# Suitable Habitat Modelling for the Yellow-breasted Chat (*Icteria virens virens*) in Point Pelee National Park, Canada

by

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# AUTHOR'S DECLARATION

I hereby declare that I am the sole author of this thesis. This is a true copy of the thesis, including any required final revisions, as accepted by my examiners.

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# Abstract

In order for conservation managers to preserve species within an area, an in-depth knowledge of the distributional patterns of focal species within a landscape is required. This is especially true when the species of concern is Threatened or Endangered and conservation of habitat is essential for species preservation. The yellow-breasted chat (*Icteria virens virens*) is one such species that is listed as Special Concern under the Species at Risk Act of Canada; the *virens* subspecies meets the criteria for Endangered. Populations within Canada are limited due the bird's natural range, which extends north into the extreme southern part of Ontario. Point Pelee National Park is one of two strongholds for this species. However, populations within the park have been declining greatly over the past few years with a 70% rate of decline between 1982 and 2008 (n =10, n=3). This decline is likely due to the lack of natural disturbance such as fire, as well as land use change to agriculture and urbanization that has resulted in a decrease of suitable habitat, outside the park. To examine these hypotheses, habitat suitability modelling is a useful tool. It offers conservation managers insight into current distributions of species, especially species of concern. The purpose of this research was to examine environmental variables relating to three bird species and use these variables to model suitable habitat within the study site (Anders Field Complex). In my study, ArcMap 10 was used to model and map suitable habitat within the Anders Field Complex of Point Pelee National Park, as this is the last known nesting grounds for the yellow-breasted chat within the park. The willow flycatcher (*Empidonax traillii*) and the white-eyed vireo (*Vireo griseus*) were also studied as they fill a similar niche and therefore strengthen the results of the study. Environmental variables were modeled to predict suitable habitat and therefore predict potential species distribution. The model used predictors such as vegetation composition of breeding territories and nest patch vegetation composition to identify potential suitable habitat within the study site. Results of the models show that there is likely no suitable habitat (0.04 ha) available for the yellow-breasted chat within the complex. Some suitable habitat was available for the willow flycatcher but seemed limited within the study site (4.1 ha), while an absence of available data on nest scale vegetation characteristics rendered modelling of the white-eyed vireo's habitat moot. Conditions within the Anders Field Complex have succumbed to succession resulting in mature conditions in vegetation structure and composition, as low dense shrub

with high herbaceous cover is being replaced with tall thicket with very little ground cover. Height of vegetation has succeeded the requirements of the yellow-breasted chat. These results show that habitat succession and therefore the loss of suitable habitat is a likely factor influencing chat populations within the Anders Field Complex. There are also factors outside the park likely affecting chat distribution including habitat loss and fragmentation at the landscape scale. Management practices, such as the re-introduction of lost mechanisms or processes within the park should focus on a broad-scale ecological approach that considers novel thinking to restoring ecological integrity. Human induced influences including land use change and introduction of exotic species have forever changed conditions within and surrounding the park, therefore restoration should be mindful to new ecosystems, as restoring to past conditions is likely unproductive. Implementing a disturbance regime such as prescribed burnings, is recommended in order to restore a lost mechanism for the renewal of early-successional habitat. Concentrating on restoration of ecosystems and the re-establishment of a shifting mosaic will provide habitat for a plethora of species including the chat, which is legally mandated by law. However, restoring habitat for the chat will likely not result in the increase of chat abundance within the park until factors outside of the park, including habitat loss and fragmentation are rectified.

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# Dedication

This thesis is dedicated to my parents, Heather Walker, Paul Landry and Linda Nadeau, who have supported and guided me in every way possible from the very beginning.

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# Chapter 1
# Introduction

Knowledge of the distributional patterns of wildlife and habitat within an area is important when managing and conserving species. This is especially true when the species of interest is considered at risk (Shabani, McArthur & Abdollahian 2009). Wildlife is dependent on its surroundings for shelter, food and water and therefore is greatly reliant on available and suitable habitat conditions. Therefore, to properly manage species within an area, the ecological study of species and their relationships between their habitats is of great importance (Shabani, McArthur & Abdollahian 2009).

Biodiversity has been argued to be essential in maintaining sustainable ecosystems. For example, it provides redundancies in a system making it more resilient to severe disturbances (Fischer, Lindenmayer & Manning 2006). Yet there has been ongoing debate of the importance biodiversity plays in ecosystem functioning and processes (Godbold & Solan 2009). Much of the literature argues that biodiversity plays a significant role in ecosystem function (Gamfeldt, Hillebrand & Jonsson 2008; Duffy 2009). This argument becomes more relevant as the wealth of empirical studies indicating negative consequences of a loss of biodiversity becomes more prevalent (Gamfeldt, Hillebrand & Jonsson 2008). Conversely, others argue that these studies often only consider a single response variable at a time which results in the oversight of the potential for different species to carry out different functions at a time (Gamfeldt, Hillebrand & Jonsson 2008). Therefore, although there is much argument for the importance of biodiversity in ecosystem function, there is much debate over its presence and the importance of patterns found in natural systems (Godbold & Solan 2009). Despite these uncertainties, many argue the importance of taking the precautionary principle as many studies, despite their limited scale and focus, suggest that the loss of biodiversity has negative consequences to ecosystem processes and function (Hector et al. 2001; Godbold & Solan 2009).

Therefore, maintaining this diversity is an important consideration in managing ecosystems. Habitat loss has been widely recognized as one of the greatest threats to biodiversity (Fischer, Lindenmayer & Manning 2006; Hanski 1998). Habitat loss both outside and inside protected areas is exacerbated by anthropogenic practices such as agriculture, resource extraction and urban development (Shabani, McArthur & Abdollahian n.d.). Within protected areas, the suppression or complete absence of natural disturbance can result in the loss of a habitat mosaic and therefore the loss of habitat for a diverse set of species. Habitat loss and fragmentation at the landscape scale can worsen the situation as suitable habitat can become unsuitable if connectivity is limited, therefore limiting the ability of species to migrate to these small protected areas. It is necessary for conservation practitioners to understand the relationships between species and habitat availability in order to better manage diversity.

## 1.1 Habitat Suitability Modelling

Habitat suitability modelling is one tool that can allow practitioners to predict and geographically reference potential suitable habitat for a species or several species of focus (Store & Jokimaki 2003). Modelling has been used to make inferences about species habitat requirements, determine abundance, density and probability of occupying a location. In this context, the main use has been to predict distributions of suitable habitat for a species of concern within a landscape (Wintle, Elith & Potts 2005). Habitat suitability models use information on species occurrence data and environmental factors to generate statistical functions that predict potentially suitable habitat, and, therefore, the distribution of species (Brotons et al. 2004). There are many predictors that can be chosen to model suitable habitat. Vegetation is often used as a predictor as it influences species distribution by producing shelter, food and potential nesting sites (Shabani, McArthur & Abdollahian 2009). Species tend to be habitat specialists with respect to vegetation types (Scott et al. 1993).

Along with predictors, occurrence data is used to model suitable habitat. Within the academic literature, there is a plethora of modelling techniques that are used to display geo-referenced suitable habitat. Their applicability and accuracy are dependent on the types of data that are used to formulate the model. Although there are many types of data that are available for modelling suitable habitat, these techniques are generally dependent on the amount of biological survey data that is available for modelling (Wintle, Elith & Potts 2005). The most common types of data used include presence-only data, presence-absence data, or little or no data. The type of modelling technique employed is often stipulated by the amount of data available. Presence-only data originats from datasets in which only the known locations of a species are recorded and analyzed (Shabani, McArthur & Abdollanhian n.d.). Presence-only data is most commonly used as it is easily accessible, often being available through counts, herbariums and other such datasets (Wintle, Elith & Potts 2005).

Presence-absence data uses distributional data including areas where the species' absence is included in the modelling. There is much academic debate about which techniques are more accurate for modelling suitable habitat. Some argue that the use of the absence data can help to limit the area of interest by eliminating habitat that is not suitable for the species of interest (Wintle, Elith & Potts 2005; Jimenez-Valverde, Lobo & Hortal 2009; Brotons et al. 2004; Hirzel, Helfer & Metral 2001).Therefore, presence-absence data can help strengthen the results if absence data is true.  However, absence data can often be susceptible to uncertain zeros (false absences) and can lead to misconstrued model results (Wintle, Elith & Potts 200; Hirzel & Metral 2001; Cianfrani et al. 2010). It can lead to inaccurately labeling habitat that is suitable as unsuitable, which can significantly influence threatened species habitat management. Little or no data is often used as a last resort when both presence and true absence data are not available, such as when the species is rare or difficult to detect (Wintle, Elith & Potts 2005). These models are developed based on expert knowledge to develop multiple criteria by which to assess and geographically pinpoint suitable habitat (Store & Jokamaki 2003; Wintle, Elith & Potts 2005).

For the purposes of this study, presence-data was to be used to model suitable habitat for the three bird species of interest. However, due the lack of distributional data, a 'no data' approach was developed. This absence of data comes as no surprise as the yellow-breasted chat, the bird of focus, has a strictly limited distribution in southern Ontario and Point Pelee National Park, and it can be difficult to detect due to the nature of its habitat. In addition, the willow flycatcher (*Empidonax trailli* A. *Tyrannidae*) and white-eyed vireo (*Vireo griseus* B. *Vireonidae*) also have limited southern Ontario populations. Suitable habitat is often defined by the conservation managers and is characterized by the goals and objectives of the managers. For the purposes of this study, suitable habitat was defined as an environmental area which supported nesting of the focal species. Presence alone does not signify suitable habitat as focal species can be observed in unsuitable habitat.

## 1.2 Point Pelee National Park

Point Pelee National Park, one of Canada’s smallest national parks, is located 50km south-east of Windsor, Ontario. The mainland portion of the park consists of a sand spit and marsh complex that reaches out into Lake Erie. The park also consists of Middle Island, a small piece of land in the Western Basin of Lake Erie (Dobbie et al. 2007). Although the park is small in size (approximately 20 $km^2$), its southern location and warmer climate have allowed the northern reaches of the Carolinian Life Zone to extend through it. The park’s location allows for a highly productive and diverse set of habitats due to a unique set of conditions including: moderate climate, a flat terrain and rich glacial soils (Dobbie et al. 2007). Habitats include marsh, forests, fields and beaches; these provide habitat for a diverse range of species. The portion of Carolinian Life zone within Canada is a mere one percent and yet it contains the largest diversity of species in the country (Dobbie et al. 2007). Many species within the park, therefore, are rare within Canada, and thus concentrations are commonly only found within the park itself. However, it should be noted that these species, including the yellow-breasted chat (*Icteria virens virens* L. (Parulidae)), are rare because they are at the northern extent of their range and that many of these species can be found in higher abundance in the main portion of their range within the United States. The importance of these peripheral populations is debatable; however, it has been suggested that conservation of peripheral populations is important for the long-term survival and evolution of species (Mayr 1982; Lesica & Allendorf 1995; Gibson, Van der Marel & Starzomski 2009). Peripheral species may provide genetic diversity within the species population allowing for adaptations to environmental changes, including drastic changes such as climate change and poleward range shifts (Gibson, Van der Marel & Starzomski 2009). Additionally, conservation of many of these species within the park is legally mandated by the Species at Risk Act of Canada (2008) as well as the Canada National Parks Act (2000) which continue to guide the protection of these species and their associated habitats.

Along with the diversity of ecosystems and associated species, Point Pelee National Park faces a multitude of challenges due to the diverse set of conditions surrounding the park. The park has seen many landscape changes as human interactions with the land have persisted over the last century and a half. The land has been significantly altered by settlement activities including logging, hunting and trapping, grazing and cultivation, fishing, sand extraction and canal development. Many of these activities began in the 1800s and continued well into the 1950s (Parks Canada 2009). Even after it was designated as a park in 1918, the land was further altered by recreational activities and the construction of hotels, cottages and campgrounds (Parks Canada 2009; Dobbie et al. 2007). Impacts from these alterations include the introduction of non-native and invasive species, the introduction of feral animals, clearing of native vegetation, alteration of disturbance regimes and the extirpation of several faunal species (Parks Canada 2009). These recreational activities persisted throughout the park until the 1960s when Parks Canada initiated a land acquisition and rehabilitation strategy which has been successful at limiting or even reversing some these human induced impacts (Parks Canada 2009; Dobbie et al. 2007). The removal of buildings and other associated facilities has allowed for the recovery of land back to naturalized areas. Moreover, implementation of a boardwalk and public transportation have limited visitation effects such as trampling and erosion (Dobbie et al. 2007). However, the park still experiences visitor impacts including road mortality and vegetation trampling and is struggling to manage implications of past use such as the removal of invasive species (Dobbie et al. 2007). To add further complication, the park's surrounding environment also heavily impacts ecosystem integrity within the park. The park's greater ecosystem can be found within the Lake Erie Lowlands Ecoregion which consists of one of the most highly populated and developed areas in the country. The ecoregion consists of a human population of approximately 7.3 million people or 23% of the Canadian population and an economic base comprised of manufacturing, agriculture and major transportation corridors (Dobbie et al. 2007; Statistics Canada 2010). The northern boundary of the park is surrounded by agricultural lands and a stretch of road lined with homes and cottages. This has left the surrounding landscape with very few small natural areas which are highly fragmented. Connectivity between the few existing natural refuges for faunal species is non-existent and therefore, areas of temporary refuge for species from human disturbance are rare (Dobbie et al. 2007).

Currently the park is commonly used for migratory bird watching, recreational beach use and hiking. Bird watching is generally the most popular activity undertaken at Point Pelee National Park. This is due to the fact that the park's unique location has also been recognized as a migrant trap, channeling a large population of bird and butterfly species migrating to their northern breeding grounds and back through to their southern wintering grounds. The park was declared an Important Bird Area by Birdlife International in 1998 (Dobbie et al. 2007). This migratory phenomenon provides visitors with an opportunity to see large numbers of a variety of bird species during the spring and fall months. However, some of these species occupy the park during the breeding season and are at the northern-most extent of their range. One example of this species is the yellow-breasted chat.

