs known as Spring Peeper. There is still a wet area in the park where black ducks will sometimes congregate in the winter but no other waterfowls or frogs remain (personal interview, October 8, 2009). If the city could restore the pond, more species would be drawn to the park.

Tree retention is another project that birders expect the city should carry out. Because of the constant loss of mature trees and old bushes due to development, birders expect that regulations should be in place to ensure that only a limited number of trees will be cut down. If feasible, the abandoned mature trees might be moved to a community park or nearby street. The city of Burnaby, British Columbia, is an example in Canada of the existence of guidelines providing technical support for tree retention, relocation and replacement (City of Burnaby, 2010). It encourages significant tree retention through site planning and promotes the preservation and management of trees on private property. Tree retention policies are similarly found in cities in England and Australia (City of Ipswich, 2008; Town of Bassendean, 2010). Halifax doesn't have as rigorous tree management policies, but now an urban forest master plan is in the process of development aimed at providing a way to sustain the urban forest, including its biodiversity values (Halifax Regional Municipality, 2010b).

Besides trees, birders paid considerable attention to the status of wetlands. Although the recently-adopted wetland policy of Nova Scotia (Nova Scotia Environment, 2009) guarantees no-net-loss of the total area of wetland, the policy does not apply to wetlands smaller than $100m^2$ (p. 8). Most urban wetlands in HRM are not big enough for protection according to the policy, but they are often especially important for urban birds. Furthermore, the ecological functioning of the wetland or restored wetlands surrounded by development are of concern to the local birder community.

### 4.3.3. Horticultural elements and yard design

A large proportion of urban habitat in metro Halifax consists of residential yards. The vegetation composition in yards varies from a tidy lawn to ornamental plants to native species or a mixture of all. These different compositions have considerable influences on the presence and survival of urban birds. In many backyards of mature residential communities in Halifax, there are yards full of bushes, which is beneficial for birds to hide from harsh weather and feed on the fruits (personal interview, September 22, 2009). A mixture of both deciduous and coniferous trees in the backyard is desirable. After deciduous trees and bushes lose their leaves in late autumn, conifers become the main shelter for birds coming to the backyard. Even dead trees may be valuable, for example Christmas trees after they have been used for celebration can still benefit birds if they are piled up in the backyards instead of discarded on the street, waiting to be composted (personal interview, July 15, 2009).

In new subdivisions, where native vegetation has been taken out and replaced with ornamental species, the habitat appears less attractive to birds or other wildlife (Acar et al., 2007; personal interview, August 13, 2009). Lawn is the least bird-friendly backyard environment, the structure is too simple and "sterile" (personal interview, July 15, 2009) to sustain a diverse group of birds. People usually fertilize it and may spray it to eliminate pests. This not only removes the food source for birds but the chemicals may enter the food chain of birds and may impair their health.

Therefore, city dwellers all play a role in urban bird conservation whether aware of it or not. What they plant and how they manage their green land matters to the avian population. From a food supply point of view, briers and berry bushes, such as inkberry, raspberry, mountain ash, Clematis, and many others provide food sources for urban birds, some even in mid winter. By encouraging city residents to adopt schemes to build wildlife-friendly gardens, bird conservation and in a broader scene, biodiversity conservation can benefit.

Naturalization of backyards within the city needs to be promoted more vigorously. Because the habitat degradation in the city is partly caused by the replacement of natural vegetation with exotic species, naturalized yards provide more native vegetation and more friendly environment for birds. While the scale of an individual backyard is not big enough to sustain a viable community of birds, when there are many in an area with decent cover they can provide as much habitat benefit collectively as city parks and nature reserves (Goddard et al., 2009). However, birders also mentioned that some exotic plants, like hawthorn bushes, are favored by birds in the city.

