8-20-2014

A population study and management suggestions for the Denslow's Sparrow (Ammodramus henslowii) at Fort, Drum, NY

Ariel D. Kirk
The College at Brockport, arielkirk@yahoo.com

A population study and management suggestions for the Henslow's Sparrow (*Ammodramus henslowii*) at Fort, Drum, NY

By

Ariel D. Kirk

A thesis submitted to the Department of Environmental Science and Biology of the College at Brockport State University of New York in partial fulfillment of the requirements for the degree of Master of Environmental Science and Biology

August 20, 2014

Department of Environmental Science and Biology

Thesis Defense and Seminar by

Ariel Kim

Seminar Date 20 August, 2014

Thesis Defense Date 20 August, 2014

Master's Degree Advisory Committee	**Approved**	**Not Approved**
Christopher Norment	✓	
Major Advisor		
Douglas A. Wilcox	✓	
Committee Member		
	✓	
Committee Member		
Graduate Coordinator	**Date** 8/21/2014	
Christopher Norment		
Chairman, Environmental Science & Biology	**Date** 8/20/14	

Acknowledgements:

I'd like to thank my major professor, Dr. Chris Norment, and my committee members, Dr. Doug Wilcox, Dr. Mark Norris, and Dr. Jim Haynes. Your suggestions and guidance through this project were invaluable and participating in your classes was a pleasure.

A big "thank you" goes out to my amazing field assistants, Dave Greer and Kristine Carlson. Your dedication, hard work, and humor through those hot days were incredibly helpful and appreciated. Ice cream breaks after work make everything okay. To the Snyder family, for their kind hospitality during my final field season, I thank you. You all were great company and we had great conversations after my long days outdoors. It was the perfect way to recharge.

I couldn't have completed my work without the financial assistance from ORISE (Oak Ridge Institute for Science and Technology) and The Distinguished Professors Award through The College at Brockport. Thank you very much for your generosity. The biologists and staff at Fort Drum Army installation were a huge help as well. I'd specifically like to thank Ray Rainbolt, Jeff Bolsinger, Jaime Marhevsky, and Ian Warden. I benefitted greatly from their knowledge of the area and their expertise regarding Fort Drum and its inner workings.

Last but not least, to all my family and friends who are too numerous to name: Thank you for your support and patience and affection throughout my endeavor. Cups of coffee, sweet treats, movie nights, good beer, couch talks, and everything in between. It all was immensely appreciated. Cheers to you.

Table of Contents:

List of Tables:

Chapter 1:

List of Figures:

Chapter 1:

Chapter 2:

Abstract:

The Henslow's Sparrow (*Ammodramus henslowii*) is one of the most threatened grassland bird species in North America. It is listed as endangered, threatened, or a species of concern in 30 of 32 states and one Canadian province in its historic range. This obligate grassland breeding bird species is now clustered in smaller areas within New York State, and with fewer numbers than before. The largest concentrations currently occur in Jefferson County, NY, within the St. Lawrence Plain ecozone, particularly at the Ft. Drum military installation. The declining populations in the Northeast are likely due to breeding and wintering habitat loss, primarily resulting from changing agricultural practices and land use over time. Henslow's Sparrow breeding behaviors and narrow habitat preferences make it a challenging species to manage for without hindering habitat for other grassland breeding birds. Specific management suggestions for Fort Drum are recommended, including seasonal timing, mowing instructions on height and needed area, and a 3-4 year rotational mowing scheme. The challenges of developing an environmental management plan for an active military training installation, including inter-departmental cooperation and flexibility within a multi-use land area, are also discussed.

Henslow's Sparrow (*Ammodramus henslowii*) ecology and abundance trends at Fort Drum, NY

Introduction:

The Henslow's Sparrow (*Ammodramus henslowii*) is native to North American grasslands and has been declining for the last 50 years (Sauer *et al.* 2013). It has been a Species of Continental Importance and a U.S. Fish and Wildlife Service Bird of Conservation Concern since 2008 (Rich *et al.* 2004). The National Audubon Society also recognized the need to safeguard this species four decades ago, when in 1974, it was listed as a species of Special Concern on its Blue List (NYS DEC 2011), which documents avian species experiencing range or population declines. It also has been listed as an endangered species in Canada since 1993 and is listed as endangered, threatened, or a species of concern in 30 of 32 states and one Canadian province in its historical range (NAS 2014). The Audubon Society also listed the Henslow's Sparrow on its Watchlist in the Red category for rapidly declining species with small populations, limited ranges, and critical conservation threats (NAS 2014).

Within New York State, Breeding Bird Atlas data showed that the distribution of breeding Henslow's Sparrows declined by 80% between surveys in 1980-1985 and 2000-2005 (McGowan and Corwin 2008). Previously, the Henslow's Sparrow had a wider range across the state, and its decline was the largest proportional decrease seen across the entire range of atlas species (McGowan and Corwin 2008). North American Breeding Bird Survey data indicate that the species, along with eight other grassland breeding bird species, has declined steeply in New York State from the

initial survey in 1966 through 2011. Two other species, the Sedge Wren (*Cistothorus platensis)* and Northern Harrier (*Circus cyaneus*) have non-significant declining trends, while no grassland breeding bird species in the state have an increasing abundance trend (Sauer *et al.* 2013). My interest in the Henslow's Sparrow is spurred by its consistent and widespread population decline in the Northeast in recent decades. This obligate grassland breeding bird is highly affected by changes in its breeding habitat, and it is possible that we may lose this species in parts of its historical range.

Given the current status of Henslow's Sparrow in New York State and other parts of the Northeast, and the species' historically high abundance in the St. Lawrence River Plain in northern New York, one major goal of my research was to complete a population study at Fort Drum and in neighboring counties of the St. Lawrence River Plain. I also sought to document habitat selection by Henslow's Sparrows at Fort Drum and develop a management plan for the base to restore this species and others dependent on similar habitats. In this chapter of my thesis, I review the species' ecology, report my own observations on its abundance at Fort Drum and surrounding areas in Jefferson County, and relate them to the species' global declining population trend. I also discuss potential reasons for the declines, related habitat changes, and difficulties in managing for the species.

Study Species and Study Area:

Ecology of the Henslow's Sparrow:

The Henslow's Sparrow is a relatively small, highly camouflaged, and inconspicuous songbird. From April through September, its insect-heavy diet consists of orthopterans, coleopterans, and lepidopterans, along with some plant material. Little is known about winter foraging (Herkert *et al*. 2013), but the species winters in the southeast United States coastal plain (Pruitt 1996, Plentovich *et al*. 1998, Thatcher *et al*. 2006). Weighing 10-15 g, with a length of 13 cm, this cryptically colored sparrow blends in well with its grassland habitat (Herkert *et al*. 2013). Its beige-olive plumage and deep chestnut-colored striping along its head and wing coverts conceal it within dull-colored grasses (Herkert *et al*. 2013). Plumage and size do not vary between sexes, so behavior is used to distinguish between males and females. Males sing and females brood and incubate during breeding season (Robins 1971).

The Henslow's Sparrow nests in thick, dense vegetative litter beneath tall grasses and builds a cupped nest 6-8 cm from the ground (Herkert *et al*. 2013). Previous studies at Fort Drum show that the active breeding season usually extends from 20 May to 30 July, with pairs sometimes completing a second brood by 10 August (Krebs 2002). Eggs are incubated for 10-11 d, and young normally fledge at 9-10 d (Herkert *et al*. 2013). Males form small territories that they establish by singing from perches close to the ground (Robins 1971). The average territory size noted over 3 years at Fort Drum was 0.38 +/- 0.06 ha, with individual territories ranging from 0.09 to 1.06 ha (Krebs 2002). Robins (1971) did not note any direct physical contact between males during territory establishment and maintenance, but

Hyde (1939) and Sutton (1959) observed chasing and side-to-side bill wagging at male intruders. After territories formed, Robins (1971) noted that buffer zones usually occurred between territories. Males would sing at perch points surrounding their territory and avoided singing within an intermediate zone between territories.