### 1.3 The Yellow-breasted Chat

The yellow-breasted chat ('the chat') is the largest of the wood warbler species. Olive brown on top with a bright yellow throat and breast, the chat measures roughly 18 cm in length and weighs approximately 25 g (Eckerle & Thompson 2001; Floyd 2008). There are two subspecies of chats: the western yellow-breasted chat (*Icteria virens auricollis*) and the eastern yellow-breasted chat (Gebauer & Cooper 2004). Differences in the morphology of the two subspecies are limited to tail length and slightly different coloured breasts. The western subspecies has a longer tail and can have a more orange-yellow breast as opposed to the bright lemon-yellow of the eastern subspecies (Cadman et al. 2007; Floyd 2008).

The chat is listed under the Species at Risk Act (SARA) as Special Concern (Environment Canada 2008). SARA is the federal government's responsibility to protecting wildlife from becoming extinct and secures actions for species recovery (Government of Canada 2008). The act is responsible for determining and listing species which are near-threatened or threatened. Species listed under Special Concern are defined as "wildlife species that may become a threatened or endangered species because of a combination of biological characteristics and identified threats" (Environment Canada 2010). However, the *virens* subspecies meets the criterion for Endangered which is defined as "a wildlife species facing imminent extirpation or extinction" (Government of Canada 2008). Declines in the chat population within the park have been observed and therefore, legal obligations mandate the protection of this species from further decline and possible extirpation.

The chat is unique in the wood warbler family. Not only is it significantly larger than most of its relatives but the chat also has a distinguishing vocal repertoire. Its call consists of rattles, grunts, chattering and whistles, unlike it relatives that have 'warbling' calls (Eckerle & Thompson 200; Floyd 2008). Only the males make use of this vocal repertoire with calling beginning early in the spring and continuing until mid-July when the males become undetectable by sound (Cadman et al. 2007). Chats have also been documented as mimics (Kroodsma & Baylis 1982), which can make detection by sound more difficult when trying to distinguish individuals amongst other calling birds.

The chat's habitat generally consists of early-successional habitat with low, dense vegetation. They can often be found in edges of forested or riparian areas, newly disturbed forests, and hedgerows of farmland (Cadman et al. 2007). Vegetation composition of nesting sites is variable between populations. McKibbin and Bishop (2010) concluded that the dominant vegetation type for nesting was dense wild rose (*Rosa* spp.) patches. However, nesting was also said to have occurred in patches with red-osier dogwood (*Cornus stolonifera*), common strawberry (*Fragaria virginiana*) and Saskatoon berry (*Amelanchier alnifolia*). In Ontario, individuals have been found nesting in raspberry (*Rubus* sp.), grapevine (*Vitis* sp.), dogwood (*Cornus* spp.), hawthorn (*Crataegus* sp.), cedar (*Juniperus* sp.), and fragrant sumac (*Rhus aromatica*) (Peck & James 1987; Cadman et al. 2007). Nest vegetation composition within Point Pelee National Park has not been well documented.

The western subspecies' most northern range occurs in the extreme south-west and south-central regions of British Columbia and small populations in south- east Alberta and southern Saskatchewan. Their breeding range extends south through most of the United States to west and central Baja California and central mainland Mexico (Gebauer & Cooper 2004). The wintering grounds range from western Mexico down through Central America to Panama. Figure 1 illustrates the range of the chat. The eastern subspecies' most northern range is restricted to the extreme southern portion of Ontario. This range, similar to the western species, extends through the United States (Central and Eastern States) to Mexico and Central America where they winter (Cadman et al. 2007). It was estimated that the Ontario population was 42 pairs or fewer (roughly 0.001% of the global population) between 2001 and 2005 (Eagles 2007; Environment Canada 2010). A significant portion of the Ontario population has been observed within two strongholds: Point Pelee National Park and Pelee Island (Cadman, Eagles & Helleiner 1987). These populations have been declining markedly in the last few years as explained below. In 1982 and 2005, exact totals of 10 and 8 pairs respectively, were observed within the park. In 2008, a systematic search was conducted and only three pairs were found, all within the Anders Field Complex, a small complex of meadow and thicket found on the east side of the park approximately halfway down the point (Environment Canada 2010).


Figure 1: Distribution of the Yellow-breasted Chat (*Icteria virens*) (Eckerle & Thompson 2001).

These three years are the only formal surveys that have been conducted for the yellow-breasted chat within the park leaving data of abundance and nesting sites limited. However, low chat numbers, such as these, are not surprising as tens of thousands of birders visit the park during the spring migrations in May and incidental observations recorded of these chats are still generally very low (Parks Canada 2010). Observations recorded on eBird, a real-time online checklist program developed by the Cornell lab of Ornithology and the National Audubon Society, show a total of two observations listed of two and three individuals within the park during the 2010 spring season (Sullivan et al. 2009). This suggests that chat numbers within the park are in fact small as the effort was substantial during the spring migration period, yet numbers observed remained very low. Although the chat follows a cyclical pattern of distribution (high populations occur with disturbance rates and decrease as conditions mature), their overall population has decreased dramatically. Chat populations within the park have historically been small; however, the rate of decline between 1982 and 2008 was 70% (n =10, n=3). This suggests that there has been a dramatic decrease in suitable nesting habitat as the species no longer nests in multiple locations within the park. Recently, it has only nested in the Anders Field Complex which, in 2005, was at risk of overgrown conditions (Parks Canada 2005). Disturbance suppression within the park and more specifically in the Anders Field Complex, has allowed succession to occur, resulting in the maturation of ecosystems. What was once low gray dogwood (*Cornus racemosa* Lam. ) patches with red raspberry (*Rubus idaeus* L.) and wild grapevine (*Vitis riparia* Michx.) bramble, as succeeded to mature dogwood patches with very sparse understory. Photos of the study site can be viewed in Appendix F. This has resulted in a change in vegetation structure and composition that is likely no longer suitable for early-successional species such as the chat. The decline in chat populations has been noted to be possibly in response to several threats including successional change, habitat loss and degradation and nest parasitism (Environment Canada 2010). The suspected leading threat to the chat within Point Pelee National Park is the loss of its preferred habitat and lack of management to maintain the landscape (Environment Canada 2010). Much of the abandoned farmland within the park has succeeded to mature forests (Askins 2000). Moreover, a large portion of the landscape within southern Ontario tends to be open agricultural fields or mature forest canopy leaving little early-successional scrub habitat in the surrounding environment.

## 1.4 Research Objectives

1. How much suitable habitat is there for the yellow-breasted chat within the Anders Field Complex?

One objective of this study was to determine habitat requirements, specifically breeding habitat requirements of the chat within the Anders Field Complex in Point Pelee National Park. Field surveys were conducted to determine bird presence within the Anders Field Complex as presence data is required to determine current bird populations and is preferable for modelling available habitat. Habitat characterization using field studies and academic review was conducted to develop parameters with which to model suitable habitat for the focal bird species. These parameters were applied to a model using ArcMap 10 which resulted in habitat suitability maps for the chat.

2. How much suitable habitat is there for species with similar habitat requirements such as the willow flycatcher and the white-eyed vireo?

Because evidence suggests that there was a very small chat population within the park, species with similar preferred habitats were also studied. This method strengthens the results by providing more insight into the chat niche-distribution relationship by providing evidence as to whether habitat availability is the limiting factor in chat presence. A focal species should be compared to other species based on levels of specified focal habitat variables. This can help limit factors affecting species distribution for a single focal species (Shabani, McArthur & Abdollanhian 2009). As such, two other species, the white-eyed vireo (also referred to as the vireo) and the willow flycatcher were also studied.

3. Is it possible to manage for the yellow-breasted chat in the current Point Pelee National Park Environment?

The suitable habitat maps and a literature review were then used to gain insight into potential chat distribution within the Anders Field Complex. This information was used to determine whether restoration of chat habitat would be successful in restoring chat populations within the Anders Field Complex and to provide recommendations for future restoration within Point Pelee National Park.

## 1.5 Ecological Theory

### 1.5.1 The Theory of Island Biogeography

The Theory of Island Biogeography (TIB) set out by Robert MacArthur and Edward O. Wilson was developed to explain patterns in geographic variations among natural insular communities (Lomolino, Brown & Sax 2010; Whittaker & Fernandez-Palacios 2007). The Equilibrium Model of Island Biogeography (EMIB), was a stepping stone for modelling species richness and endemism based on two biogeographical processes (immigration and extinction) and two physical features (isolation and area) (Chen, Jiao & Tong 2011; Whittaker & Fernandez-Palacios 2007). The EMIB postulates that the balance between immigration and extinction determines the number of species found on a given island. Immigration rates are a function of the distance of the island to the main source pool, with closer islands experiencing a higher immigration rates than islands further away. Extinction rates are a function of island area; as the size of islands decreases, the rate of extinction increases (Whittaker & Fernandez-Palacios 2007).

Since its inception in the 1960s, the TIB has played a significant role in the development of ecological and biogeographical thought. It has set the stage and, through expansion, adaptation and replacement, has resulted in new theories (Lomolino, Brown & Sax 2010; Whittaker & Fernandez-Palacios 2007). Moreover, its application to conservation biology has played a pivotal role in park management, as managers race to understand and mitigate species loss caused by a reduction in habitat and an increase in landscape fragmentation. It has been generally established by conservation biologists that such factors are increasing the loss of species at the local, regional and global scales (Whitmore and Sayer 1992). As habitat loss and fragmentation increase the number of isolated habitat patches, conservation biologists have looked to the TIB in search of predictive models for guidance in better managing these systems. Habitat patches can often be referred to as 'habitat islands', as they are isolated in much the same way an island is; these patches are surrounded by strongly contrasting habitat that create barriers for movement (Whittaker & Fernandez-Palacios 2007). This often occurs in areas which are heavily influenced by human disturbance and development. Protected areas, for example, are often surrounded by extensive agriculture, urbanization or other human-altered landscapes, which no longer provide good habitat for species found within the park. Due to the lack of connectivity, this isolation can result in a decrease in species richness as suggested by the TIB (Oliver et al. 2011). Laurance (2010) stresses that although the study of fragmented habitats has surpassed the simplicity of the TIB, the theory continues to provide a conceptual framework for understanding such habitat islands and continues to inform researchers to this day.

Point Pelee National Park is an example of how habitat patches, through habitat loss and fragmentation, have become habitat islands. As mentioned, land use change in the surrounding landscape has left very little green space. Even more so, the Anders Field Complex could be considered such a habitat island, as it is the last early-successional stand left within the park, and is one of few in the surrounding landscape.

### 1.5.2 Metapopulation Dynamics and Related Analysis

Along with the TIB, metapopulation dynamics, a concept developed by Richard Levins in the 1970s, is concerned with the dynamics among local populations. This concept, unlike the TIB, suggests that populations are not in isolate but rather consists of a collection of populations that are separated by patches of unsuitable habitat (Whittaker & Fernandez-Palacios 2007). These populations are intrinsically linked through dynamic processes such as colonization and extinction (Hanski 1998). However, the classic metapopulation model assumes that patches are equal in size and distance to each other, which is unlikely the case for many species in highly fragmented landscapes. As a result, a core-sink model variant was established to demonstrate populations where there is a large, 'mainland' habitat island with smaller satellite populations (Whittaker & Fernandez-Palacios 2007). These satellite populations can only persist regionally where there is a balance between extinction and colonization.

Another concept that sprouted through the TIB is that of Minimum Viable Population (MVP). MVP is the minimum number of individuals that are needed to sustain an isolated population over the long term. This is usually defined as the effective population size (only breeding individuals) that provides 95% probability of persistence for 100 years (Whittaker & Fernandez-Palacios 2007). Attempts to calculate the viability of the single populations is referred to as the Population Viability Analysis (PVA). PVA has been a useful tool for park managers in establishing management plans for species of focus. Many studies have been conducted using these tools to establish approximate numbers of what is viable within a given population. This in turn, based on biota natural histories, such as size, can help establish a Minimum Viable Area (MVA). This concept was taken even further by Hanski et al. (1996) who introduced the Minimum Viable Metapopulation (MVM), which encompasses metapopulation dynamics into the analysis. This concept suggests that there is a minimum number of local populations that is required for a particular population to persist and therefore a minimum amount of suitable habitat (Whittaker & Fernandez-Palacios 2007). Hanski (1998) suggests that spatially realistic metapopulation models can generate species-specific or landscape- specific predictions that may increase managers' understanding of the metapopulation dynamics within the temporal scale in which managers operate.

Conducting such analysis for chats, as well as other indicator species, will benefit conservation within the park as it will help inform managers of the broader scale influences which likely affect local populations. Furthermore, research into the metapopulation dynamics of chats within the park may be extended to explain relationships between core and satellite populations elsewhere helping to further inform conservation at these locations. Knowing what the MVP is may provide awareness into whether the park is able to even hold such a population based on available habitat. It is more likely that the population itself is in fact a satellite population which is heavily reliant on the core population further south in the United States for colonization to balance extinction rates.

### 1.5.3 Non-Equilibrium Theory and Novel Ecosystems

Past ecological theory such as Island Biogeography Theory has been based on equilibrium assumptions. Wallington, Hobbs & Moore (2005) argue that such modelling is likely to be inadequate in forming management practices and suggest new ecological thought founded in non-equilibrium theory. Non-equilibrium ecology is centered on the idea that ecosystems are dynamic, complex and unpredictable with disturbance as a driving process influencing structure and function of the system (Wallington, Hobbs & Moore 2005). Where disturbance is considered rare in classic equilibrium theory and recovery to a singular ‘climax state’, the non-equilibrium theory stresses the potential for multiple stable states which are difficult to predict due to inherent biophysical chances. Moreover, the non-equilibrium theory emphasizes the fact that systems are not closed off entities but are rather a piece of a very intricate puzzle (Wallington, Hobbs & Moore 2005). The implications of these thoughts are paramount to conservation biology. Wallington, Hobbs & Moore (2005) conclude their review of ecological thought by summarizing key messages for conserving biodiversity. Important, is the fact that ecosystems are dynamic and in constant change; therefore, conservation reserve manages should set and prioritize goals with this in mind (Wallington, Hobbs & Moore 2005).