### 4.3.4. Bird Feeders

Bird feeders are another example of how urban bird conservation can be integrated into the daily life of urban dwellers. Three or four decades ago, not many bird feeders could be found in metropolitan Halifax and the peripheral area (personal interview, August 13, 2009). The number of urban birds has increased in recent years, particularly with booming numbers of urban birds in the winter that come to backyards (focus group, October 25, 2009). Local birders reported their belief that the condition of wintering birds is advanced by feeders, especially seed-eating birds (personal interview, August 19, 2009). Feeders increased the number of birds such as Mourning Dove *(Zenaida macroura)*, Song Sparrow and Downy Woodpecker *(Picoides pubescens)* (focus group, October 25, 2009). Furthermore, with the presence of bird feeders, some birds such as Pine Warbler *(Dendroica pinus)* and Northern Cardinal that were previously rare in the city are becoming more common due to having learnt to utilize the bird feeders.

On the other hand, bird feeders may also have some negative influences on the avian community. Feeders are good for "urban exploiters" (Blair, 1996), which are adept at using the resources generated by humans. For example, the number of European Starlings in metropolitan Halifax has increased greatly owing to urban feeders and dumps. Their population augmentation has exacerbated the food and habitat competition between species. Individual starlings are more aggressive and less afraid of anthropogenic disturbances than other species; they can drive cavity nesters away from feeders.

Fortunately, their population in the city now appears to have stabilized (focus group, October 25, 2009).

In addition to favoring a few urban-dominant species, feeders attract predatory birds like Sharp-shinned Hawk *(Accipiter striatus)* because of the concentrated groups of seed-feeding birds. The same is true of house cats and other potential predators. The more frequent occurrence of predators around bird feeders is a direct threat to birds and discourages them from feeding on anthropogenic food sources (Beckerman et al., 2007).

In the winter of 1997-1998, there was an outbreak of disease in bird communities caused by *Salmonellosis*. Many urban birds such American Goldfinch and House Sparrows were affected and the disease ranged from Labrador to New York. The incidence of disease has been related with the population density at feeders (Kirkwood & Macgregor, 1998) but this finding is not fully confirmed (Daoust et al., 2000). Prescott et al. (2000) considered that hygiene at bird feeders is vital for the health of birds in late winter (Prescott et al., 2000).

Local birders thought overall that the benefit of having bird feeders outweighs the detriments, although the effects of artificial food sources haven't been fully studied. Besides the strong support feeders provided for wintering urban birds and migrants, they have significant social value for educating city dwellers on bird conservation.

*Black-capped chickadees (Poecile atricapillus) probably are responsible for more people become feeder watchers than any other species. They are doing very well with the feeder, if the population decreases, that will be a giant red light, a giant buzzer. They are taking so many things, there will be almost zero chance for them not to find food during the day* (focus group, October 25, 2009).

Starting with feeding and observing backyard birds, to getting familiar with the species and their songs, behavior and characteristics, to then recording the species and

abundance periodically, city residents acquire and accumulate their bird knowledge in this way in daily life. When this kind of knowledge is collected and analyzed on a wide terrestrial scale and over a long range of time, it can be applied to large-scale bird studies for improving bird conservation strategies. One of the world's leading research organizations, the Cornell Laboratory of Ornithology has over 200,000 citizen-science participants who record bird information in backyards and report to the database. This project provides an excellent example of how local knowledge can be used for public education and scientific research.

### 4.4. Monitoring Ecological Integrity (EI) of Halifax Using Birds

The study did not focus on bird species in each important habitat that has been identified, nor did it apply natural science methods such as field surveys to study birds. However, its findings can be applied to facilitate future urban bird programs in Halifax. Monitoring stations can be set up in places like Sullivan's Pond or Point Pleasant Park which are important for birds in different seasons and to which Halifax residents have easy access. By studying and keeping records about how bird species and abundance change in these places, we will have a better understanding at how urban areas and human activities influence bird community.