Henslow's Sparrows are relatively particular in their breeding-site preference and have low return rates to previous nesting grounds (Krebs 2002, Monroe and Ritchison 2005, Dornak 2010). Dornak (2010) compared return rates of Grasshopper Sparrows (*Ammodramus savannarum*) and Savannah Sparrows (*Passerculus sandwichensis*) to Henslow's Sparrows in western Pennsylvania because all three species are obligate grassland breeding birds and nest sympatrically. She found that Henslow's Sparrows had the greatest variation in abundance and were the least likely of the three species to return to a survey site from one year to the next (Dornak 2010). In a four-year study in Maryland, five Henslow's Sparrows returned to breeding grounds out of 87 total individuals banded (Skipper 1998). Ingold *et al.* (2009) documented 15 returns between 2001 and 2009 out of 114 Henslow's Sparrows captured during the study. The differences among breeding site fidelity probably can be attributed to each species' tolerance of habitat changes. Savannah Sparrows are more tolerant of habitats with a more diverse vegetation structure than Henlsow's Sparrows (Dornak 2010). Bollinger (1995) noticed that the three species differed in population abundance as hayfields aged. Savannah Sparrow populations did not differ between newly planted hayfields and those over 15 years old, while both

Grasshopper and Henslow's Sparrow abundance and species richness increased as fields aged. Henslow's Sparrows were only observed settling in the oldest hayfields.

Henslow's Sparrows routinely prefer large open fields with dense, tall grasses (Thogmartin *et al.* 2006), thick ground litter, and standing dead vegetation (Bajema *et al.* 2001, Herket *et al.* 2013). These combined habitat components usually result after vegetation has grown and developed following disturbance, whether by fire, farming practices, routine mowing, or other methods. Some short, woody vegetation may be tolerated and used as singing perches (Herkert *et al.* 2013). Peterson (1983) and Patten (*et al.* 2006) noted that Henslow's Sparrow populations have decreased in historical breeding areas due to encroaching woody vegetation during succession. Forest edges and treelines have a negative impact on the distribution of some grassland birds, including Henlsow's Sparrows (Walk and Warner 1999). Besides having the potential to fragment grassland habitat, treelines and fence-lines may reduce the appearance of openness of an area that may be the initial draw to the breeding grounds by grassland birds (Walk and Warner 1999). Grassland birds avoid nesting within 50 m of woody edges (Winter *et al.* 2000, Renfrew *et al.* 2005, Ellison *et al.* 2013). In a study where treelines along fences were removed, Henslow's Sparrow densities were 2-4 times greater than in pre-treatment seasons or at control sites (Ellison *et al.* 2013). This potential avoidance of treelines may also negatively influence nesting near roads (Patten *et al.* 2006).

Study Area:

The St. Lawrence River Plain physiographic region encompasses nearly 12 M ha of southeastern Canada and northern portions of New York and Vermont (Ruth 2006). Over 110,115 ha of agricultural grasslands specific to grassland breeding birds in the St. Lawrence River Plain have been identified as Important Bird Area (IBAs) of New York State (Ruth 2006).

Besides IBA lands, the surrounding landscape in northern New York within Lewis, Jefferson, and St. Lawrence counties had over 2 M ha of farmland as of 2007 (USDA 2014). More recently in 2012, there were over 76,700 ha of hayed lands that were farmed and available to obligate grassland breeding birds to nest in the three counties (NASS 2014).

Fort Drum has approximately 43,300 ha on base, including 6,251 ha of habitat suitable for obligate grassland breeding bird species (USAGFD 2011), which represents one of the largest functional, managed grassland sites in the Northeast (McGowan and Corwin 2008). Fort Drum's grassland IBA supports 11 state-listed birds and is the largest IBA in New York State (Wells 1998). In addition to the Henslow's Sparrow, some of these state-listed species include the Sedge Wren (*Cistothorus platensis*), Short-eared Owl (*Asio flammeus*), Upland Sandpiper (*Bartramia longicauda*), and Least Bittern (*Ixobrychus exilis*). As with many other northeastern grasslands, cool-season grasses such as Kentucky bluegrass (*Poa pratensis*), orchard grass (*Dactylis glomerata*), and timothy (*Phleum pratense*) dominate Fort Drum grasslands; goldenrod (*Solidago* spp.), aster (*Symphyotrichum* spp.), willow (*Salix* spp.), and dogwood (*Cornus* spp.) are also abundant. This

vegetation composition creates problems for managers attempting to use dormant-season burning as a management tool to control succession by woody plants because dormant-season burning may increase the occurrence of warm-season goldenrod and woody shrub species, particularly dogwood, that regenerate after a fire event (Mitchell and Malecki 2000).

Although mowing is a tool for woody vegetation removal, it may also eliminate habitat elements that Henslow's Sparrows prefer for breeding habitat. Fort Drum biologists have noted that Henlsow's Sparrows will not settle in a mowed area until the grasses have grown considerably and there is a litter layer available. Consequently, managers at the installation are beginning to use herbicides on grassland habitat after the breeding season and only targeting dense areas with heavy shrub clumps (personal communication, Jeff Bolsinger, Fort Drum Fish and Wildlife Management Program). Heavy-wheeled trucks, large tracked vehicles, and constant training in some grassland areas also may prevent succession from progressing (Krebs 2002, Guretzky *et* al. 2006). However, recent increased deployment of troops has substantially decreased the amount of training and disturbance at Ft. Drum, which has allowed woody vegetation to become more established, negatively affecting open grassland habitat (personal communication, Ray Rainbolt, Fort Drum Fish and Wildlife Management Program).

Methods:

Henslow's Sparrow Surveys:

I conducted my study at Fort Drum within training areas 12 and 13 (Figures 1 and 2) from May through August of 2011 and 2012, using both point counts and detailed observations on known Henslow's Sparrow locations. Although 100, 100-m radius grassland point count stations were used during grassland bird surveys conducted on the base from 1995-1998, I surveyed only 43 of these sites in 2011 and 41 sites in 2012 due to vegetative succession over time throughout the grassland training areas. Two points were dropped from the study between years because they contained too much woody vegetation. I defined the most appropriate points for my study to be those that were >250 m away from each other, measured from the center of each point, to prevent double-counting birds, and also >500 m away from any forest edge, to eliminate strong edge effects. These parameters were used whenever possible, but to gain a large enough sample size, 16 of the total survey points were within the minimum ranges for forest distance and/or distance from a neighboring survey point. All distance calculations from survey points and forest edges were done using 2009 Geographic Information Systems (GIS) land maps of the installation. Point-count surveys were conducted using 100-m-radius circular plots. After waiting 3 min after arriving at a station, my assistants and I recorded the number of Henslow's Sparrows heard or seen during a 5-min interval. Each plot was surveyed once in June, July, and August for a total of three counts per field season. Survey times were between 0500 and 0900 Eastern Daylight Time (EDT), which included the most common hours of grassland bird vocalization. My field assistants and I did not

survey point count stations in high winds or on rainy days because detectability was poor in these conditions.

Abundance data from the current study were compared to historical point-count data from Fort Drum gathered from 1995 through 2010, although the extent to which data were collected was inconsistent over the years (personal communication, Jeff Bolsinger, Fort Drum Fish and Wildlife Management Program). Data on Henslow's Sparrow abundance were collected during two studies within the same part of the base, using the same point count locations; these studies were completed by the Fish and Wildlife Management Program personnel in the 1990s (personal communication, Jeff Bolsinger, Fort Drum Fish and Wildlife Management Program) and by Robin Krebs in the early 2000s (Krebs 2002).

In addition to conducting point counts in Fort Drum grasslands, I used roadside monitoring to revisit fields throughout Jefferson County that were previously sampled by Nick Leone (unpublished data), and Lazazzero (2006) to place population trends at Fort Drum in a regional context. Each roadside point count lasted 5 min, during which all visual and auditory detections were recorded. Henslow's Sparrow detections at each of the 32 road-based sites were placed in distance categories of ≤ 100 m and ≥ 100 m. Roadside count stations were located throughout much of Jefferson County, in the towns of Brownville, Clayton, Leray, Orleans, Pamelia, Philadelphia, and Theresa. Roadside surveys occurred twice in 2011 and three times in 2012.

Habitat measurements:

In an attempt to quantify Henslow's Sparrow habitat selection at Ft. Drum, I measured vegetation in each circular plot at six points separated by 16.6 m along each of four 100-m transects positioned in the four cardinal directions and passing through the center of the plot, for a total of 24 vegetation samples per 100-m-radius point-count station. I centered a 1 m^2 sampling frame over each point and visually estimated the following vegetation cover variables: live graminoid, live forb, live goldenrod, woody vegetation, live total cover, and standing dead vegetation. I used a modified Daubenmire cover class system (Daubenmire 1959) and calculated the average cover class values using mid-point values with the following categories: 0%, >1-5%, 6-15%, 16-25%, 26-50%, 51-75%, 76-100%. At each point, I also used a Robel pole (Robel *et al.* 1970) to measure height and density of vegetation. Finally, I measured litter depth to the nearest cm at the center of a 1-m^2 sampling frame and also tallied the number of plant genera within the frame.