Not only do systems experience inherent change in natural processes, they are also susceptible to human induced influences which are occurring at rapid rates. These anthropogenic influences result in new species compositions and relative abundances which have not previously occurred within a given system. These systems are referred to as novel or emerging ecosystems (Hobbs et al. 2006). As inadvertent and deliberate human action continue to escalate, so too do novel ecosystems. These novel ecosystems are the result of factors including climate change, altered disturbance regimes, extinctions and fragmentation (Seastedt, Hobbs & Suding 2008). Hobbs et al. (2006) list three main reasons for novel ecosystem presence:

1. "*Human impact has resulted in local extinction of most of the original animal, plant and microbial populations and/or the introduction of a suite of species not previously present in that biogeographical region.*
2. *Predominating urban, cultivated or degraded landscapes around target ecosystems create dispersal barriers for many animal, plant and microbial species.*
3. *Direct (e.g. removal of natural soil, dam construction, harvesting, pollution) and indirect (e.g. erosion due to lack of vegetation or overgrazing) human impact has resulted either in major changes in the abiotic environment or a decrease in the original propagule species pool, both of which can prevent the re-establishment of pre-existing species assemblages*."

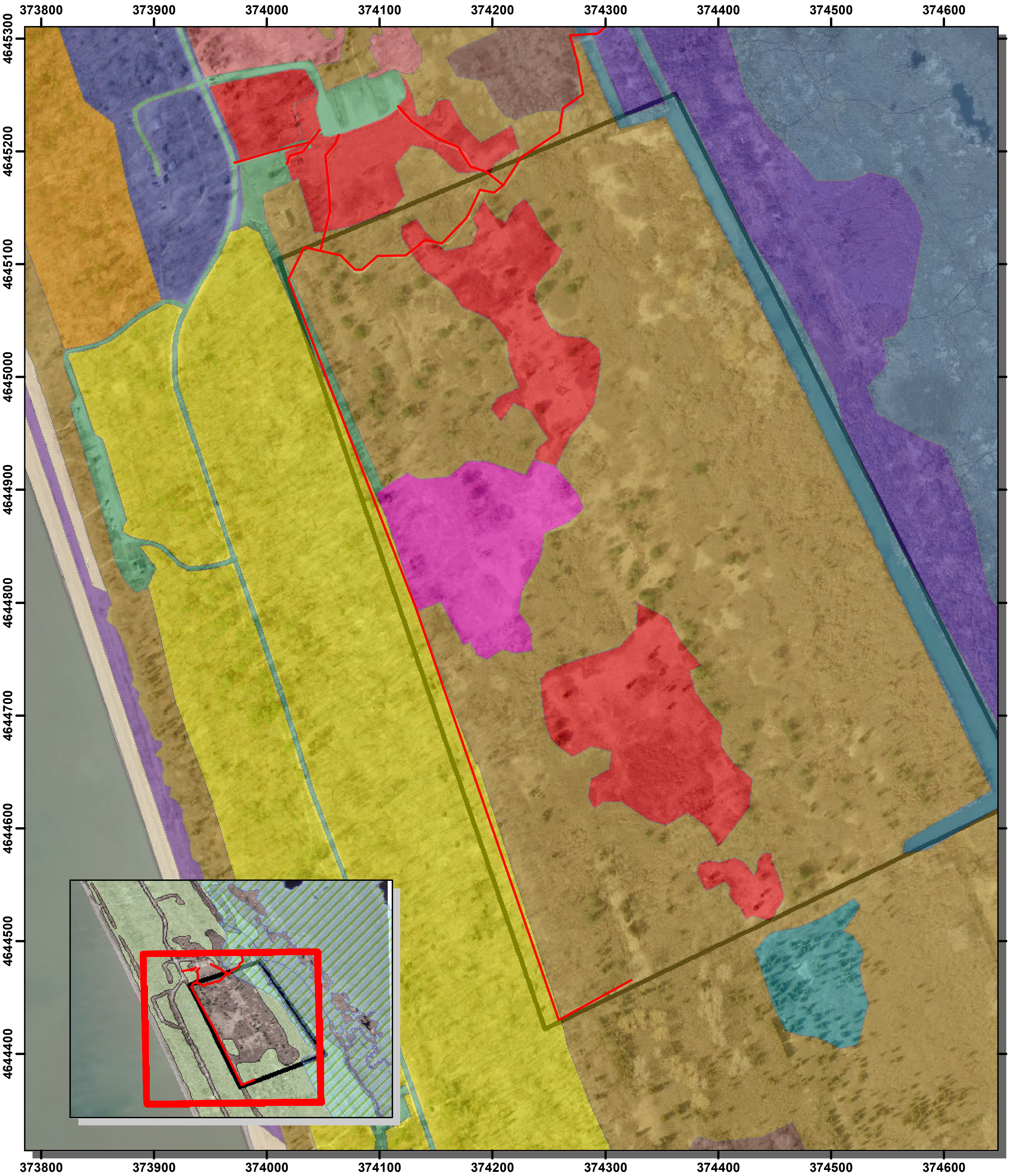
These factors can be extensive and very difficult to control or reverse. Therefore, restoration of ecosystems influenced by the above factors, to historical conditions is often unproductive due to limited time, effort and financial support (Hobbs et al. 2006; Hobbs 2007). Point Pelee National Park has been subjected to numerous human interactions including the suppression of disturbances, the introduction of non-native and invasive species and land use changes surrounding the park. The effects of all these interactions are not well-known; however, it can be suggested that land use change has resulted in dispersal barriers for many organisms, as the park becomes more isolated from other fragments; this may be the case for species such as the chat. Moreover, the introduction of invasive species such as Spotted Knapweed (*Centaure amaculosa* L. *Asteraceae*) and the Emerald Ash Borer (*Agrilus planipennis F. Buprestidae*), are creating changes in species composition within the park (Dobbie et al. 2007). Abiotic changes are also being seen at the park and surrounding areas including increased erosion rates (Dobbie et al. 2007). As novel ecosystems are the result of changes through human interaction, they require intervention in order to manage their development (Hobbs et al. 2006). Management of these systems is controversial, but it is agreed that actions should focus on maintaining species diversity and should anticipate inherent changes (Seastedt, Hobbs & Suding 2008). This approach requires an adaptive framework that includes resilience thinking in order to build adaptability and flexibility into the ecosystem of focus (Seastedt, Hobbs & Suding 2008; Wallington, Hobbs & Moore 2006; Holling 1996). Ecological resilience is the ability of a system to undergo change and maintain its function (Wallington, Hobbs & Moore, 2005; Holling 1996). When resilience is lost it is unable to recover from a major disturbance and often flips into a different state where function and structure have changed (Holling 1996). Once this flip has occurred, the system is unable to recover without intervention. This flip can have detrimental effects on resource management and species diversity (Walker & Salt 2006).

Ecosystems are dynamic and complex, regardless of the ecological theory conceived and all theories play their part in understanding such complexity. It is important that managers develop an adaptive framework that seeks to use monitoring as a means of assessing the success of any restoration efforts.

# Chapter 2
# Methods

## 2.1 Study Site

Since 2005, the Anders Field Complex is the last known breeding location of the chat within Point Pelee National Park. This is because much of the surrounding ecosystems have succeeded to woodland systems. The Anders Field Complex is the largest area (approximately 27 ha) of early-successional thicket type that exists within the park. It consists of three ecosites: Dry-Moist Type/Drummond’s Dogwood Thicket type, Dry-Fresh Mixed Meadow Ecosite, and Canada Blue Grass Graminoid Meadow type (Wormington 2006). Ecosites bordering the study area include a Dry Oak Woodland type to the west and a Water Lily- Bullhead Lily floating-leaved Shallow Aquatic type to the east. Moreover, a small Dry-Fresh Red Cedar Coniferous Woodland type is located south of the site (SOLRIS 2008). The study site is located on the west end of the spit mid-way from the point and is south-east of the DeLaurier Homestead (historical site of the park). A small cemetery is located in the southwest corner and visitor trails run along the west side of the site. The study site, with ELC classifications and bird presence sampling points can be viewed in Figure 2. Photographs of the Anders Field Complex can be viewed in Appendix F.




**Legend**

Trails

Anders Field Complex

**Ecological Land Classification**

- Anthropogenic
- Buttonbush Mineral Deciduous Thicket Swamp Type
- Canada Blue Grass Graminoid Meadow Type
- Cattail Organic Shallow Marsh Type
- Dry - Fresh Drummond's Dogwood Deciduous Shrub Thicket Type
- Dry - Fresh Hackberry Deciduous Woodland Type
- Dry - Fresh Red Cedar Coniferous Woodland Type
- Dry - Fresh White Pine - Hackberry Mixed Forest Type
- Dry Red Oak Woodland Type
- Dry Sand Dropseed Open Sand Barren Type
- Dry – Fresh Hackberry Deciduous Forest Type
- Dry-Fresh Mixed Meadow Ecosite
- Fresh - Moist Cottonwood Deciduous Forest Type
- Little Bluestem – Switchgrass – Beachgrass Open Graminoid Sand Dune Type
- Sea Rocket Sand Open Shoreline Type
- Water Lily – Bullhead Lily Floating-leaved Shallow Aquatic Type

Figure 2

**Ecological Land Classification Anders Field Complex 2004**

0 50 100 150 Meters

**Data Sources:**
**Essex County: Orthoimagery 2008 [Computer file] JD Barnes Limited, Toronto, Ontario.**

**Ontario Base Mapping [Computer file]. n.d. Ontario. Available at http://www.geographynetwork.ca/website/obm/viewer.htm [Jan 26th, 2011]**

**Southern Ontario Land Resource Information System (SOLRIS). Toronto, Ontario: The Ontario Ministry of Nautral Resoruces, 2008.**

**Map created by Jessica Walker using: ArcMap GIS [ERSI]. Version 10. Redlands, CA: Environmental Systems Research Institute, Inc., 2011.**

**Date: February 25, 2012**

NAD83 - UTM Zone 17
Scale: 1:2,500 (11x17")
Airphoto: Spring 2008

N

## 2.2 Determining Species Presence

Field surveying of bird presence began in early May 2010, when individuals display territorial behaviour, and continued until the end of July 2010 when chats cease to vocalize and detection becomes very difficult (Cadman et al. 2007). Field surveying for the three bird species follows the BBIRD field protocol (Martin et al. 1997). Using stratified random sampling, six 50-meter plots were established within the Anders Field Complex. A list of random numbers (1 through 6) were generated and used to establish the order by which the plots would be surveyed. Each plot was 100 meters from the edge of the Anders Field Complex and 200 meters from each other; this allowed for the samples to be independent of each other (Martin et al. 1997). Plot locations can be seen in Appendix A. Because of the potentially small population sizes within the park and limited timing for sampling, past records of chats from Wormington (2006) were mapped and supplied as additional surveying plots. Surveying began each day a half-hour after sunrise and only occurred when weather conditions were conducive to surveying (i.e. sampling did not occur during storm events, heavy rain or wind). Two plots were visited per day and sampling of all three species occurred during each visit to the plot. Surveying occurred for three days followed by a day of rest as per the research permit granted by Parks Canada. This protocol was developed in order to limit the amount of stress and disturbance to any breeding birds within the site.

The method for determining bird presence was modeled after McKibbin and Bishop (n.d.) as follows. Once a plot was located and entered, the observer sat quietly for 10 minutes to listen for and observe any chats. If there were no observations, a playback technique was employed. A recording of a male chat was played for 30 seconds, followed by two minutes of silence to listen for any responding male vocalization. If this resulted in no response, the playback procedure was completed once again. If there was still no response, the observer continued to perform the same procedure for the flycatcher and the vireo. The playback procedure was used specifically because chats are often difficult to detect visually, as they are secretive but, can be quite territorial and vocal (Carter, Stolen, & Breininger 2006; Eckerle & Thompson 2001). After the playbacks were completed presence or absence of each species was recorded. As well, any incidental wildlife was documented during the playback surveys. A list of incidental bird species can be seen in Appendix B.

Due to the lack of bird activity at the assigned plot locations, the playback technique was also employed at locations chats had been either seen or heard. through the study period. Records of such sightings were obtained through the bird sighting book in the visitor center and through personal correspondence with birders in the park.

### 2.3 Habitat Characterization – Vegetation Surveys

Habitat characterization occurred at the community scale throughout the Anders Field Complex using 26 randomly selected points. At each 1 $m^2$ sampling point height, Diameter at Breast Height (DBH), species composition and site description were recorded. This data was then further used to create point data on ArcMap 10 for vegetation structure (soil, grasses, herbaceous, shrubs and trees) which was then used to develop a height variable map for the Anders Field Complex.

Methods for assessing vegetation at the micro-habitat scale were greatly reduced due to the absence of birds within the Anders Field Complex. Characterization of vegetation at the nest scale was conducted for chats and flycatchers (no evidence, past or present was available for the vireo); vegetation characterization for chat nesting habitat was conducted using past chat nesting sites documented in Wormington (2006). To characterize habitat at each nest patch measurements were recorded at a 5-meter radius around the UTM centroid and divided into quadrats for ease of sampling. Species composition, percent cover of vegetation type and heights were recorded. This procedure was also completed for the three flycatcher territories that were estimated in the Anders Field Complex. These territories were estimated using the several observations of vocalizing males within the park. As observations were limited to three sightings, territories for surveying were estimated around the points of observation. In addition to field surveying, academic literature was used to provide a more comprehensive analysis of suitable habitat. Literature was exclusively used for characterizing habitat for the vireo as there was no evidence or reporting of presence within the Anders Field Complex. Nest patch sampling points can be viewed in Figure 3.