As mentioned in the second chapter, researches (Temple & Wiens, 1989; Hostetler & Knowles-Yanez, 2003)has indicated that bird species or bird guilds can be used to examine EI on a coarse scale. Therefore, long-term monitoring programs could be set up in some of the important urban bird habitats and geared towards examining variation in diversity and abundance of some indicator species and guilds. An example would be monitoring of urban exploiters: European Starlings, Rock Doves, and others. When the monitoring accompanies other research work on urbanization and vegetation changes in those environment, more will be known about the relationship between birds and urban EI.

### 4.5. Education for urban bird conservation

*The impacts of urbanization on native species are poorly studied, but educating a highly urbanized human population about these impacts can greatly improve species conservation in all ecosystems* (McKinney, 2002).

Public education is the key to bird conservation in the urban context. Without a well-informed public, urban bird conservation will face many more barriers to achieving its goals. Many of the values that are derived from urban birds depend on whether people can see them, or have places to get in touch with them (personal interview, July 27, 2009). Therefore criteria for selecting and conserving urban bird habitat need to include consideration of representative bird species, habitat structure, and opportunities for public engagement. Unless people have more opportunity to get in touch with birds and appreciate their existence, it is difficult for urban residents to realize that bird and bird conservation are closely related with their daily life.

The Nova Scotia Bird Society organizes monthly bird walk for beginners in Point Pleasant Park and Sullivan's Pond. Bird walks are a good education tool to encourage city dwellers to study birds and appreciate them. These popular outings play an important role in bringing new members into the world of birds and passing on local knowledge. In addition to bird walk, other environmental NGOs, museums and academic institutions can incorporate vegetation, birds, invertebrates, mammals and other knowledge into different natural walks. Program like this should be designed to be very accessible to whoever wants to learn and also should be specially geared towards young people. Local birders pointed out the ongoing challenge of enrolling younger people and keeping the diversity of members (personal interview, July 15, 2009). In addition to field trips, involving more people in more citizen science programs on birds may be another way to attract the attention of urban resident.

# CHAPTER 5 – CONCLUSIONS

## 5.1. Benefits and limitations of the study

Bird study is one of the few research fields in which citizen science has been successfully utilized to engage large numbers of volunteers (Trumbull et al., 2000). Surveying bird watchers and mining databases that record a wealth of information provided by birders are commonly used tools for bird studies at both local and landscape scales (Lepcayk, 2005; Caruana et al., 2006). Studies of bird distribution and abundance would not have such ample information without the participation of millions of amateurs. For urban ecosystems and residential ecosystems, the cumulative activities of local birders can play a critical role in studying the avian community, their habitats, and the potential contributions of cities to conserving biodiversity.

In this study, the knowledge of birders has been applied to identify important bird habitats, as well as their characteristics, in a specific urban study area. By contrasting these with protected areas in the same region, places that are important for birds and vulnerable to development have been indicated for future research and urban planning. An intrinsic limitation of the study is, however, that the study approach is limited to the habitats of birds. Selecting birders as study participants naturally biases the habitat identification outcomes. Compared with significant habitat specified by the Department of Natural Resources (DNR) of Nova Scotia (Government of Nova Scotia, 2010b), important bird habitat described by the birders covers a larger percentage of the study area, and includes most of the significant habitat identified by the government. Three reasons might lead to this consequence.

Firstly, DNR included the following definitions for the "significant areas" (Government of Nova Scotia, 2010b):

- Sites where species at risk or other species of conservation concern can be found and/or;

- Sites where unusually large concentrations of wildlife occur and/or;
- Habitats that are rare in the province

Because species at risk and large concentrations of wildlife are less likely to occur in urban contexts, attention was naturally not drawn to urban habitats. Also, rare habitat types in the city core are probably not unique within the province as a whole and thus are ignored, despite the benefits endowed from having these in urban locations, such as playing major roles in environmental education. Secondly, the compilation of the "significant habitats" was supplied by local naturalists, museums, universities and conservation data centers (Government of Nova Scotia, 2010b); it was not based on a thorough survey carried out with rigorously objective survey methods. The result therefore is not a comprehensive list of significant habitats in the province. Even so the current study has limitations too. It is based on local birders' knowledge, and therefore although the areas identified are important for the survival of birds or for overall urban avian diversity, they might not be as important for other wildlife, and thus may not have been identified by DNR.