Each field sampled during roadside counts was categorized as fallow, row crop, hayfield, or pasture. The percent woody cover of each field was estimated visually using another modified Daubenmire classification system: 0-5%, 5-15%, 15-25%, 25-50% and >50% woody cover. I documented both field type and percent cover of woody plants at each site to help understand habitat preferences of Henslow's Sparrow at these locations.

Results:

Henslow's Sparrow numbers at Fort Drum fluctuated over the ten non-consecutive years in which data were collected from 1995 and 2012, with general decrease to the recent observations of n = 2 and n = 1 individuals in 2011 and 2012, respectively (Figure 4). Without higher abundances in these two years, the vegetation data I collected (Table 1) could not be used statistically to assess preferred breeding habitat, or used to compare breeding and non-breeding sites. Moreover, 24 of the remaining 41 point-count sites were greatly altered by mowing by Land Rehabilitation and Maintenance (LRAM), a component of the Integrated Training Area Management (ITAM) team before the 2012 breeding season. This was done to provide artillery training areas for the soldiers on base (personal communication, Ray Rainbolt, Fort Drum Fish and Wildlife Management Program). The sample size of pertinent survey sites was substantially reduced because of this action, so vegetation measurements taken in 2012 were not a true representation of breeding habitat.

I observed that Henslow's Sparrows settled in areas with moderate litter depth (3-5 cm), a high percentage of live cover (85-90%), and a moderate amount of graminoid cover (10-40%). Forb and goldenrod cover ranged between 25-60% and 17-39%, respectively; woody vegetation (2-16%) and standing dead cover (0-9%) values generally were low (Table 1). One site was used again in 2012, but it is unknown if the territorial male was a bird returning from the previous year.

Data from roadside surveys throughout Jefferson Co., NY between 1995 and 2012 showed a general decrease in Henslow's Sparrow presence (Figure 5). These roadside survey points were classified by agricultural field type (Figure 6) and by

percent cover of shrubs and woody vegetation (Figure 7). In both years, most fields had not been worked and remained fallow with little woody vegetation. Henslow's Sparrows were found in active hay fields, pasture land, and fallow agricultural fields; woody cover classes in these fields ranged from 0-5% to 15-25%.

Discussion:

My data show that although populations at Fort Drum and in the surrounding area of Jefferson County fluctuated between 1995 and 2012, there was a very strong decrease through time in the number of individuals present during the breeding season at Fort Drum and in surrounding parts of Jefferson County. At Fort Drum, the largest decreases occurred between 1998 and 2000 and again between 2009 and 2011 (Figure 4). Krebs (2002) also found that Henslow's Sparrow abundance fluctuated over the breeding seasons when she studied them at Fort Drum. Both the local population within Fort Drum and the population in Jefferson County showed the species' characteristic population fluctuations among breeding seasons. In Jefferson County, Lazazzero (2006) noted only four of 159 roadside sites studied in 2004 and two sites of the same 159 total sites in 2005 had settled Henslow's Sparrows during the breeding season.

The limited number of singing males detected at Fort Drum during the 2011 and 2012 breeding seasons could have been due partly to surveying in the early morning hours rather than at night. Walk (*et al.* 2000) found that Henslow's Sparrows were recorded significantly more frequently during night surveys

performed 4 hrs after sunset than during those performed at dusk (0.5 hrs after sunset) or after sunrise. Henslow's Sparrows were more vocal during bright, moonlit nights. In Jefferson County, Lazazzero (2006) also found evidence that detection of Henslow's Sparrow song was greater at night than during daylight hours, specifically under half and full moon phases. However, because I wanted to compare my results to those gathered during previous studies of Henslow's Sparrows in the region, and these studies surveyed for the species during daylight hours, I also conducted counts during the same time period of the day.

Henslow's Sparrow abundance has declined steadily from 1966 to present in New York State and the New England/Mid-Atlantic coast region, as indicated by North American Breeding Bird Survey data (Sauer *et al.* 2013). The St. Lawrence Plain region is one of the most important and expansive breeding areas of grassland habitat in the Northeast (BSC 2013), and Henslow's Sparrows have experienced long-term and more recent significant decreasing population trends in the region. More recent data collected from 2000-2010 show inconclusive statistical significance for trends in the Eastern region (Sauer *et* al. 2013). This does not necessarily indicate that the population is recovering in the state or the Eastern survey region, but it could be simply an artifact of the short timeframe and low incidence of the species on BBS routes. The Breeding Bird Atlas of New York State also noted a steep decline in Henslow's Sparrow populations from its first edition covering the years 1980-1985 to its most recent edition covering 2000-2005. In the first edition, the study species was found in 348 of 5,332 5 x 5 km^2 survey blocks within the state; by the next atlas

effort, only 70 blocks reported Henslow's Sparrow activity. This large decrease in distribution is likely due to grassland habitat loss through changes in agricultural land use in the region, specifically from abandonment of large pastures and hayfields, and conversion of grassland habitat to row crops, a trend that began in the 1950s and continues to escalate (Sample and Mossman 1997). The concurrent shift from grass hay to alfalfa hay also has decreased populations by increasing mortality on the nesting grounds, as alfalfa is harvested sooner and more frequently than grass hay (Sample and Mossman 1997).

In 2000, Partners in Flight developed the St. Lawrence Plain Bird Conservation Plan, which indicated that grasslands within this region were the most important habitat type for focused conservation efforts, and that the Henslow's Sparrow was the top focal species for this priority habitat (Rosenberg 2000). The species ranked 27, highest of the 10 grassland species, with a ranking of 22 or greater indicating that a species is of high global priority. The objectives for the St. Lawrence Plain Bird Conservation Plan were to double the current Henslow's Sparrow population over the next ten years as long as the species-specific management did not negatively affect other priority species, and to sustain the current grassland habitat where there were no Henslow's Sparrows (Rosenberg 2000).

Unfortunately, stopping the decrease in agricultural grassland has not been successful. From 2002 to 2007, total farmland in Jefferson and St. Lawrence counties dropped by 196,768 ha (NASS 2014). Hayfields other than alfalfa that have historically provided nesting areas decreased in Jefferson and St. Lawrence counties

by 10,562 ha between 1992 – 2012 (NASS 2014). Acreage in corn and other row crops has increased in the last 20 years in these same agricultural areas, diminishing suitable breeding habitat for grassland breeding birds (NASS 2014).

Researchers have noted that Henslow's Sparrows settle in small clusters of conspecifics (Cully and Michaels 2000, Dornak 2010) and are also attracted to an area by the song of other settled Henlsow's Sparrows (Mills *et al.* 2006). These characteristics allow the birds to target good habitat from birds that have settled before them in the same season, but they also result in irregular nesting patterns that may make population studies and management more difficult.

Migration challenges and poor wintering sites are also factors that may negatively affect Henslow's Sparrow populations. Migration is an energetically costly undertaking for birds, and the availability of food resources and the quality of wintering grounds directly affect survival success (Johnson and Sherry 2001, Newton 2010, Alves *et al.* 2013). Henslow's Sparrows winter in the southeastern United States (Herkert *et al.* 2013), and Thatcher (2006) noted higher survivorship of Henslow's Sparrows in pine savanna areas that have been recently burned. Bechtoldt (*et al.* 2005), Thatcher *et al.* (2006) and DiMicili *et al.* (2007) found that prescribed fires increased habitat quality, survivability, and density of cutover muhly (*Muhlenbergia expansa*), a grass species that Henslow's Sparrows preferred over other seed plants and one that responds strongly after a fire event. Graminoid and sedge seeds were available before and after the burn but were rejected in favor of *M. expansa* (DiMiceli *et al.* 2007). DiMiceli *et al.* (2007) also noted that the pine

savanna ecosystems as a whole have diminished to 5% of their former range, potentially limiting survival of Henslow's Sparrows overwintering in the region.

Many of the southeastern states show fluctuation and population declines for the Henslow's Sparrow wintering habitat (Figure 3a). Data from that National Audubon Society's Christmas Bird Count is measured in individuals/party-year. This allows for the amount of observers in each field party to be accounted for when birds are observed and recorded (NAS 2010). Most of the states have similar low population trends, but in Mississippi Henslow's Sparrow trends have increased in recent years (Figure 3b). This may be due to existence of the 8,000 ha pine-savanna habitat of the Mississippi Sandhill Crane National Wildlife Refuge and the 3-5 year fire management plan the on-site biologists follow to keep the ecosystem stable and healthy (USFWS 2014).

Habitat loss in both breeding and wintering grounds probably plays an important role in declines of Henslow's Sparrows in the Northeast, but other factors may come into play as well. A recent study (Mineau and Whiteside 2013) argued that pesticide use also has negatively affected grassland bird populations. Their study connected declines in grassland bird populations detected by the Breeding Bird Survey to potentially lethal levels of agricultural pesticides (Mineau and Whiteside 2013). This effect did not take into account the loss of food resources from damaged vegetation that also occurs from the use of chemical products (Mineau and Whiteside 2013).