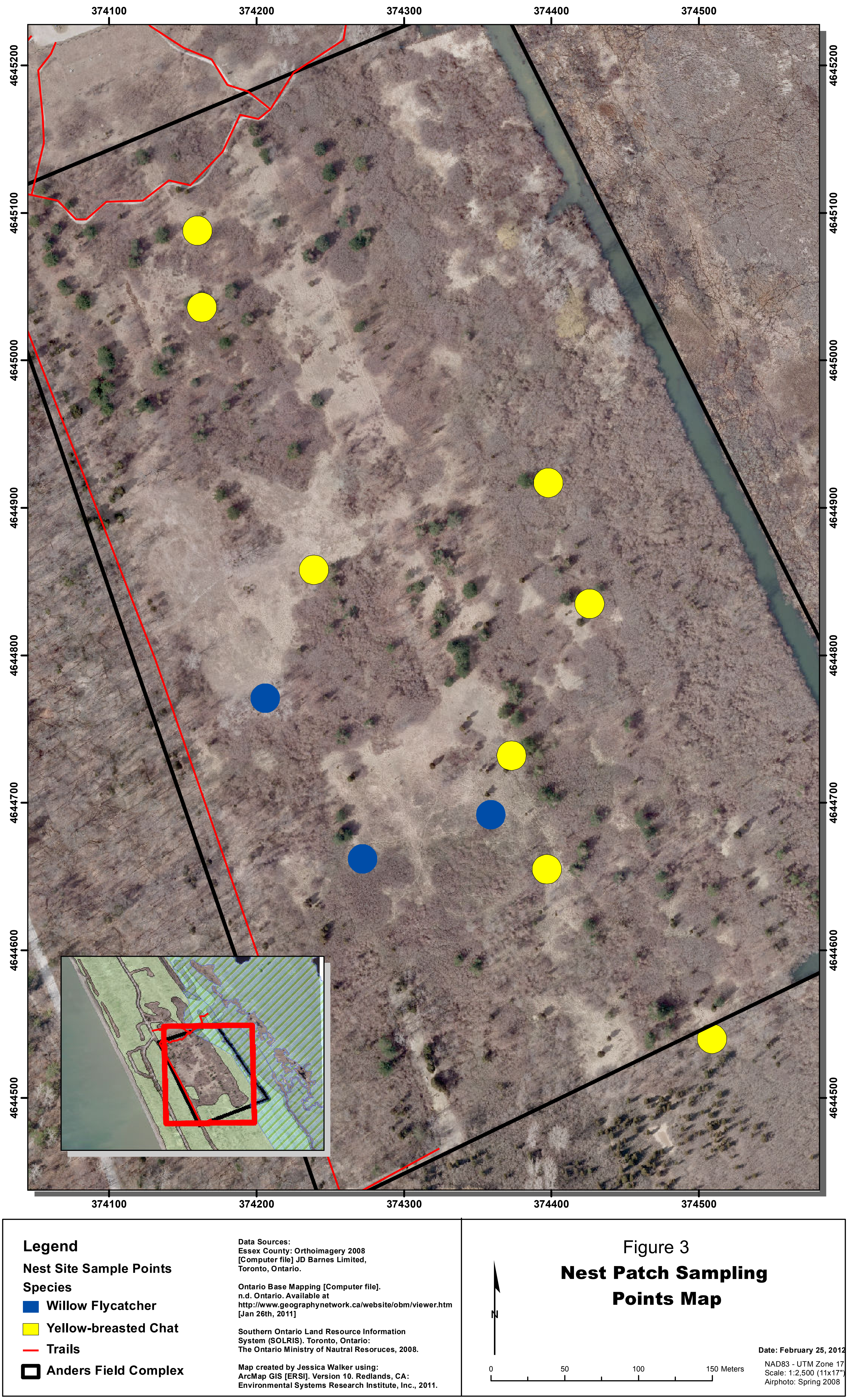



Figure 3
**Nest Patch Sampling Points Map**

## 2.4 Habitat Modelling

To model suitable habitat spatially, habitat variable maps were produced in ArcMap 10. These maps were developed using information collected at the 26 random points and from ortho-photographs (Essex County Orthoimagery 2008). Vegetation structure (bare soil, grasses, herbaceous, shrubs, and trees) were identified using the aerial photographs and point features were created to further characterize the Anders Field Complex vegetation structure. Heights for the created points were determined by generating random numbers between the minimum and maximum of the associated vegetation type from the field data using R Version 2.13.1 2011. These point features were converted to raster datasets in order to make the values continuous for analysis. This was completed using a spatial analyst interpolation tool referred to as Inverse Distance Weighted (IDW). This interpolation method estimates the cell values by averaging the values of the neighbouring cells (ERSI 2010). For both the chat and the flycatcher, there were six habitat variable maps produced including: percent cover of soil, grasses, herbaceous, shrubs and trees as well a height variable map. Variable maps can be seen in Appendix C.

Once the variable maps were completed a model was created using ModelBuilder on ArcMap 10, as seen on Figure 4 and Figure 5 below. The models developed reclassified the variable maps established by parameters that were selected based on the literature review and the results from the bird species nest site characterization values from the field surveys. Reclassification of the variable maps was conducted using a suitability scale of 1 to 5 with 5 representing the most suitable values and 1 representing unsuitable sites. Table 1 and Table 2, show the values used for reclassification of the variable maps for the chat and the flycatcher, respectively. Once the model was run and reclassified, a weighted overlay tool was used to combine the new variable maps to produce a suitability map. A weighted overlay was used to place higher influence on variables that play a more significant role in site selection. For both the chat and the flycatcher, higher influences were given to height of vegetation and to percent of shrub and herbaceous, as these bird species are early-successional species that rely on shrubs of specific stand heights for nesting. Numerical inputs for the weight overlap can be viewed in Table 3 below. Modelling for the vireo was not conducted due to limited available data.

Table 1: Reclassification Values for the Yellow-breasted Chat

| Suitability Index | Percent Soil | Percent Grasses | Percent Herbaceous | Percent Shrub | Percent Tree | Height (m) |
|---|---|---|---|---|---|---|
| 1 | 55 -100 | N/A | 0-20 | 85-100 | 85-100 | 10-30 |
| 2 | 25 -55 | 0-30 | 20-40 | 0-15, 60-85 | 60-85 | 5-10 |
| 3 | 21.25 -25 | 75-100 | 40-60 | 15-30 | 30-45 | 3-5 |
| 4 | 11.25 -21.25 | 45-75 | 60-80 | 45-60 | 0-15 | 0-1.68, 1.95-3 |
| 5 | 0 -11.25 | 30-45 | 80-100 | 30-45 | 15-30 | 1.68-1.95 |

Table 2: Reclassification Values for the Willow Flycatcher

| Suitability Index | Percent Soil | Percent Grasses | Percent Herbaceous | Percent Shrub | Percent Tree | Height (m) |
|---|---|---|---|---|---|---|
| 1 | 40-100 | 80-100 | 0-20 | 0-20 | 80-100 | 20-30 |
| 2 | 30-40 | 0-20 | 80-100 | 80-100 | 60-80 | 10-20 |
| 3 | 20-30 | 60-80 | 40-60 | 60-80 | 40-60 | 5-10 |
| 4 | 0-10 | 20-40 | 20-40 | 20-40 | 20-40 | 0-2 |
| 5 | 10-20 | 40-60 | 60-80 | 40-60 | 0-20 | 2-5 |

Table 3: Weight Overlay Percent Influence Values

| | Overlay % Influence | | | | | |
|---|---|---|---|---|---|---|
| **Species** | **Percent Soil** | **Percent Grasses** | **Percent Herbaceous** | **Percent Shrub** | **Percent Tree** | **Height (m)** |
| Yellow-breasted Chat | 5 | 10 | 15 | 20 | 10 | 40 |
| Willow Flycatcher | 5 | 5 | 10 | 10 | 10 | 40 |