Nevertheless, even though the results of the current study are biased towards the values of local birders, the study should be helpful for urban planners and other decision-makers. The HRM Urban Forest Master Plan which is currently being created is an example of the kind of opportunity that arises during urban planning for meaningful input on biodiversity conservation. The current study has revealed avian habitats that are perceived to be important in the urban context, where the social and educational values of the habitats may outweigh their capacity for sustaining wildlife. The study has also provided a baseline for future studies on urban habitats in Halifax, NS.

Although the outcomes of the study have satisfied the initial objectives, some methods and research processes might be improved in future similar studies for more effective communication with participants and obtaining richer information. Local birders were contacted by means of a snowball-sampling method, and each interviewee was asked at the end of their interview to recommend excellent local birders who should be contacted for this study. The method ensured that all participants were respected in the

local birder community for their expertise and knowledge of birds, but no information was gathered during the interview that could directly allow the researcher to estimate their birding experience, such as the length time they had been bird-watching or the surveys they had worked on. Birders were also not asked where they resided. With the exception of some common favorite birding places, such as Hartlen Point and Point Pleasant Park, birders tended to refer more often to those areas closer to where they have lived for many years. Thus some small hotspots were identified that attract less common species such as Northern Cardinals, but only by birders who live in vicinity. If birders' addresses had been acquired and documented, the influence of domicile on important avian habitat could have been assessed. On the other hand, intrusive personal questioning was purposefully avoided because the study was not designed to conduct research on the birders themselves, which would have required altering the research methods and protocols, possibly to the detriment of the mapping objectives.

With respect to the specific methods used, some improvements could be made in future research on this subject. Two practical factors might have led to less effective communication with the participants than was intended. One is the lack of labeling on the maps that were used for the interviews; the other is that birders were asked to work with two maps at the same time, although they were given the choice to work with only one of them. People have mental maps of geographic locations and the differences between the mental maps and the equivalent objective geographic maps can be substantial (Kitchin, 1994). Most birders drove to the birding places to which they referred, and the locations of the places stored in their minds often related to the community name, street name or highway number. The GIS spatial data are not necessarily reflected in the mental maps of the places they know even though they are very familiar with the city and its bird habitats. Over-looking this fact led to time-consuming direction finding on the map in some cases, which might have slightly frustrated some participants, influencing their confidence in sharing knowledge and also affecting the accuracy of the information they provided. For similar studies in the future, maps should be well labeled when presented to the interviewees. The maps could also be emailed to participants beforehand to give them a better opportunity to orient themselves relative to the map.

Providing participants with both "the whole study area" and "the intensive study area" may also have reduced the effectiveness of communication. Three birders chose to work with only one map while the others worked with both. It was originally intended that providing maps at two different scales would allow greater details to be drawn out at the finer scale, but no evidence was found that the scale of habitat mentioned by the birders was influenced by the different scales of maps provided to them. Because the intensive study area was a part of the whole study area, information redundancy was very noticeable when birders were asked to talk about avian habitats on both maps. It turned out the investment of time and funding resources on the intensive study area could have been better allocated to improving other aspects of the quality of the study.