In conclusion, all lines of evidence indicate that the Henslow's Sparrow population in the Saint Lawrence River Plain has declined substantially since the 1960s. There are many possible reasons for this regional decline, including breeding habitat loss through changing farming practices, wintering habitat loss through loss of native pine ecosystems in favor of managed timber plantations, inadequate food supplies at wintering grounds or stopover sites due to fire suppression, or increases in pesticide use. Henlsow's Sparrow's nomadic behavior and low annual return rates to breeding sites also make it a particularly difficult species to track and study.

Some disturbance treatments are more suitable and effective based on the breeding site location and surrounding geography. For Fort Drum, the primary means of disturbance is a structured mowing plan that is flexible for military training needs and also allows for species diversity and richness. Fort Drum and the surrounding area still offer large expanses of grassland habitat in the Northeast United States, even with habitat loss, and still may provide important breeding habitat for Henslow's Sparrows and the grassland bird guild as a whole. However, to do so will require a management scheme that acknowledges the specific needs of the Henslow's Sparrow while also allowing for flexibility of land use on an active military base. The following chapter will describe pertinent management characteristics and specific suggestions for Fort Drum to manage for the Henslow's Sparrow.

Literature Cited:

Alves, J.A., T.G. Gunnarsson, D.B Hayhow, G.F. Appleton, P.M. Potts, W.J. Sutherland, and J.A. Gill. 2013. Costs, benefits, and fitness consequences of different migration strategies. Ecology 94: 11-17.

Bajema, R. A., T.L. DeVault, P.E. Scott, and S.L. Lima. 2001. Reclaimed coal mine grasslands and their significance for Henlsow's Sparrows in the American Midwest. Auk. 118: 422-431.

Bechtoldt, C.L., P.C. Stouffer. 2005. Home range size, response to fire, and habitat preferences of wintering Henslow's Sparrows. Wilson Bulletin, 117: 211-225.

Bollinger, E.K. 1995. Successful changes and habitat selection in hayfield bird communities. The Auk. 112: 720-730.

BSC (Bird Studies Canada). 2013. Lower Great Lakes/St. Lawrence Plain. [Online.] Bird Studies Canada, ON, Canada. Available at: http://www.bsceoc.org/international/bcrs/13.html

Cully Jr., J.F. and H.L. Michaels. 2000. Henslow's Sparrow habitat associations on Kansas tallgrass prairie. Wilson Bulletin. 112: 115–123.

Daubenmire, R.F. 1959. Canopy coverage method of vegetation analysis. Northwest Science 33: 43-64.

DiMiceli, J.K., P.C. Stouffer, E.I. Johnson, C. Leonardi and E.B. Moser. 2007. Seed preferences of wintering Henslow's Sparrows. Condor. 109: 595-604.

Dornak, L. L. 2010. Breeding patterns of Henslow's Sparrow and sympatric grassland sparrow species. Wilson Journal of Ornithology. 22: 635-645.

Ellison, K.S., C.A. Ribic, D.W. Sample, M.J. Fawcett, and J.D. Dadisman. 2013. Impacts of tree rows on grassland birds and potential nest predators: A removal experiment. [Online.] PLoS ONE, DOI: 10.1371/journal.pone.0059151.

Guretzky, J., A. Anderson and J. Fehmi. 2006. Grazing and military vehicle effects on grassland soils and vegetation. Great Plains Research. 16: 51-61.

Herkert, J. R., P. D. Vickery, and D. E. Kroodsma. 2013. Henslow's Sparrow (*Ammodramus henslowii*), The Birds of North America Online. Ithaca: Cornell Lab of Ornithology, Ithaca, New York. Available at: http://bna.birds.cornell.edu/bna/species/672doi:10.2173/bna.672

Hyde, A. S. 1939. The life history of Henslow's Sparrow, *Passerherbulus henslowi* (Audubon). University of Michigan Press, Ann Arbor, Michigan. Miscellaneous publication number 41.

Ingold, D.J., J.L. Dooley, and N. Cavender. 2009. Return rates of breeding Henslow's Sparrows on mowed versus unmowed areas on a reclaimed surface mine. Wilson Journal of Ornithology. 121: 194-197.

Johnson, M.D. and T.W. Sherry. 2001. Effects of food availability on the distribution of migratory warblers among habitats in Jamaica. Journal of Animal Ecology 70: 546–560.

Krebs, R. 2002. The breeding ecology of, and effects of military activity on, the

Henslow's Sparrow at Fort, Drum, New York. M.S. thesis, The College at Brockport, State University of New York, Brockport, NY.

Lazazzaro, S. 2006. A multi-scale analysis of grassland bird habitat relationships in the St. Lawrence River Valley, NY. M.S. thesis, The College at Brockport, State University of New York, Brockport, New York.

Lazazzero, S and C.J. Norment. 2006. A multi-scale analysis of grassland bird habitat relations in the St. Lawrence River Valley. The Nature Conservancy and The Research Foundation of the State University of New York, No. NYHER 031008. The College at Brockport, State University of New York, Brockport, New York.

McGowan, K. J. and K. Corwin. 2008. Henslow's sparrow. Pages 558-559 *in* K. J. and K. Corwin, editors. The second atlas of breeding birds in New York State. Comstock Publishing Associates. Ithaca, New York.

Mills, M., J.D. Rising, and D.A. Jackson. 2006. Attraction during establishment of least flycatcher clusters. Journal of Field Ornithology. 77: 34-38.

Mineau P. and M. Whiteside. 2013. Pesticide Acute Toxicity Is a Better Correlate of U.S. Grassland Bird Declines than Agricultural Intensification. [Online.] PLoS ONE 8(2): e57457. DOI:10.1371/journal.pone.0057457.

Mitchell, L. R. and R. A. Malecki. 2000. Use of prescribed fire for management of old fields in the Northeast. 000-000, L.A. Brennan, editor. National Congress on Fire Ecology, Prevention, and Management Proceedings, No. 1. Tall Timbers Research Station, Tallahassee, Florida.

Monroe, M.S. and G. Ritchison. 2005. Breeding biology of Henslow's Sparrow on reclaimed coal mine grasslands in Kentucky. Journal of Field Ornithology. 76: 143-149.

(NAS) (National Audubon Society, Inc.) 2010. The Christmas Bird Count Historical Results [Online]. National Audubon Society, Inc. Available at: http://www.christmasbirdcount.org

NAS (National Audubon Society, Inc.) 2014. The 2007 Audubon Watchlist. [Online.] National Audubon Society, Inc. Ivyland, PA. Available at: http://birds.audubon.org/2007-audubon-watchlist

NASS (National Agricultural Statistics Service). 2014. National Agricultural Statistics Service. [Online.] United States Department of Agriculture, Washington, D.C. Available at: http://www.nass.usda.gov/Statistics_by_Subject/Environmental/index.asp

Newton, Ian. 2008. The migration ecology of birds. First Edition. Academic Press. London, England.

NYS DEC (New York State Department of Environmental Conservation) 2011. Henslow's Sparrow fact sheet. [Online.] Department of Environmental Conservation, New York State. Available at: http://www.dec.ny.gov/animals/59554.html

Patten, M.A., E. Shochat, D.L. Reinking, D.H. Wolfe, and S.K. Sherrod. 2006. Habitat edge, land management, and rates of brood parasitism in tallgrass prairie. Ecological Applications. 16: 687-695.

Peterson, A. 1983. Observations on habitat selection by Henslow's Sparrow in Broome County, New York. The Kingbird. Summer: 155-164.

Plentovich, S.M., N.R. Holler, and G.E. Hill. 1998. Site fidelity of wintering Henslow's Sparrows. J. Field Ornithol. 69: 486-490.

Pruitt, L. 1996. Henslow's Sparrow status assessment. U.S. Department of the I Interior, Fish and Wildlife Service, Fort Snelling, Minnesota. Summary of report availiable at: http://www.fws.gov/midwest/eco_serv/soc/birds/hens_ss.html

Renfew, R.B., C.A. Ribic, and J.L. Nack. 2005. Edge avoidance by nesting grassland birds: A futile strategy in a fragmented landscape. Auck. 122: 618-636.