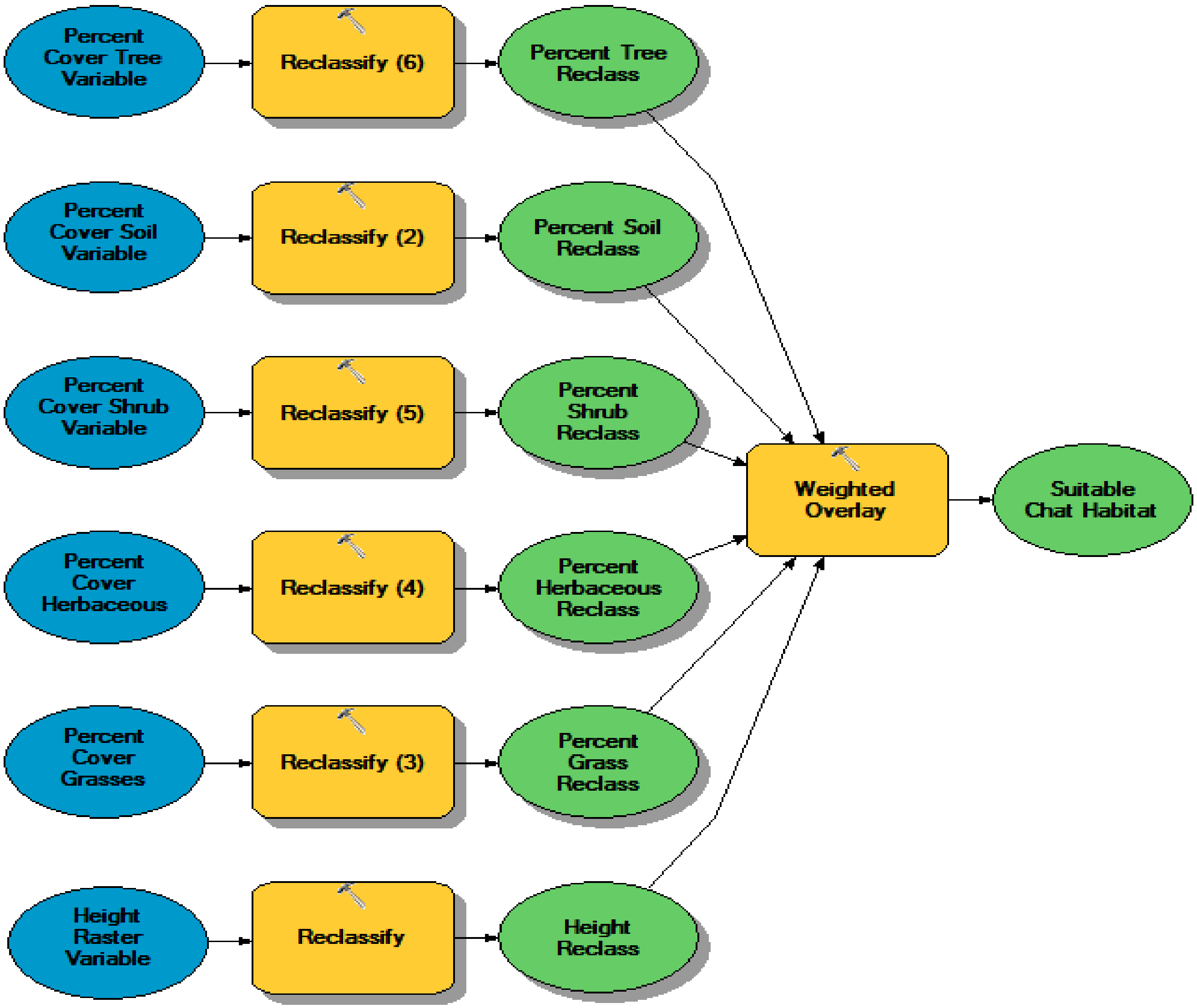



**Figure 4: Modelbuilder Model for the Yellow-breasted Chat**

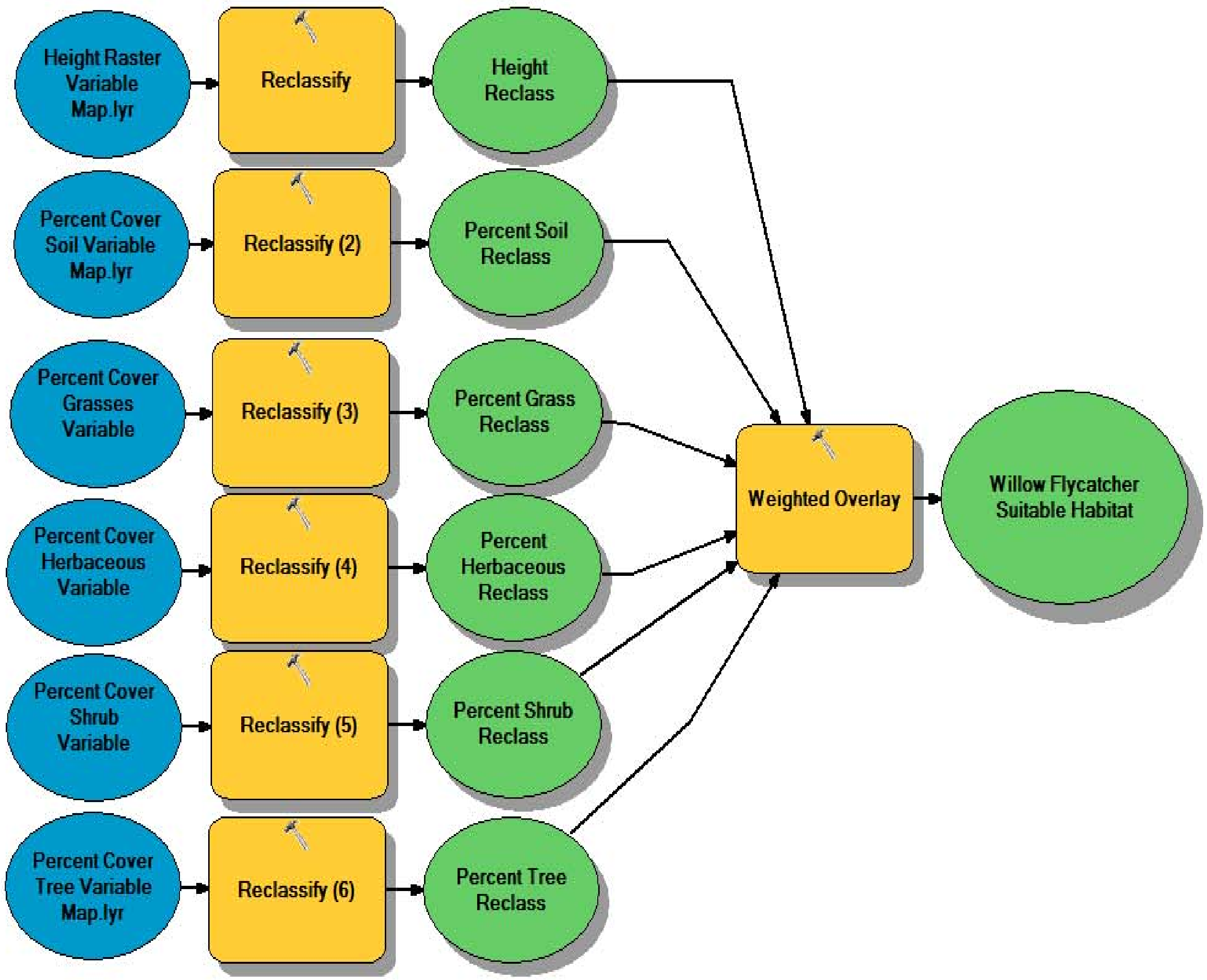



**Figure 5: Modelbuilder Model for the Willow Flycatcher**

# Chapter 3
# Results

## 3.1 Bird Presence

There were no observations of the chat or the vireo within the Anders Field Complex during the 2010 surveying period. However, three separate observations were documented for the flycatcher. The limited number of observations resulted in three flycatcher territories being estimated for further vegetation analysis (17N 0374273 4644662, 17N 0374359 4644692, 17N 037206 4644771). These territories can be viewed in Figure 3. Readers should note that habitat suitability modelling does not depend on actual presence of a given species; hence the habitat characterization proceeded as described in the methods (Chapter 2).

## 3.2 Habitat Characterization

Results of the random sampling of vegetation within the Anders Field Complex varied and allowed for characterization of the landscape. Table 4 shows the results below. The heights in the table were further used to create data that increased the model results for the height raster variable map.

Vegetation characterization at the territory patch scale was also conducted at chat and flycatcher territory locations. Percent cover was estimated for soil, grasses, herbaceous vegetation, shrubs and trees. These estimates for the chat were 8.93%, 38.39%, 69.22%, 33.90% and 28.73% respectively. Estimates for percent cover for the flycatcher are 17.08% soil, 53.75% grasses, 80.0% herbaceous, 42.42% shrub and 16.83% tree. Species composition at each site varied; lists of species can be found for the chat and flycatcher sites surveyed in Appendix B and C. Results of the avian literature review, which helped characterize site suitability, can be viewed in Table 5 below. The avian literature review included more information than was used for the models to provide managers with a summary on the available information for each species.

**Table 4: Summary of Random Sampling of Landscape Vegetation**

| Sample Point | Species Present | Easting | Northing | Height (m) | DBH (cm) | Description |
|---|---|---|---|---|---|---|
| **104** | Dogwood | 374262 | 4644648 | 6 | 4.4 | Dogwood Patch |
| **105** | Dogwood | 374348 | 4644940 | 7.5 | 3.5 | Mature Dogwood Patch |
| **107** | Willow | 374300 | 4644846 | 6.5 | 5.6 | Mature taller trees |
| **108** | Dogwood | 374304 | 4644907 | 1.5 | 0 | Edge of small patch |
| **109** | Dogwood | 374352 | 4644688 | 2.5 | 1.3 | Edge of Dogwood Patch |
| **110** | Dogwood | 374394 | 4644753 | 5.5 | 3.1 | Dogwood Patch |
| **111** | Oak | 374224 | 4645134 | 9.5 | 14 | Tall Herbaceous |
| **117** | Grasses | 374117 | 4645202 | 1 | 0 | In Willow patch |
| **118** | Dogwood | 374325 | 4644678 | 1.5 | 0 | Edge of forest Patch |
| **119** | Black Walnut | 374242 | 4644703 | 13.5 | 26.1 | Black Walnut on edge of Forest with Large Trees |
| **120** | Staghorn Sumac | 374234 | 4644727 | 5.5 | 9 | 15 m from Edge |
| **121** | Dogwood | 374392 | 4644670 | 2.2 | 1.3 | Young Dogwood patch, 10 m into Patch |
| **123** | Dogwood | 374374 | 4644746 | 1.5 | 0.8 | Edge of Patch |
| **124** | Pine | 374430 | 4644612 | 11 | 37.4 | Mature Dogwood Patch |
| **128** | Willow | 374259 | 4645044 | 2.3 | 1 | Edge of Patch, Dogwood approx. 5m. |
| **131** | Bare Soil | 374311 | 4644680 | 0 | 0 | Bare soil Patch |
| **132** | Grass and Horsetail | 374436 | 4644704 | 0.8 | 0 | Open Meadow |
| **133** | Sand | 374208 | 4645117 | 0 | 0 | Bare Soil on Trail |
| **134** | Dogwood | 374242 | 4644961 | 7 | 4.9 | Dogwood Patch |
| **135** | Staghorn Sumac | 374270 | 4649011 | 6.5 | 13.2 | Sumac Patch |
| **136** | Dogwood | 374246 | 4644941 | 1.4 | 0 | Edge of dogwood/Sumac Patch |
| **137** | Black Walnut | 374087 | 4644935 | 15 | 0 | On Path |
| **138** | Dogwood | 374065 | 4645078 | 1.5 | 0 | Dogwood/Vine Patch at edge center approx. 3 m |
| **139** | Staghorn Sumac | 374097 | 4645069 | 1.5 | 0 | Sumac and Vines |
| **140** | Cactus and Sand | 374082 | 4645065 | 0.1 | 0 | Cactus |
| **141** | Dogwood | 374317 | 4644953 | 2.5 | 0.9 | Grown over Path, Mature Dogwood |

**Table 5: Mapping Variable Literature for the Yellow-breasted Chat, Willow Flycatcher and White-eyed Vireo**

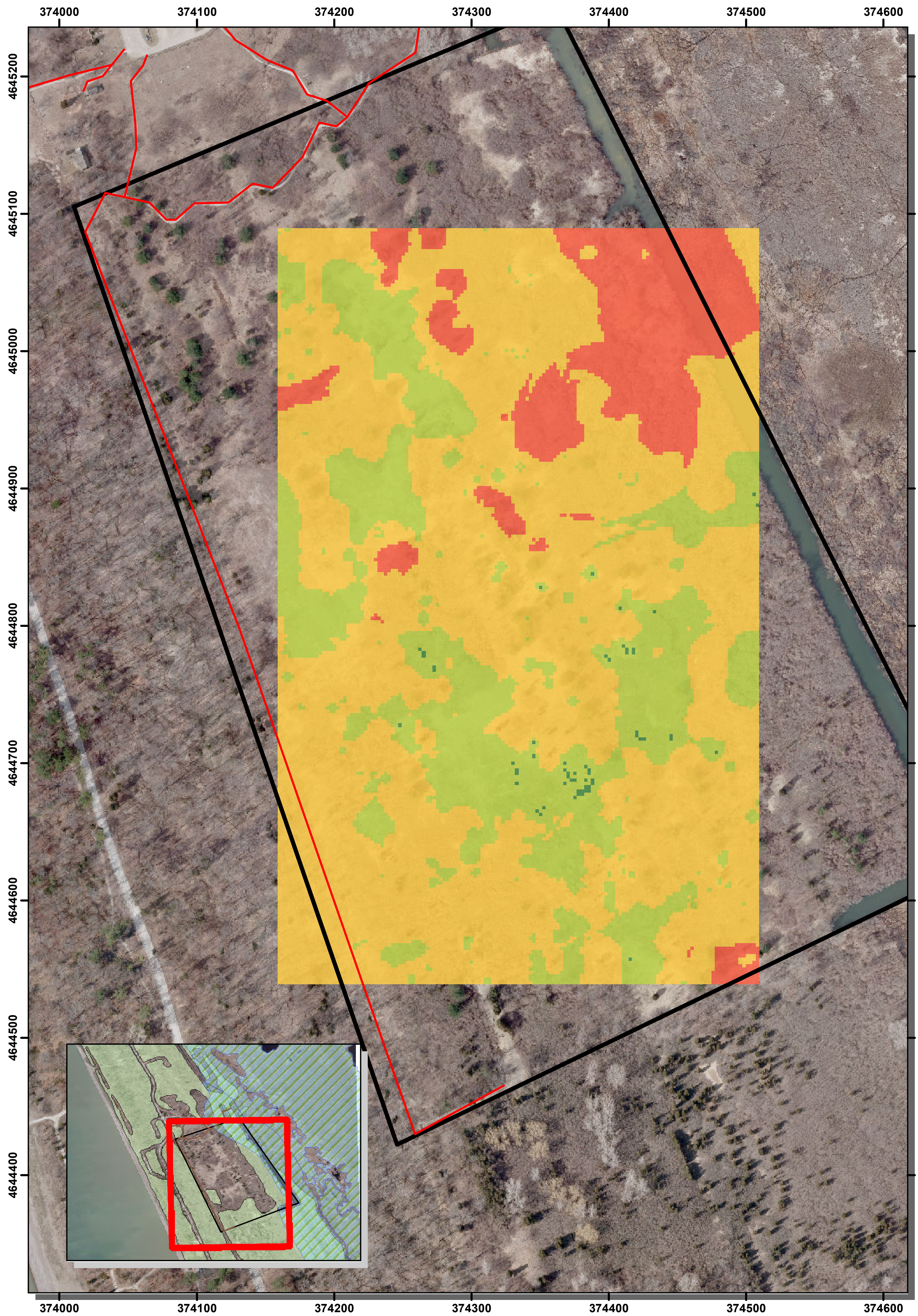
| Map Variables | Yellow-breasted Chat | White-eyed Vireo | Willow Flycatcher |
|---|---|---|---|
| **General Habitat Description** | Habitat consists of early-successional scrub including low deciduous or coniferous vegetation. These include early-shrubby abandoned agricultural fields, power-line corridors, clear-cuts, fencerows and forest openings and edges (Eckerle and Thompson 2001). | Habitat consists of deciduous scrub, overgrown pasture, succeeding old fields and woodland edges, streamside thickets (Bent 1950, Graber et al. 1985). Prefer later successional-stages than the Chat (Nolan 1960). | Can be found in early-successional treed and shrubby swamps and other moist areas. Breeding habitats include upland pastures which are succeeding to shrub thickets, grasslands with shrubs near open water dominated by willows (Salix Spp.) (Hopp et al. 1995). |
| **Patch Size** | Territory Patch size varies with populations but, closest population estimates in Ohio is 4 ha (Environment Canada 2010). | Territory Patch size was estimated at 1.3 ha (as cited in Hopp et al. 1995). Kilgo et al. (1998) estimated territory size between 0.1 to 1.8 ha | Territory patch size ranges from 0.32 to 2.47 ha (as cited in Sedgewick & Knopf 1992). |
| **Age of Stand** | 6.6 ± 0.4 years (Lehnen & Rodewald 2009a). | Noted to be 20-45 year-old pasture land in Illinois (Graber et al. 1985) and 20-50 year old abandoned pastureland in Virginia (Kirby 1994). | N/A |
| **Species Present** | In Ontario, individuals have been found nesting in raspberry (*Rubus* sp.), grapevine (*Vitis* sp.)(Cadmen et al., 2007), dogwood (*Cornus* spp.), hawthorn (*Crataegus* sp.), cedar (*Juniperus* sp.), and fragrant sumac (*Rhus aromatic*) (Peck and James 1987). | N/A | Ontario populations found in areas dominated by hawthorn bushes (*Crataegus* spp.), crabapple trees (*Malus* spp.), willows (*Salix* spp.), Poplars (*Populus* spp.) and alders (*Alnus* spp.) (Barlow and McGillivray 1983). |
| **Percent Cover of Vegetation** | 48% Shrubs, 31% Trees, 20% grass and forbs, 1% bare soil and 1% other cover (McKibbin and Bishop 2010). | Taller trees cover 10 – 20% (Kirby 1994) | Nesting habitat was characterized by 49.29% Willow sp., 37.47% herbaceous cover, 9.97% water and 50.71% non-willow sp. (Sedgewick & Knopf 1992). |
| **Distance to Water** | 0-1000 m (McKibbin and Bishop 2010). | N/A | 10.71 m (Sedgewick & Knopf 1992 |

| Map Variables | Yellow-breasted Chat | White-eyed Vireo | Willow Flycatcher |
|---|---|---|---|
| **Average Stand Height** | < 3 (Environment Canada 2010). Mean shrub height in Okanagan was between 1.68 and 1.95 m (McKibbin and Bishop 2010). | Found in low shrubbery, high foliage from 0 – 1 m high (Hopp et al. 1995). | 3.38 m (Sedgewick & Knopf 1992). |
| **Distance to Built-up Areas** | 5-1600 m from secondary or dirt roads and 50 -1500 m from nearest building (McKibbin and Bishop 2010). | N/A | N/A |

### 3.3 Suitable Habitat Modelling

Suitability maps for both the chat and the flycatcher can be viewed in Figure 6 and Figure 7 below. The total area of suitable habitat for the yellow-breasted chat was 369 $m^2$ (0.04 ha). As the minimum territory patch size is 4 ha (Environment Canada 2010), it can be suggested, based on the model, that there is no suitable habitat for the chat within Anders Field Complex. However, there are areas of less suitable habitat including classes 4, 3 and 2 with 45 475$m^2$ (4.6 ha), 123 725$m^2$ (12.4 ha) and 22 931 $m^2$ (2.3 ha) respectively.