### 5.2. Recommendations

Based on experience gained from the current research, some general recommendations can be made for future research incorporating citizen science on urban birds, their habitats, and their conservation. On the local scale, the study has provided a baseline for the important bird habitats within Halifax metropolitan area, and if it is repeated every decade or so the results will contribute to knowledge of urban ecology, which is a relatively neglected field of study. Variation trends can reveal not only how urbanization has altered ecosystems, but also how the distribution of wildlife reacts to such changes over long periods. It also may reveal changes in birders' evaluation criteria regarding urban bird conservation. Studies have shown that citizen science projects engage participants in thinking processes that are similar to scientific research, and thus might trigger changes in those thinking processes and attitudes towards nature conservation (Trumbull et al., 2000; Brossard et al., 2005). Furthermore, if local birding programs such as the Tucson Birding Count (Tucson Bird Count, 2010) can be designed and adapted towards engaging students and children in HRM, they could promote scientific thinking as well as stimulate conservation means and actions in the future.

Maps are direct visual communication tools for interpreting scientific data in plain graphic form that relates to human communities. With the development and improvement of GIS it is much easier than before to store and analyze maps created by using different

sources of bird data. The study reported here is a case in point. The study has shown that mapping as a research approach can be adopted in both social science and natural science projects as a conduit to connect a broader audience with scientific studies, and into scientific research.

From an urban wildlife conservation perspective, the study only revealed important habitats for avian communities. The distribution and habitat demands of mammals, invertebrates, plants and some keystone species should be surveyed and studied before drawing conclusions on the locations of significant urban habitats for overall wildlife. Additionally, because natural habitats in urban areas support many human values including being important for outdoor education (Willison, 1996), developing an evaluation system for assessing the social and educational values of urban habitats is vital for the proper management of semi-wild spaces in the city.

## Appendix One: Questionnaire for the interview

Instructions:

The questionnaire aims to explore local knowledge of places that are important for urban bird conservation in Halifax. Questions are divided into two sections. The first section examines the location and geographic features of the avian hotspots, while the second investigates the specific habitat characteristics. The questions in the second section will be asked in reference to each site identified in section 1.

We recognize that habitat is often related with certain kinds of birds but I don't want to pre-define the guilds which may prejudice your answers by creating my categories. Instead, I want you to help me to define the relevant guilds of birds so that your knowledge will be presented in a more natural way. You may want to talk about specific species of birds, which is fine, but the focus of the study is on all urban birds in Halifax, not any specific species.

You will be required to draw polygons on two maps of different scale to represent the urban habitat for birds. “Polygon” is the word used by map-makers to describe a line drawn around a place on a map. The first map is one-ninth of the second one and is its central square when the whole study area is divided into 9 equal-area squares. On the map of the intensive study area, you can identify the region of interest as small as a backyard or even a specific patch of bushes, or as large as you like. On the intensive study area map we will appreciate the most detailed information that you can provide. For the second map, showing the whole region of interest, more general information is expected due to the lower resolution and the larger scale of the map. However, if you could provide detailed information regarding the larger habitat patches of interest, that will also be appreciated.

Section 1

Can you tell me where you have often gone birding within the scope of these two maps?

Where are the places that you think are important for the conservation of urban birds in the Halifax metropolitan area during

breeding season? Please represent these places with red polygons

winter? Please represent these places with black polygons

autumn migration? Please represent these places with orange polygons

spring migration? Please represent these places with purple polygons

What factors did you take into consideration when you defined a place as an important place or "hotspot" for urban bird conservation?

How do you rate each of the factors that you identified on a 3-point scale?

Very important

Important

Somewhat important

Section 2

What characteristics of each place have essential or important influences on the presence of birds? Please note that we are interested in habitat qualities, such as vegetation composition or abundance, a nearby water body, reliable food sources (including feeding stations), and so on. You may, however, identify any characteristics that you think are relevant.

Please describe these characteristics in as much detail as you can provide.

Does the importance of these characteristics vary with season and if so, how?