Rich, T.D., C.J. Beardmore, H. Berlanga, P.J. Blancher, M.S.W. Bradstreet, G.S. Butcher, D.W. Demarest, E.H. Dunn, W.C. Hunter, E.E. Iñigo-Elias, J.A. Kennedy, A.M. Martell, A.O. Panjabi, D.N. Pashley, K.V. Rosenberg, C.M. Rustay, J.S. Wendt, and T.C. Will. 2004. Partners in Flight North American Landbird Conservation Plan. Cornell Lab of Ornithology, Ithaca, NY

Robel, R.J., J.N. Briggs, A. D. Dayton, and L. C. Hulbert. 1970. Relationships between visual obstruction measurements and weight of grassland vegetation. Journal of Range Management. 23: 295-297.

Robins, J.D. 1971. A study of Henslow's Sparrow in Michigan. Wilson Bulletin 83: 39-48.

Rosenberg, K.V. 2000. Partners in flight bird conservation plan for the St. Lawrence

Plain (Physiographic Area 18). Partners in Flight. Northeast Regional Coordinator Kenneth V. Rosenberg. Cornell Lab of Ornithology. Ithaca, New York.

Ruth, J.M. 2006. Partners in Flight - U.S. Website. Version 1/4/2013. Served by the USGS Patuxent Wildlife Research Center, Laurel, Maryland, USA. Available at: http://www.partnersinflight.org

Sample, D.W and M.J. Mossman. 1997. Managing habitat for grassland birds, a guide for Wisconsin. Bureau of Integrated Science Services, Department of Natural Resources. Madison, Wisconsin.

Sauer, J.R., J.E. Hines, and J. Fallon. 2013. The North American Breeding Bird Survey, Results and Analysis 1966-2007. Version 5.15.2008. USGS Pautuxent Wildlife Research Center, Laurel, Maryland. Available at: http://www.mbrpwrc.usgs.gov/bbs/bbs.html

Skipper, C.S. 1998. Henlsow's Sparrows return to previous nest site in Western Maryland. North American Bird Bander. 23: 36-41.

Sutton, G.M. 1959. The nesting fringillids of the Edwin S. George Reserve, Southeastern Michigan. Jack Pine Warbler 37: 127-151.

Thatcher, B.S., D.G. Krementz, and M.S. Woodrey. 2006. Henslow's Sparrow winter survival estimates and response to prescribes burning. Journal of Wildlife Management. 70: 198-206.

Thogmartin, W.E., M.G. Knutson, and R.J. Sauer. 2006. Predicting regional abundance of rare grassland birds with a hierarchical spatial count model. Condor. 108: 25-46.

USAGFD (US Army Garrison Fort Drum). 2011. Integrated Natural Resources Management Plan. Natural Resources Branch, Environmental Division, Directorate of Public Works and Integrated Training Area Program, Range Branch, Training Division, Directorate of Planning, Training, Mobilization & Security, Fort Drum, New York.

USDA (USDA Census of Agriculture). 2014. 2007 census publications. United States Department of Agriculture, Washington, D.C. [Online.] Available at: http://www.agcensus.usda.gov/Publications/2007/index.php

USFWS (U.S. Fish and Wildlife Service). 2014. Mississippi Sandhill Crane National Wildlife Refuge. Southeast Region Fish and Wildlife Service. [Online.] Available at: http://www.fws.gov/mississippisandhillcrane/history.html

Walk, J.W. and R.E. Warner. 1999. Effects of habitat area on the occurrence of grassland birds in Illinois. American Midland Naturalist. 141: 339-344.

Walk, J.W., E.L. Kershner, R.E. Warner. 2000. Nocturnal singing in grassland birds. Wilson Bulletin. 112: 289-292.

Wells, J.V. 1998. Important Bird Areas in New York State. [Online.] National Audubon Society, Albany, NY. Available at: http://ny.audubon.org.

Winter, M., D.H. Johnson and J. Faaborg. 2000. Evidence for edge effects on multiple levels in tallgrass prairie. Condor. 102: 256-266.

Tables and Figures:

Table 1: Average values and ranges for vegetation variables in three Henslow's Sparrow territories in 2011 and 2012 at Fort Drum military installation.

Vegetation Variables	Territory 1 (2011)	Territory 2 (2011)	Territory 3 (2012)	Range of values
% live cover	89.3	89.1	85.8	85-89
% graminoid	39.1	26.5	10.8	10-40
% forb	50.9	37.2	25.1	25-60
% *Solidago* spp.	17.5	14.0	39.1	17-39
% woody vegetation	7.1	2.5	15.6	2-16
% standing dead	8.8	0.0	0.8	0-9
genera count ($1m^2$)	6.9	7.5	9.2	7-9
litter depth (cm)	5.2	3.8	2.9	3-5
robel score	2.6	5.0	5.4	3-5

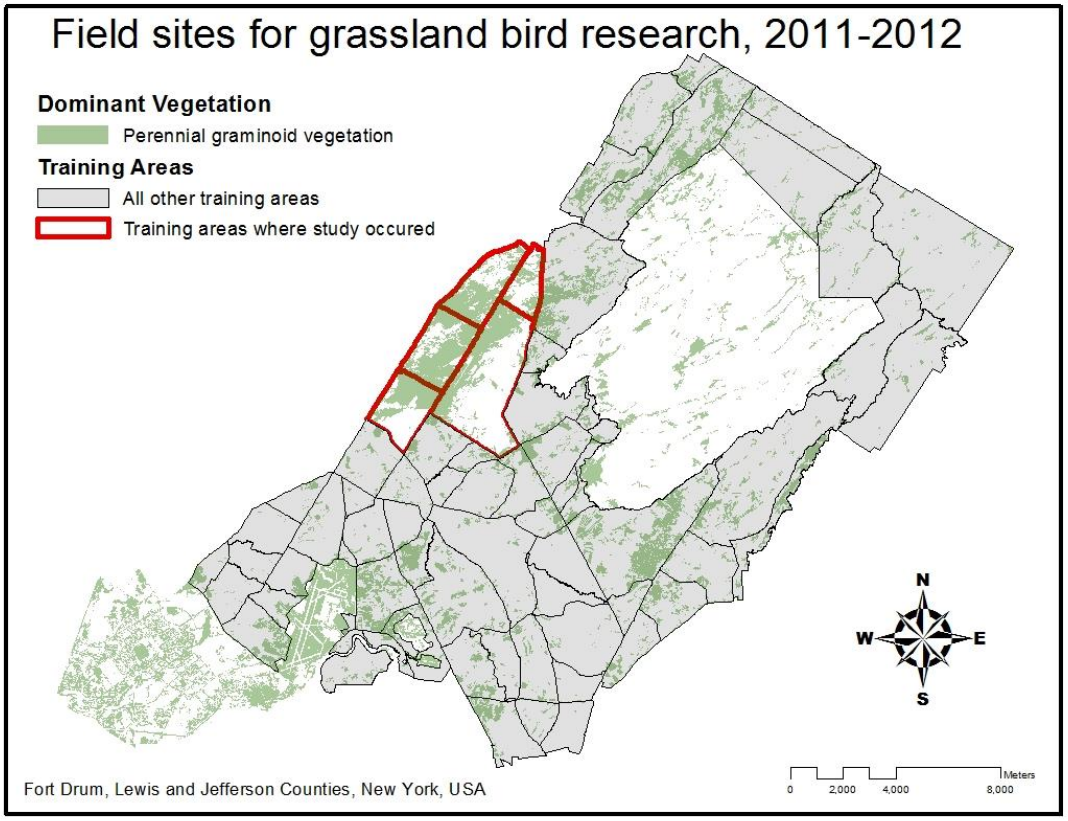

Figure 1: Map of Fort Drum and training areas where the study occurred (map by D. Greer, research assistant for this study).