The total area of suitable habitat for the flycatcher was 40 694 $m^2$ (4.1 ha). As the minimum territorial patch size ranges from 0.32 to 2.47 ha (Stein 1958; Walkinshaw 1966; Eckhardt 1979) there is potential for the site to have ideal suitable habitat. Areas of the less suitable habitat classes (4, 3 and 2) were 104 763 $m^2$ (9.6 ha), 46 669 $m^2$ (4.7 ha) and 375 $m^2$ (0.04 ha) in that order. General practice includes rounding off the decimal places as the model is likely not precise to 2 decimal places.




**Legend**

**Suitable Chat Habitat**

- 1
- 2
- 3
- 4
- 5
- Anders Field Complex
- Trails

**Data Sources:**
**Essex County: Orthoimagery 2008 [Computer file] JD Barnes Limited, Toronto, Ontario.**

**Ontario Base Mapping [Computer file]. n.d. Ontario. Available at http://www.geographynetwork.ca/website/obm/viewer.htm [Jan 26th, 2011]**

**Southern Ontario Land Resource Information System (SOLRIS). Toronto, Ontario: The Ontario Ministry of Nautral Resoruces, 2008.**

**Map created by Jessica Walker using: ArcMap GIS [ERSI]. Version 10. Redlands, CA: Environmental Systems Research Institute, Inc., 2011.**

Figure 6

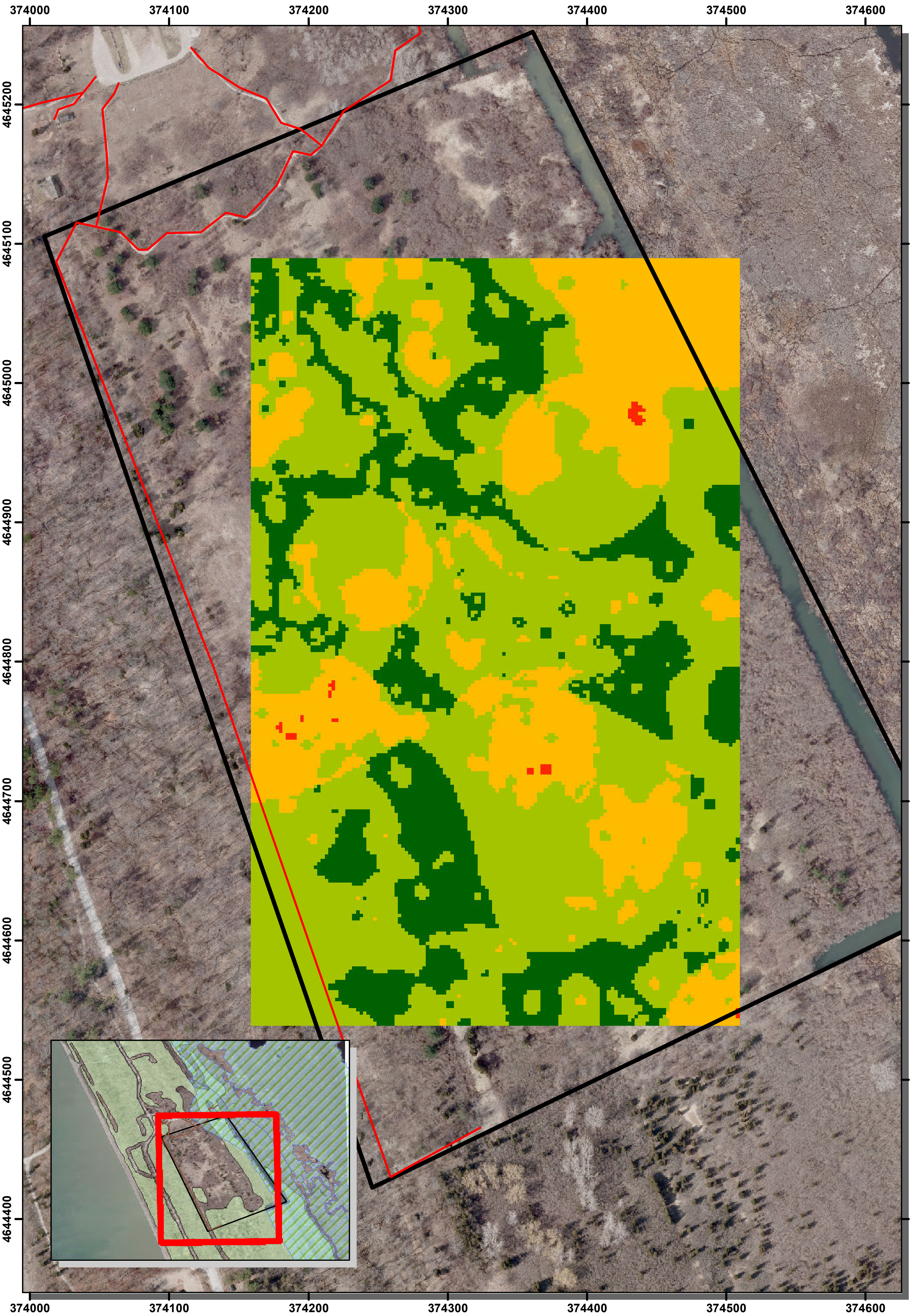
# Habitat Suitability Map

*Yellow-breasted Chat (Icteria virens virens)*

N

0 50 100 150 Meters

**Date: February 25, 2012**
NAD83 - UTM Zone 17N
Scale: 1:3,000 (11x17")
Airphoto: Spring 2008




**Legend**

Anders Field Complex

Trails

**Suitable Flycatcher Habitat**

1

2

3

4

5

Data Sources:
Essex County: Orthoimagery 2008
[Computer file] JD Barnes Limited,
Toronto, Ontario.

Ontario Base Mapping [Computer file].
n.d. Ontario. Available at
http://www.geographynetwork.ca/website/obm/viewer.htm
[Jan 26th, 2011]

Southern Ontario Land Resource Information
System (SOLRIS). Toronto, Ontario:
The Ontario Ministry of Nautral Resoruces, 2008.

Map created by Jessica Walker using:
ArcMap GIS [ERSI]. Version 10. Redlands, CA:
Environmental Systems Research Institute, Inc., 2011.

Figure 7

# Habitat Suitability Map

***Willow Flycatchert (Empidonax traillii)***

N

0 50 100 150 Meters

**Date: February 25, 2012**
NAD83 - UTM Zone 17N
Scale: 1:3,000 (11x17")
Airphoto: Spring 2008

# Chapter 4
# Discussion

The main objective of this research was to determine whether or not there was suitable habitat for the chat. However, in order to determine whether habitat suitability was a limiting factor in the absence of the chat, two other species, the flycatcher and the vireo were also studied as they fill a similar niche within the park. Due to a decline in chat presence, it was predicted that there was a reduction in suitable habitat (nesting habitat) for the chat within the Anders Field Complex. After modelling suitable habitat for the chat and flycatcher, it was observed that this was in fact true for the chat. The model produced by ArcMap 10 showed areas of suitable habitat as extremely limited (only 0.04ha) which is much smaller than their minimum territory range (4 ha) and therefore, unsuitable. This would explain why no observations of the chat were made in the 2010 summer study – or indeed why chats are so uncommon in the Park.

However, the model for the flycatcher shows suitable habitat within the Anders Field Complex; the total area of suitable habitat within the park is 4.1 ha where the minimum territory patch size often associated with flycatchers is between 0.32 ha and 2.47 ha. These results are consistent with field observations as there were three observations of territorial displays of the flycatcher during the 2010 summer study.

Available suitable habitat for the willow flycatcher was present within the Anders Field Complex. However, considering there was only 4.1 ha of such available habitat and patch size minimums range from 0.32 ha to 2.47 ha, this would suggest that there is limited suitable habitat within the Anders Field Complex. This can be supported by the fact that only three observations of flycatchers were made in the Anders Field Complex in the 2010 summer survey. These results seem appropriate in reference to a variable such as average stand height. Chats prefer stands that generally average less than 3 meters (Dobbie et al. 2007) whereas the willow flycatcher has been documented to nest in stand heights averaging 3.38 meters (Sedgewick & Knopf 1992). Therefore, it may be that the state of the Anders Field Complex consists of threshold conditions where it is no longer suitable for the chat but, has yet to fully mature past the willow flycatcher's height preference. This may be an indicator that habitat loss is a factor in the decline in these species within the Anders Field Complex.

There was not enough available information on the white-eyed vireo to produce an accurate model of suitable habitat within the Anders Field Complex. However, this should not be surprising as past records of their presence within the park are highly limited and found outside of the study site (Wormington 2006). This absence of data is due to a lack of historical formal surveys conducted within the park and more specifically within the Anders Field Complex and an absence of observations during the 2010 field surveys.

A scarcity of suitable habitat is a likely cause for the absence of the chat within the Anders Field Complex. It cannot be concluded as the sole factor affecting the distribution of the chat within the greater ecosystem or specific location because there are cross-scalar factors (see Holling 1996; Store & Jokimaki 2003, Shabani et al. 2009; Saab 1999). The presence of willow flycatchers, although in small numbers suggests that there is still some, albeit limited, early-successional habitat available in the Anders Field Complex. This may suggest that although habitat is limited, it is still present and other factors outside of the park may be influencing chat abundance within Point Pelee National Park.  It is therefore suggested that a multi-scale approach be taken when resources allow for it, as microhabitat scale modelling does not allow for extension into large-scale management or conservation biology (Store & Jokimaki 2003; Saab 1999; Girvetz & Greco 2009). Understanding habitat and patch size for a focal species, although very important, is just the beginning step in understanding a complex system. It is necessary to also look at the landscape scale when using vegetation as a predictor (Saab 1999; Shabani et al. 2009). The Anders Field Complex community scale was an important step in understanding chat distribution and habitat availability within the park.  Beyond this scale, the results of the study indicate the need to investigate other factors influencing chat distribution. A look into the macro-scale or landscape scale is necessary in order to fully understand the dynamics of chat distribution. The implications of factors such as habitat loss, fragmentation and isolation can all influence bird distribution within a given area. These factors, tied with natural history variables such as dispersal and site fidelity, can provide clues on effective management practices.

## 4.1 Issues on a Broader Scale

Human activities have drastically altered the landscape both within and surrounding the park, specifically resulting in the loss of habitat for early-successional species. This loss of habitat can be seen on several scales: Point Pelee National Park has lost much of its early-scrub habitats to succession, while habitat in the landscape surrounding the park (in southern Ontario) has been lost due to land use changes such as agriculture and urbanization. In Essex County, 97% of the land has been altered for agriculture, industry and urban development (Parks Canada 2009). The resulting green islands - aside from the park - consist mostly of small treed woodlots scattered through agricultural fields. Not only have there been large habitat losses within Southern Ontario but losses in shrubland habitat have also occurred within the eastern United States (Lehnen & Rodewald 2009b; Askins 2000). In Eastern North America, of the ecosystems that have decreased by more than 98%, 55% were of grasslands, savannah and barren communities, and 24% of shrubland communities (Noss et al. 1995; Thompson & DeGraaf 2001). The accumulation of habitat loss has also resulted in a highly fragmented landscape, as patches of early-successional habitat become more isolated due to a lack of connectivity. The TIB has recently been applied to such isolated patches to try and understand the underlying processes which may influence the distribution of a focal species (Laurance 2010; Whittaker & Fernandez-Palacios 2007; Oliver et al. 2011). The theory has provided a model that has supplied conservation managers with conceptual utility in understanding the importance of park size and connectivity in species diversity and distribution (Laurance 2010).

Point Pelee National Park has previously been considered as such an ‘island’ by the park, as it is a natural area which is surrounded by a large body of water (Lake Erie) and heavily human-altered landscapes (Dobbie et al. 2007). However, in regards to the chat, the Anders Field Complex community could also be considered as a habitat island, as it is early-successional habitat surrounded by mature forests and wetlands. One reason for the decline in chat populations over the last few decades may be attributed to isolation from the colonist population further south in the United States. In other words, suitable habitat becomes harder to find as connectivity decreases, reducing the chances of immigration to the island.

This receding range is likely the result of shrinking habitat in northern Ohio. Populations of chats have decreased significantly in locations south of Point Pelee National

Park. It has been estimated that the chat populations in Ohio have decreased by 2.6% per year with very low abundances in the northern part of the state (Ohio Department of Natural Resources 2011) This decline has also been suspected to be the result of the significant decreases in habitat in the upper half of the state (Cadman 2010). Despite current knowledge on the landscape structure, little is known about how these implications influence chat distribution with the study area.

Natural history variables such as dispersal and site fidelity are two important characteristics to consider when focusing on the landscape ecology of bird species, as they play a significant role in bird distribution. Tied with knowledge of habitat loss and fragmentation (increased isolation) these variables may provide insight into the recruitment and immigration patterns for a specific location. A study conducted by Lehnen and Rodewald (2009) determined the dispersal rates of the chat within southeastern Ohio. They discovered that natal dispersers travelled further than their breeder counterparts and observed high numbers of short distance movements averaging 500 m, with the greatest observed dispersal distance of 7 km. These short distance movements were suspected to be investigations of potential future breeding territories.