## Appendix Two: Nvivo Coding Nodes

| Type | Name |
|---|---|
| Free Node | Breeding spots |
| Free Node | breeding spots- less sure |
| Free Node | Characteristics of Albro Lake |
| Free Node | Characteristics of Alderney Ferry Terminal |
| Free Node | Characteristics of Bedford Basin |
| Free Node | Characteristics of Birch Cove Park |
| Free Node | Characteristics of Bissett Lake |
| Free Node | Characteristics of BLT trail |
| Free Node | Characteristics of Blue Mountain Birch Cove |
| Free Node | Characteristics of Chebucto area |
| Free Node | Characteristics of Cole Harbor |
| Free Node | Characteristics of Conrose field |
| Free Node | Characteristics of Cow Bay |
| Free Node | Characteristics of Cow Bay Marsh |
| Free Node | Characteristics of Dartmouth & Cole Harbor heritage museum |
| Free Node | Characteristics of Devil's Island |
| Free Node | Characteristics of Duncane's cove |
| Free Node | Characteristics of Eastern passage |
| Free Node | Characteristics of Fairview Cemetery |
| Free Node | Characteristics of Fort Needham Park |
| Free Node | Characteristics of Frog Pond |
| Free Node | Characteristics of George Island |
| Free Node | Characteristics of Hartlen Point |
| Free Node | Characteristics of Hemlock Ravine |
| Free Node | Characteristics of Herring Cove |
| Free Node | Characteristics of Lake Nichols |
| Free Node | Characteristics of Lawlor Island |
| Free Node | Characteristics of little Belcher marsh |
| Free Node | Characteristics of Long Lake Provincial Park |
| Free Node | Characteristics of Mainland Common nearby wetland |
| Free Node | Characteristics of McNabs Island |
| Free Node | Characteristics of Northwest Arm |
| Free Node | Characteristics of Oathill lake and some other lakes |
| Free Node | Characteristics of Point Pleasant Park |
| Free Node | Characteristics of public garden |
| Free Node | Characteristics of Purcell's Cove |
| Free Node | Characteristics of Railway cut |
| Free Node | Characteristics of residential area near rotary |
| Free Node | Characteristics of Russell Lake |

| Type | Name |
|---|---|
| Free Node | Characteristics of Seaview Park |
| Free Node | Characteristics of sewer outflow |
| Free Node | Characteristics of spots in breeding season |
| Free Node | characteristics of spots in fall |
| Free Node | Characteristics of spots in spring |
| Free Node | Characteristics of spots in winter |
| Free Node | Characteristics of Spruce Hill Lake |
| Free Node | Characteristics of Sullivan's Pond |
| Free Node | Characteristics of the Salt Marsh Trail |
| Free Node | Characteristics of the south end |
| Free Node | Characteristics of Topsail Lake Area |
| Free Node | Characteristics of Tribune Head |
| Free Node | Characteristics of Tuft's Cove |
| Free Node | Characteristics of Williams Lake |
| Free Node | Characteristics of Wright's Cove |
| Free Node | Differences in spring migration and fall migration |
| Free Node | factors to define a hotspot |
| Free Node | Fall spots |
| Free Node | Fall spots-less sure |
| Free Node | Feeder |
| Free Node | general characteristics of the hotspots |
| Free Node | past birding spots |
| Free Node | past winter spot |
| Free Node | pockets in the city and their characteristics |
| Free Node | Predator |
| Free Node | Random |
| Free Node | Rating of importance of factors |
| Free Node | Regular birding spot |
| Free Node | Social Value |
| Free Node | species mentioned by birders |
| Free Node | spring spot |
| Free Node | spring spot- less sure |
| Free Node | Suggestions |
| Free Node | Threats |
| Free Node | winter spot |
| Free Node | winter spot-less sure |

| Type | Name |
|---|---|
| Tree Node | Regular birding spot |
| Tree Node | Important habitat in each season |
| Tree Node | General characteristics of the hotspots |
| Tree Node | Characteristics of the spots in one season |
| Tree Node | Characteristics of a specific location |
| Tree Node | Species mentioned by birders |
| Tree Node | Threats and opportunities |
| Tree Node | Others |

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