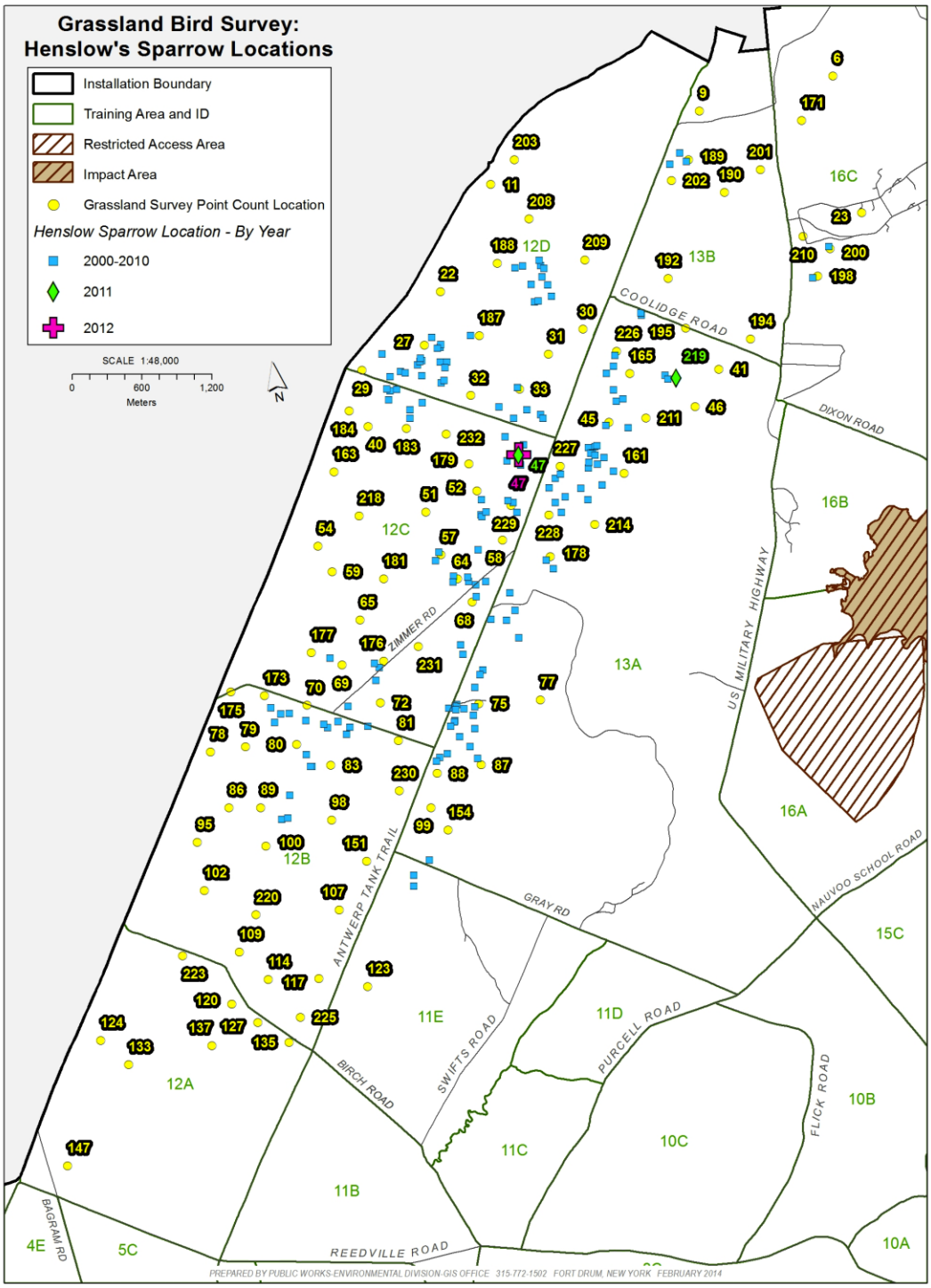

Figure 2: Map of grassland training areas and Henslow's Sparrow locations within this study (map by J. Marhevsky, Fort Drum Environmental Division).

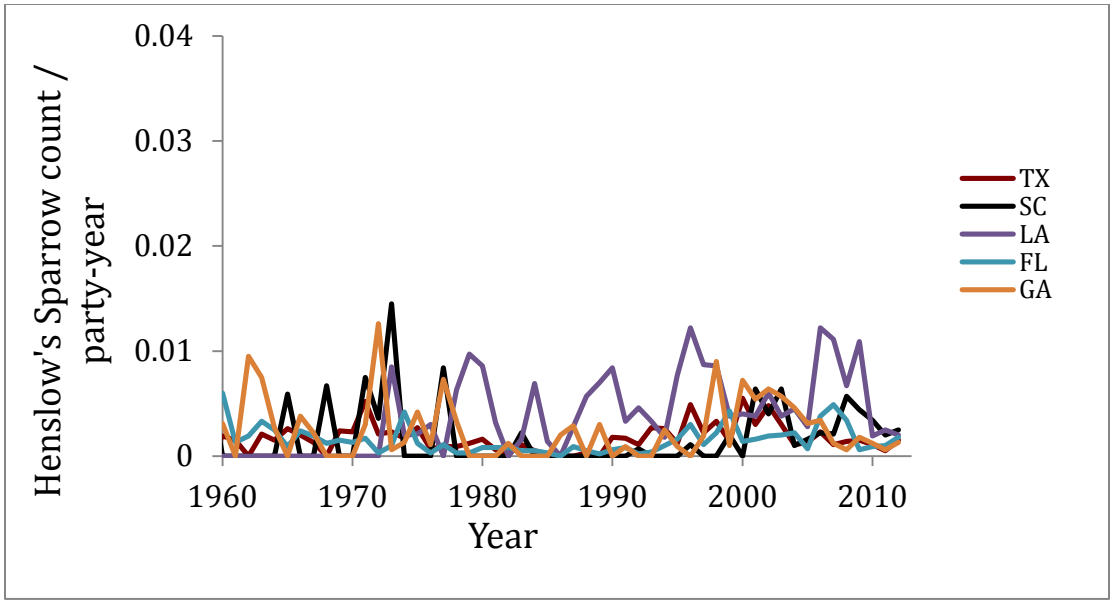

Figure 3a

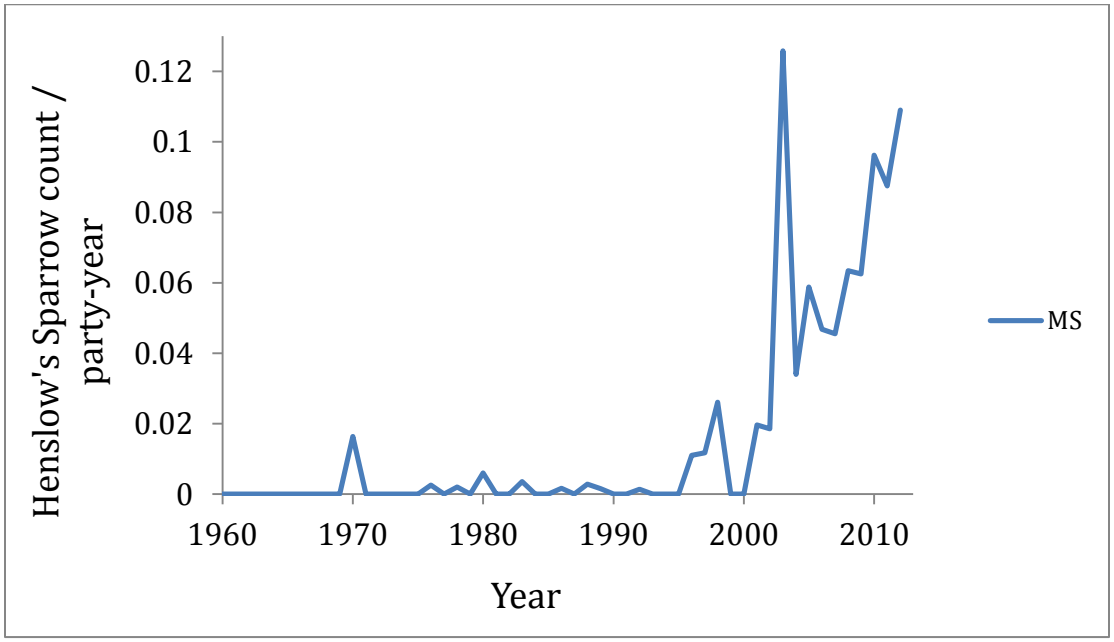

Figure 3b

Figure 3: Christmas Bird Count data of 6 southeastern states showing:

a. Fluctuating populations and low populations numbers.

b. A recent increase in population numbers in Mississippi, unlike other areas of wintering habitat.