This information may provide a window into potential movement restrictions of the chat to the park and surrounding landscape. If habitat and connectivity are extremely limited from southern Ohio to southern Ontario (as is suggested), this could imply a major barrier in chat movement to Point Pelee National Park and in turn, the Anders Field Complex. That being said, some outliers may travel significantly farther but, as habitat is near non-existent in the northern reaches of its range, it would be synonymous to finding ‘a needle in a haystack’. This may be further stressed by the fact that there were several sightings of chat early in the breeding season within other areas of the park. These individuals were likely overshoots and unable to find territory or mates.  Moreover, although chats show signs of site fidelity (McKibbin and Bishop n.d.), these averages seem to vary with populations and have been documented to be rather low in the eastern subspecies population (Thompson & Nolan 1973). Reasons for this low site fidelity may be linked to the natural cycling of chat populations linked with their dynamic nature of the preferred habitat. Low site fidelity, as well as fragmentation and habitat at the macro-scale, could be contributors to the absence of chats within the site. Chat movement and site fidelity behaviour in Southern Ontario, and more specifically the park, are needed to fully understand the implications of these characteristics. Radio-tagging birds, as conducted in Lehnen and Rodewald's (2009) study may provide such insight into these characteristics allowing for a more informed understanding of chat distribution at the local scale.

Habitat loss, fragmentation and dispersal characteristics could all play a potentially significant role in the distribution of chats within Point Pelee National Park. However, further studies are needed to confirm such assumptions and to what degree they may affect chat distribution. A metapopulation analysis and PVA would provide managers with a great amount of understanding and set the context for restoration goals for chat habitat. In order to restore habitat for the chat, the Minimum Viable Population (MVP) or the Minimum Viable Metapopulation should be determined in order to know the minimum amount of habitat required (Askins 2001). This information is especially important because, if the park cannot possibly sustain the MVP (or the Minimum Viable Metapopulation in the greater landscape system) due to limitations set out by size restrictions (the park being fairly small in size) and fragmentation, then restoration would likely be unproductive. In other words, restoring habitat within the Anders Field Complex may be insufficient for restoring the chat population to the park due to other pertinent overlying factors. Until the significance of these influences are determined and rectified, it is unlikely that restoration of chat habitat will be productive in re-establishing chat populations within the Anders Field Complex. Cooperation with government and conservation agencies in Ohio is necessary to restore large portions of early successional habitat in order to restore species populations such as the chat.

### 4.2 Restoration and Management

Knowing that there is still a gap in understanding chat distribution and population dynamics within the park, it is recommended that restoration goals should take on an ecological approach which prioritizes ecological integrity. An ecological approach focuses on the process involved in maintaining function and not simply on an end-point. In the case of the Anders Field Complex, the goal should focus on restoring lost mechanisms and not the number of chats within the park. Using the chat, along with the flycatcher and other appropriate species as indicators for early-successional habitat, would provide an opportunity for restoration of an ecosystem that is in serious threat of extirpation. As mentioned previously, early-successional habitats within the park are at serious risk of succeeding to mature closed canopy systems (Askins 2001; Dobbie et al. 2007). This loss of early-successional habitat poses a great threat to biodiversity as it would likely result in a significant decrease in the number of species found within the park.

Restoring such conditions to the park by re-establishing a mosaic of habitats will increase ecological integrity within the park and likely benefit many species at risk as well. Importantly, this approach would also satisfy the park's mandate: "maintenance or restoration of ecological integrity, through the protection of natural resources and natural processes, shall be the first priority when considering all aspects of the management of parks…" (Canada Department of Justice 2000). In order to restore and maintain early-successional habitat within the park, the most logical solution is to restore the mechanism that has since been lost from the system. Succession to mature canopy ecosystems has been the primary result of the suppression of natural disturbance regimes (grazing and fire) within the park (Askins 2000; Dobbie et al. 2007). To re-establish the lost mechanism, it is recommended that the park establish a disturbance regime that will prevent early-successional habitats from being lost in the mosaic. Long-term repeated disturbances are likely to help maintain biodiversity and increase the chances of persistence (Langston 1998). The Anders Field Complex is an ideal location for such re-introduction of a disturbance regime as it closes resembles the early-successional habitat types of focus. This is especially important as the park, which consists of a significant portion of wetland, has limited options for restoration of these habitats.

Disturbance regimes are set to attempt to mimic natural processes that introduce a new state providing a different set of functions and structures within an ecosystem (Wallington, Hobbs & Moore 2005). There are many factors to consider when developing a disturbance regime for a specific system including disturbance type, frequency and size. These factors will also greatly depend on the manager's goals and the historic range of variability (Askins 2001; Thompson & DeGraaf 2001; Wallington, Hobbs & Moore 2005). Several methods have been used to implement disturbance regimes; several of the more common silviculture methods undertaken include the use of herbicides and mechanical methods such as felling, ploughing and prescribed fires (Thompson & DeGraaf 2005). Annand and Thompson (1997) studied the impacts of different management practices on bird species within Mark Twain National Forest in southeast Missouri. They discovered that some bird species, such as the chat and the vireo, were more abundant in areas of clear-cutting than other management practices such as shelterwood, group selection and single-tree selection. Understanding historical natural disturbance within the Park could provide insight into effective techniques which have worked in the past and help predict future responses to a disturbance regime implementation (Wallington, Hobbs & Moore 2005).

The size of the area influenced by the disturbance regime is often dependant on the goals of the managers and available space, as often park managers are restricted to the boundaries of the park itself. The goals of the managers at Point Pelee National Park should reflect the need for more early-successional habitat using bird assemblages as an indicator. Thompson and DeGraaf (2001) suggest that larger, even-aged clear-cuts are more effective at producing “recognizable patches of early-successional habitat”. More importantly, the authors mention the fact that there are breeding birds restricted to these even-aged habitats but not for uneven-aged stands created by single-tree selections.

Similar recommendations have been made by Lehnen and Rodewald (2009b) who suggest fewer but larger harvests be implemented to provide more habitat for shrubland birds and to reduce the edge effects on the mature forest bird species. Moreover, patches should be clustered in close proximity to limit risk posed by the interpatch movements that often occur with shrubland species, especially the chat (Lehnen & Rodewald 2009a). Knowing the Minimum Viable Population, and the minimum suitable patch size for several early-successional avian keystone species, can guide managers to the extent and size of habitat that is required by a set of species within the park.

Disturbance frequency is another important factor to consider when implementing a disturbance regime as it influences the structure and function of an ecosystem. If the frequency is too high, the system does not likely have time to recover, while if the frequency is too short, the system will likely succumb to succession resulting in a loss of intended function and structure and a lower resilience to disturbance (Wallington, Hobbs & Moore 2005; Thompson & DeGraaf 2001).  Managers can determine the appropriate disturbance frequency by using models to predict outcomes under different disturbance regimes (Landres et al. 1999).

Although research has suggested that clear-cutting benefits many early-successional avian species, this technique usually has too many detrimental impacts on all else including forest avian species, herptofauna and mammal species (Lehnen & Rodewald 2009; Demaynadier & Hunter 1998; Enge & Marion 1986; Fuller, Harrison & Lachowski 2004). As the goal of restoration should be maintaining biodiversity, this technique should be limited as it could have negative impacts on other species of concern found within the Anders Field Complex, including the Prickly- Pear Cactus (*Opuntia humifusa* R. Cactaceae). Therefore, methods such as group cuttings, supplemented by prescribed burns, are preferred as they provide a more holistic approach that will help to maintain early-successional habitat without greatly reducing abundances of other species (Nesmith et al. 2011). Group cuttings would allow for the initial removal of overgrown dogwood patches and prescribed fire would ideally be used to maintain early-successional habitat conditions. Prescribed burns can be effective at manipulating woody and herbaceous vegetation and is therefore beneficial to reducing woody encroachment on early-successional habitats (Wright 1974; Bragg & Hulbert 1976; Lewis et al. 1981). These practices have been conducted at the nearby Rondeau Park with success (Dougan & Associates & McKay 2009).

However, as suggested by the study conducted by Dougan & Associates and McKay (2009), the effects of prescribed burns has unknown implications for species such as *Opuntia humifusa*.  In areas where *Opuntia humifusa* is present, a less invasive method such as selective cutting should be supplemented. Patch sizes for restoration should be as large as possible as many early-successional bird species prefer large even-aged stands (Thompson & DeGraaf 2005; Lehnen & Rodewald 2009). This will also help to reduce edge effects on the surrounding forest bird assemblages. Frequency of disturbance will likely depend on the results of further research into past natural disturbance regimes, but it is suggested that a range of frequencies be utilized so as to increase the chances of maintaining a diverse set of habitats required by different species (Wallington, Hobbs & Moore 2005; Whittaker & Fernandez- Palacios 2007). This technique also closely resembles natural disturbances that are often unpredictable and chaotic (Holling 1996; Wallington, Hobbs & Moore 2005).

Restoration of a disturbance regime, and therefore, early-successional habitat will indirectly benefit the chat if factors outside of the park are rectified. It will also provide habitat and support any overshoots and will create nesting habitat in the event that the connectivity to the park is restored. This approach not only fulfills the parks mandate but, also indirectly addresses the SARA mandate in trying to recover the chat species.

Models of suitable habitat are only as accurate as the data used to create them. Therefore, it is imperative that managers should not take the model as a completely accurate representation of the species distribution as the model was subject to several uncertainties due to the unique natural history of the chat within the park. However, as restoration of early-successional habitat proceeds and research into the macro-ecology of the chat becomes available, uncertainties may become certainties. Therefore, it is highly advised that an adaptive framework be implemented. This is even more imperative as Point Pelee National Park is subjected to high levels of human interaction and the inherent changes that follow it. The park should be considered a novel ecosystem as there are many human induced effects that have, and continue, to greatly influence change within and surrounding the park.

## 4.3 Concluding Remarks

Point Pelee National Park has never supported a large population of chats. Their limited distribution is mainly a result of their natural range which is limited to the southernmost part of Canada (Cadman et al. 2007). As mentioned, their decline was suspected to be the result of a decrease in suitable habitat within the park (Environment Canada 2010). The results of this study suggest that there is a lack of suitable habitat within the Anders Field Complex for chats. Although a lack of habitat can be linked to the absence of chats within the site, it cannot be ruled as the only reason for absence as there are other scales and related factors involved that need to be considered. There is a myriad of other potential impacts that could affect the suitability of habitat and that could influence their distribution within the park. Some of these reasons include: connectivity, fragmentation and a decrease in southern populations. A macro-ecological look into chat populations and distributions is necessary in order to understand how these influences affect chat populations at the regional scale.

Restoration of the Anders Field Complex to early-successional habitat should take into consideration the fact that there may be other underlying reasons why the area no longer supports breeding chat populations within the park. These impacts, mentioned earlier, should be taken into account in management decisions; park managers should be mindful to novel ecosystems as conditions which are out of the manager's control may push ecosystems into new directions. Restoring the study site by re-introducing a disturbance regime that mimics natural disturbances would allow for a diversity of ecosystems within the park and support higher biodiversity and, in turn, ecological integrity within the park. The Anders Field Complex is a good location for such implementation as it has supported such diversity in the recent past. The implementation of a management strategy would also allow for novel ecosystems to persist within the park, while maintaining a diverse of habitats. This is especially necessary in Point Pelee National Park, as the park faces a plethora of management issues including invasive species, human disturbances and loss of habitat.

Management of chat populations within the park is a difficult challenge as there are many factors which influence its distribution. Implementing a disturbance regime is recommended although its effectiveness for specifically restoring chat populations is difficult to surmise. Consequently, managers should look at the macro-scale and consider novel ecosystems as natural distributions can be prone to change. Future research into chat populations within southern Ontario will help provide pieces to an ever-expanding puzzle as it will provide managers with a better understanding of the dynamics and relationships between bird distribution and habitat availability as an indicator of ecosystem integrity (natural resources and processes). In the end, management should focus on habitat and cease to focus on focal species that are already rare within the area and unlikely to persist in abundant populations. Habitat restoration not only meets the legal requirements set forth by policy but also focuses management on productive goals and objectives.

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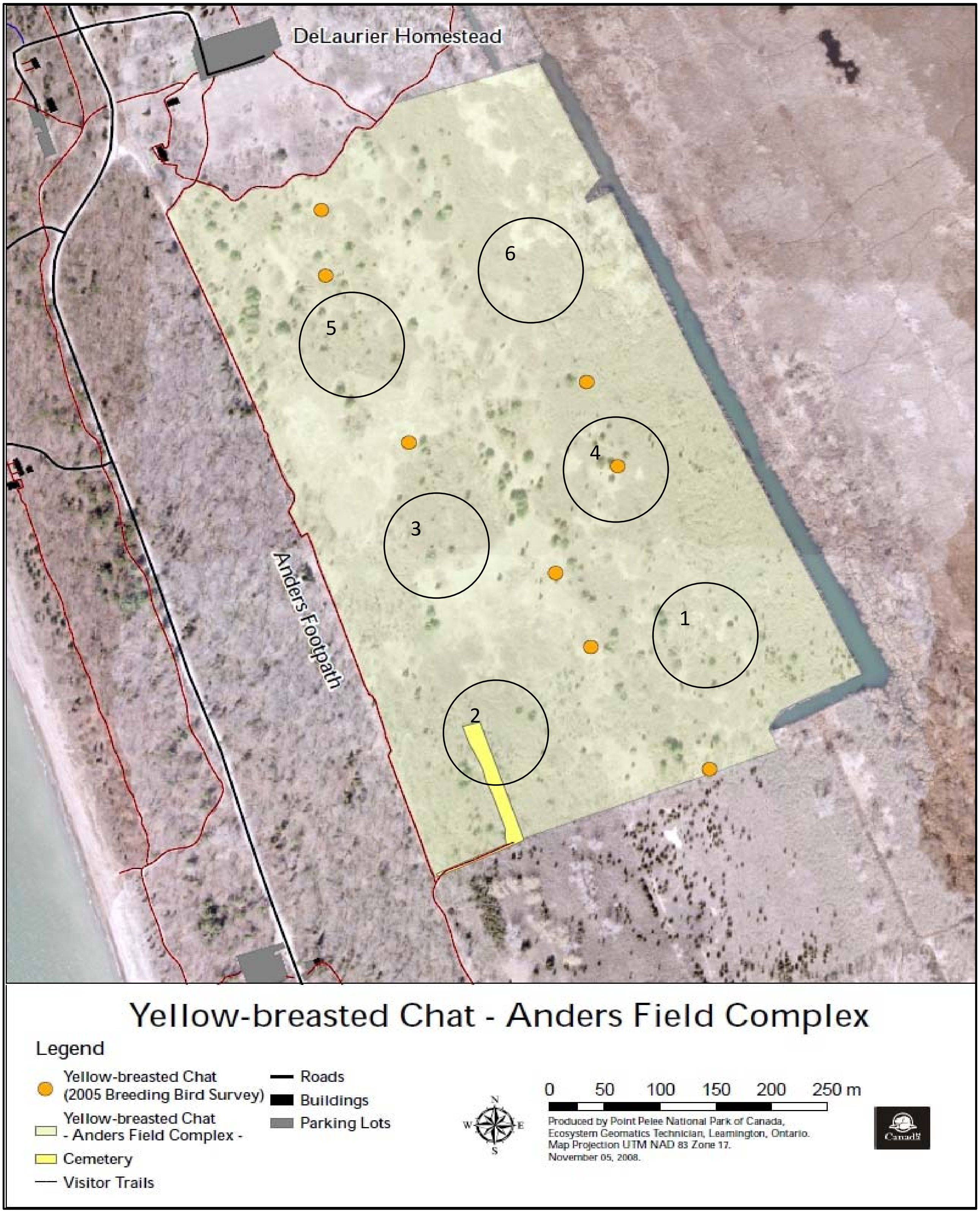
# Appendix A