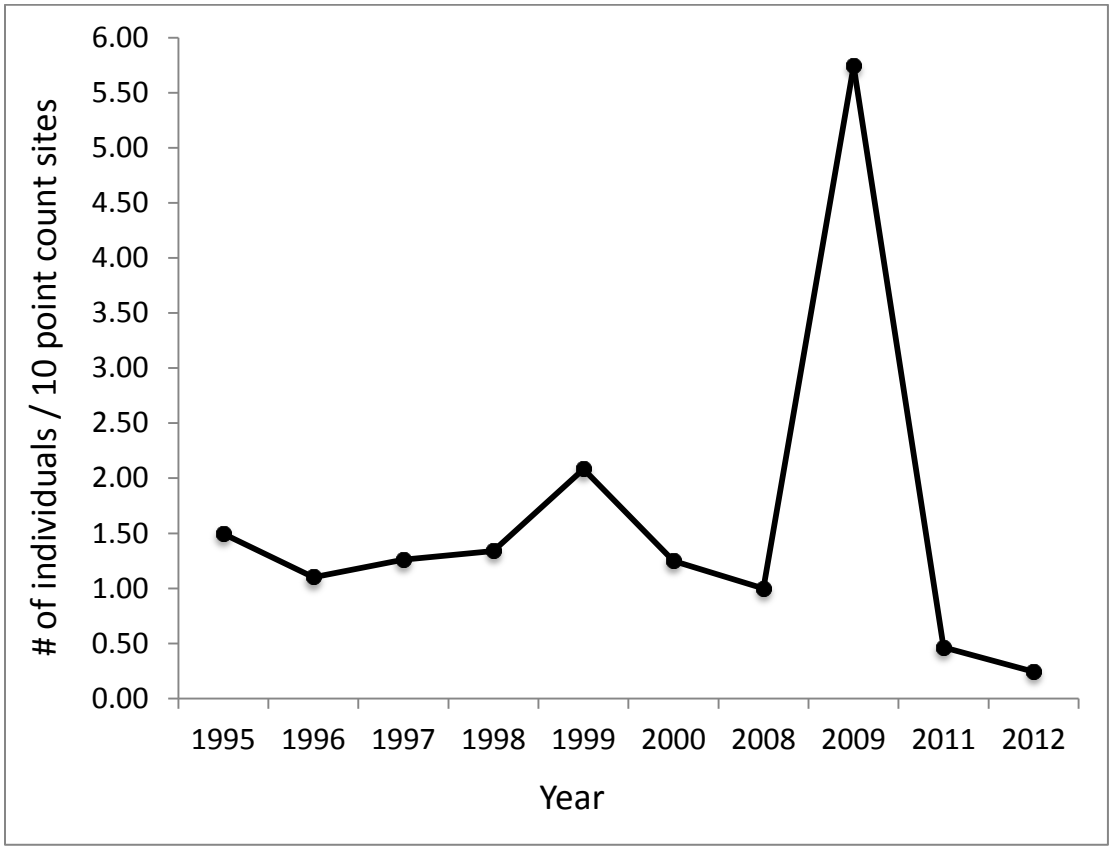

Figure 4: Point count data for Henslow's Sparrow at Fort Drum, NY, 1995 – 2012. Data from 1995-1998 using 127 point count locations (Ft. Drum Environmental Division for the Grassland Breeding Bird Project); 1999 and 2000 using 48 point count locations (Krebs 2002); 2008 using 90 and 2009 using 46 point count locations (personal communication, Jeff Bolsinger, Fort Drum Fish and Wildlife Management Program); and 2011, 2012 using 43 and 41 point count locations, respectively (present study).

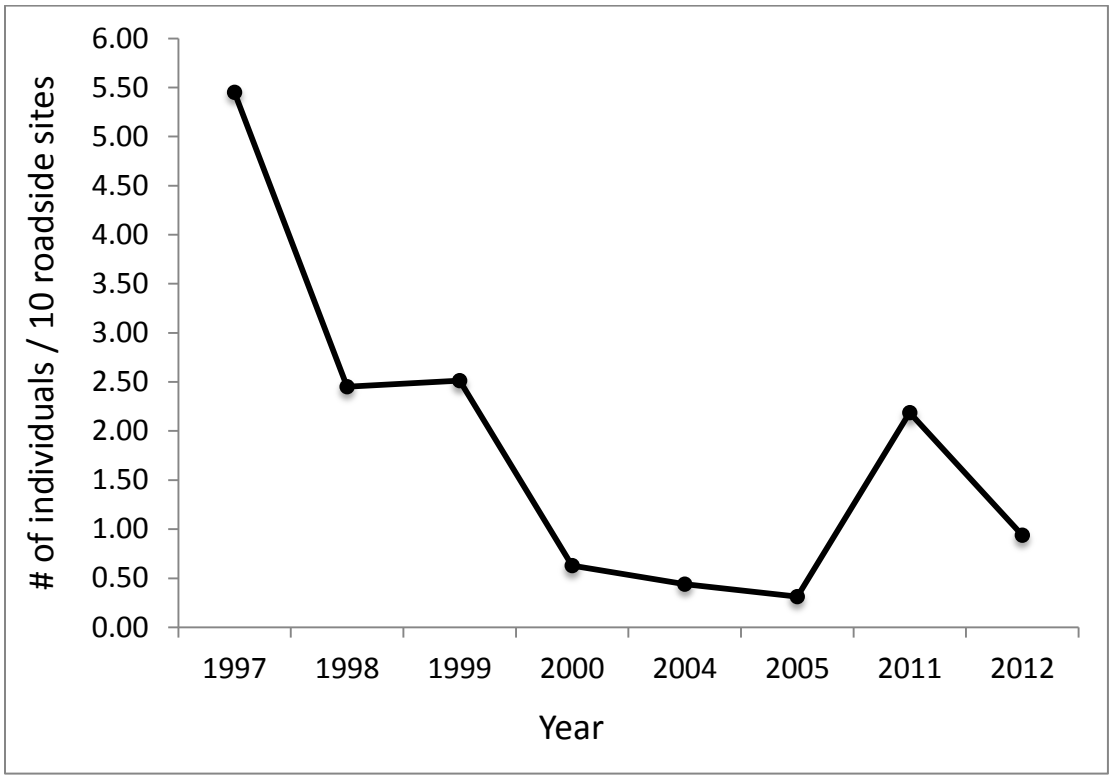

Figure 5: Abundance counts for Henslow's Sparrows at roadside sites in Jefferson Co., NY from 1997 to 2012. Data from 1997-2000, 2004 and 2005 using 159 roadside sites (Lazazzero and Norment 2006), and 2011, 2012 using 32 sites (present study).

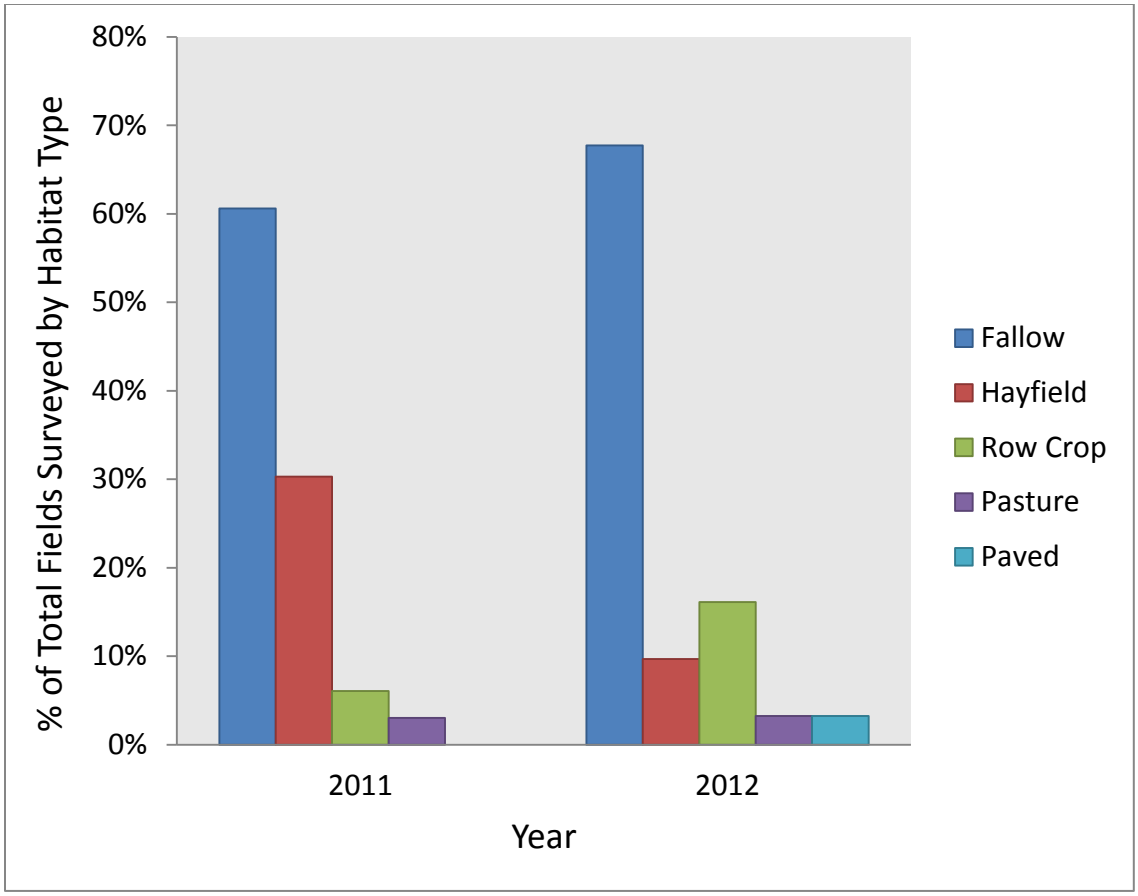

Figure 6: Classification of 32 roadside count sites surveyed in 2011 and 2012, by field type.