# Bird Survey Study Plots in Anders Field Complex


DeLaurier Homestead
Anders Footpath
1
2
3
4
5
6
Yellow-breasted Chat - Anders Field Complex
Legend
Yellow-breasted Chat (2005 Breeding Bird Survey)
Yellow-breasted Chat - Anders Field Complex -
Cemetery
Visitor Trails
Roads
Buildings
Parking Lots
N
S
E
W
0 50 100 150 200 250 m
Produced by Point Pelee National Park of Canada, Ecosystem Geomatics Technician, Leamington, Ontario.
Map Projection UTM NAD 83 Zone 17.
November 05, 2008.

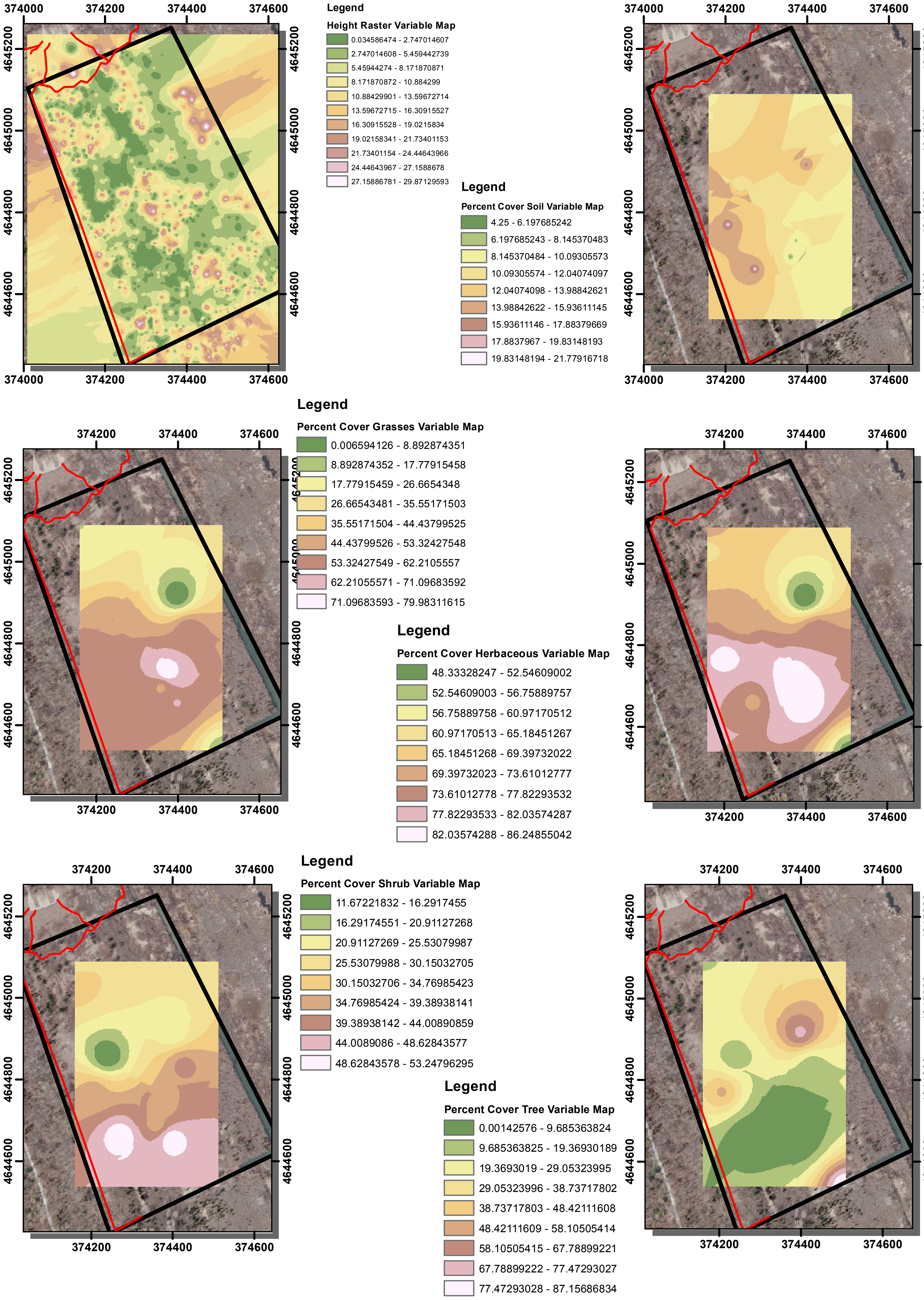
# Appendix B

## Incidental Avian Species List

| Scientific Name | Common Name |
|---|---|
| *Agelaius phoeniceus* | Red-Winged Blackbird |
| *Ardea herodias* | Great Blue Heron |
| *Bombycilla cedrorum* | Cedar Waxwing |
| *Bubo virginianus* | Great Horned Owl |
| *Cardinalis cardinalis* | Northern Cardinal |
| *Cathartes aura* | Turkey Vulture |
| *Coccyzus americanus* | Yellow-billed Cuckoo |
| *Colaptes auratus* | Northern Flicker |
| *Cyanocitta cristata* | Blue Jay |
| *Dendroica magnolia* | Magnolia Warbler |
| *Dendroica pensylvanica* | Chestnut-sided Warbler |
| *Dendroica petechia* | Yellow Warbler |
| *Dumetella carolinensis* | Gray Catbird |
| *Geothlypis trichas* | Common Yellowthroat |
| *Icterus galbula* | Baltimore Oriole |
| *Icterus spurius* | Orchard Oriole |
| *Ixobrychus exilis* | Least Bittern |
| *Meleagris gallopavo* | Wild Turkey |
| *Molothrus ater* | Brown Headed Cowbird |
| *Myiarchus crinitus* | Great-crested Flycatcher |
| *Phalacrocorax auritus* | Double-crested Cormorant |
| *Picoides pubescens* | Downy Woodpecker |
| *Poecile atricapillus* | Black-capped Chickadee |
| *Quiscalus quiscula* | Common Grackle |
| *Spinus tristis* | American Goldfinch |
| *Sturnus vulgaris* | European Starling |
| *Tachycineta bicolor* | Tree Swallow |
| *Thryothorus ludovicianus* | Carolina Wren |
| *Troglodytes aedon* | House Wren |
| *Turdus migratorius* | American Robin |
| *Tyrannus tyrannus* | Eastern Kingbird |
| *Zenaida macroura* | Mourning Dove |

# Appendix C

# Percent Cover and Height Variable Maps




# Variable Maps for Anders Field Complex 2010

**Legend**

Trails

Anders Field Complex

0 100 200 300 400 Meters

N

Data Sources:
Essex County: Orthoimagery 2008 [Computer file] JD Barnes Limited, Toronto, Ontario.

Ontario Base Mapping [Computer file]. n.d. Ontario. Available at http://www.geographynetwork.ca/website/obm/viewer.htm [Jan 26th, 2011]

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Map created by Jessica Walker using: ArcMap GIS [ERSI]. Version 10. Redlands, CA: Environmental Systems Research Institute, Inc., 2011.

Date: February 25, 2012
NAD83 - UTM Zone 17
Scale: 1:10,000 (11x17")
Airphoto: Spring 2008

# Appendix D

# Plant Species List for the Yellow-breasted Chat Nest Sites

| Scientific Name | Common Name |
|---|---|
| *Agropyron repens* | Quackgrass |
| *Alliaria petiolata* | Garlic Mustard |
| *Asclepias syriaca* | Common Milkweed |
| *Asparagus officinalis* | Wild Asparagus |
| Berteroa incana | Hoary Alyssum |
| *Bromus inermis* | Smooth Brome |
| *Campanula rapunculoides* | Creeping Bellflower |
| *Celtis occidentalis* | Common Hackberry |
| Centaurea maculosa | Spotted knapweed |
| Clinopodium vulgare | Wild Basil |
| *Convolvulus arvensis* | Field Bindweed |
| *Cornus racemosa* | Gray Dogwood |
| *Elymus hystrix* | Bottlebrush grass |
| *Equisetum arvense* | Field Horsetail |
| *Fraxinus quadrangulata* | Blue Ash |
| *Geum canadense* | White Avens |
| *Geum sp.* | Avens species |
| *Gleditsia triacanthos* | Honey Locust |
| *Juglans nigra* | Black Walnut |
| *Juniperuss virginiana* | Red Cedar |
| *Schizachyrium scoparium* | Little Bluestem |
| *Melilotus alba* | White Sweet Clover |
| *Mentha sp.* | Mint species |
| *Nepeta cataria* | Catnip |
| *Parthenocissus quinquefolia* | Virginia Creeper |
| *Pinus strobus* | White Pine |
| *Platanus occidentalis* | American Sycamore |
| *Populus sp.* | Poplar species |
| *Prunus virginiana* | Chokecherry |
| *Ptelea trifoliata* | Common Hop Tree |
| *Quercus muehlengerii* | Chinquapin Oak |
| *Quercus rubra* | Red Oak |
| *Rhus aromatica* | Fragrant Sumac |
| *Rhus radicans* | Poison Ivy |
| *Rhus typhina* | Staghorn Sumac |
| *Ribes oxyacanthoides spp. oxyacanthoides* | Bristly Wild Gooseberry |
| *Robinia pseudoacacia* | Black Locust |
| *Rubus idaeus* | Red Raspberry |
| *Solidago spp.* | Goldenrod species |
| *Salix spp.* | Willow species |
| *Saponaria officinalis* | Bouncing Bet |
| *Urtica dioica* | Stinging nettle |
| *Verbascum thapsus* | Common Mullein |
| *Vitis riparia* | Riverbank Grape |

# Appendix E
# Plant Species List for the Willow Flycatcher Nest Sites.

| Scientific Name | Common Name |
|---|---|
| *Agropyron repens* | Quackgrass |
| *Alliaria petiolata* | Garlic Mustard |
| *Asclepias syriaca* | Common Milkweed |
| *Asparagus officinalis* | Wild Asparagus |
| Berteroa incana | Hoary Alyssum |
| *Bromus inermis* | Smooth Brome |
| *Campanula rapunculoides* | Creeping Bellflower |
| *Celtis occidentalis* | Common Hackberry |
| Centaurea maculosa | Spotted knapweed |
| Clinopodium vulgare | Wild Basil |
| *Convolvulus arvensis* | Field Bindweed |
| *Cornus racemosa* | Gray Dogwood |
| *Elymus hystrix* | Bottlebrush grass |
| *Equisetum arvense* | Field Horsetail |
| *Fraxinus quadrangulata* | Blue Ash |
| *Geum canadense* | White Avens |
| *Geum sp.* | Avens species |
| *Gleditsia triacanthos* | Honey Locust |
| *Juglans nigra* | Black Walnut |
| *Juniperus virginiana* | Red Cedar |
| *Schizachyrium scoparium* | Little Bluestem |
| *Melilotus alba* | White Sweet Clover |
| *Mentha sp.* | Mint species |
| *Nepeta cataria* | Catnip |
| *Parthenocissus quinquefolia* | Virginia Creeper |
| *Pinus strobus* | White Pine |
| *Platanus occidentalis* | American Sycamore |
| *Populus sp.* | Poplar species |
| *Prunus virginiana* | Chokecherry |
| *Ptelea trifoliata* | Common Hop Tree |
| *Quercus muehlengerii* | Chinquapin Oak |
| *Quercus rubra* | Red Oak |
| *Rhus aromatica* | Fragrant Sumac |
| *Rhus radicans* | Poison Ivy |
| *Rhus typhina* | Staghorn Sumac |
| *Ribes oxyacanthoides spp. oxyacanthoides* | Bristly Wild Gooseberry |
| *Robinia pseudoacacia* | Black Locust |
| *Rubus idaeus* | Red Raspberry |
| *Solidago spp.* | Goldenrod species |
| *Salix spp.* | Willow species |
| *Saponaria officinalis* | Bouncing Bet |
| *Urtica dioica* | Stinging nettle |
| *Verbascum thapsus* | Common Mullein |
| *Vitis riparia* | Riverbank Grape |

# Appendix F

# Site Photographs

Photo 1: Canada Blue Grass Graminoid Meadow Type in Anders Field Complex.


Photo 2: Interior of Dry-Fresh Drummond's Dogwood Deciduous Shrub Thicket Type.

Photo 3: Edge of Dry-Fresh Drummond's Dogwood Deciduous Shrub Thicket Type and Canada Blue Grass Graminoid Meadow Type.