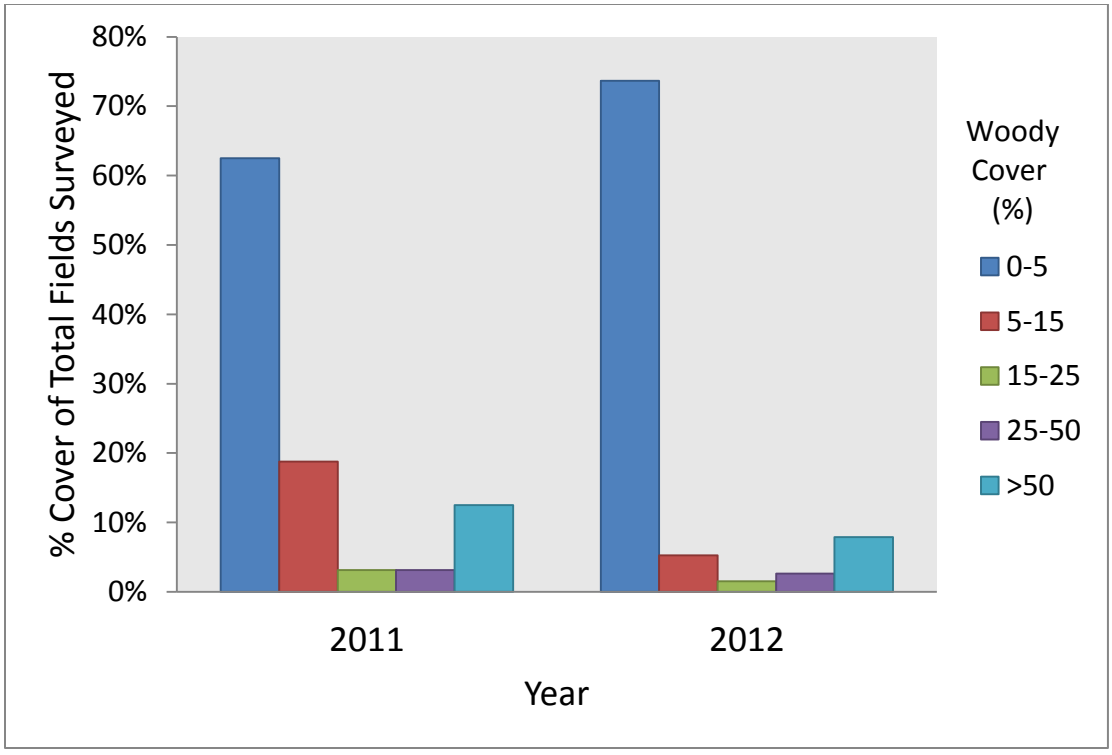

Figure 7: Classification of 32 roadside sites by woody cover class category

Chapter II: A management plan for the Henslow's Sparrow at Fort Drum and in surrounding areas of Jefferson Co., NY

Over the last 40 years, Henslow's Sparrow populations have declined significantly at the Fort Drum military installation and across other parts of Jefferson County, New York (Sauer *et al.* 2013). These declines can be attributed in part to the species' preference for specific habitat characteristics maintained by occasional disturbance (Dornak *et al.* 2013). Also, Henslow's Sparrow behavior, including its attraction to conspecifics in nesting areas, nomadic nature and low return rates, may make detection difficult (Dornak 2010). Because of these specific habitat needs and behaviors, quality habitat is imperative if the Henslow's Sparrow is to breed successfully; in the Northeast, maintaining this habitat may require intensive and frequent manipulation. Wintering habitat in the southeast pine ecosystems is also declining, making the Henslow's Sparrow vulnerable in both its summer and winter ranges.

Species-specific habitat preferences and behaviors related to management:

The Henslow's Sparrow is a challenge to manage, in part because of its relatively narrow breeding habitat requirements. Its preferred habitat includes large tracts of tall, dense grasslands with low woody vegetation cover and a deep litter layer to use for both nest material and cover from predators (Herkert *et al.* 2013). It

is an area-sensitive species (Herkert 1994, Winter and Faaborg 1999), and its population densities decrease as habitat fragmentation increases (Bollinger 1995, Winter and Faaborg 1999, Lazazzero 2006). Lazazzero and Norment (2006) found that the probability of occurrence of eight grassland bird species in Jefferson Co., NY, including Henlsow's Sparrows, increased as habitat patch area increased. The mean abundance of the eight obligate grassland bird species was 1.70 ± 0.13 in 2004 and 2.00 ± 0.23 in 2005. In the same years, the abundance average for the Henslow's Sparrow was 0.02 ± 0.01 and 0.03 ± 0.00, respectively (Lazazzero and Norment 2006). Henslow's Sparrows were found in field sizes ranging from 5 to 576 ha (Lazazzero and Norment 2006). Habitat fragmentation not only decreases patch size, it also increases the edge effect for breeding grassland birds, which increases the potential for losing nests to predation (Helzer and Jelinski 1999), Winter and Faaborg 1999, Herkert *et al.* 2003). Hill and Diefenbach (2014) noticed that Henslow's Sparrow densities were lower on irregularly-shaped habitat patches, and they suggested that increased edge effect in these habitat patches negatively affected the species, whether by predation or edge avoidance. The perimeter-to-area ratio that reflects both the shape and area of a habitat patch is an important predictor of both individual grassland species and overall species richness (Helzer and Jelinski 1999).

The edges between grasslands and other habitat can create travel lanes for predators to gain access to ground nesting passerines (Fritzell 1978) and increases the chances of incidental nest predation (Vickery *et al.* 1992). Snakes become a larger threat in fragmented grassland areas than in large patches with a decreased edge

effect (Weatherhead and Blouin-Demers 2004). More than one-third of documented predators of grassland bird nests recorded by Renfrew and Ribic (2003) were primarily species that preferred wooded areas. Thus, predators using the forested areas that surround Fort Drum's grasslands could negatively affect nesting grassland birds such as Henslow's Sparrows simply by fragmenting grassland habitat (Bollinger and Gavin 2004) and preying on nests.

Henslow's Sparrow breeding success may vary by location and year (Vickery and Herkert 2001, Monroe and Ritchison 2005). Winter and Faaborg (1999) found 59 nests at their southwestern Missouri study site and observed a 57.6% nesting success for Henslow's Sparrows. In Michigan, Robins (1971) observed a 54% success rate, and in Oklahoma, Reinking (*et al*. 2000) found a 45% success rate for the species. Predation on ground-nesting grassland birds is a major factor in individual losses to species populations (Ricklefs 1969, Martin 1993) and increases as habitat patch size becomes smaller (Gates and Gysel 1978, Wilcove 1985, Robinson *et al*. 1995).

The vegetation structure of an area is important in managing for grassland birds, and the makeup of habitat patches can determine if Henslow's Sparrows nest or not. In northeastern grassland habitats, the increase in woody vegetation due to invasion by shrubs and small trees decreases densities of area-sensitive grassland breeding birds like the Henslow's Sparrow (Coppedge *et al*. 2001, Graves *et al.* 2010, Hill and Diefenbach 2014). Indeed, assuming a linear rate of decrease, Hill and Diefenbach's (2014) study predicts an annual population reduction in the central Pennsylvania region of 7% due to vegetation changes and woody vegetation increase,

4% higher than what is predicted for the Appalachian Mountain region for the Henslow's Sparrow (Sauer *et al.* 2013). Hill and Diefenback's (2014) research suggests that local scale vegetation characteristics of grass and forb cover are important in Henslow's Sparrow occupancy patterns. Tall, thick, dense grasses are a hallmark of Henslow's Sparrow habitat (Sample 1989, Herkert 1994, Mazur 1996), but standing dead stems are also needed to use as perch points (Kahl *et al.* 1985, Zimmerman 1988, Zimmerman 1992, Mazur 1996). Mazur (1996) found that Henslow's Sparrows in eastern New York preferred territory with greater vegetation density, tall vegetative matter, and the occurrence of upright, sturdy, dead stems. Vegetative species used as perch points vary across fields and regions, but having plants with tall, strong stalks is important for Henslow's Sparrows' breeding behavior (Mazur 1996). Mazur's (1996) findings agree with other research showing that Henslow's Sparrows, in comparison with many other grassland breeding birds, favor more dense grassland habitat and a narrower set of habitat parameters (Herkert 1994, Dornak *et* al. 2013). Other grassland birds, such as Savannah Sparrows (*Passerculus sandwichensis*) and Bobolinks (*Dolichonyx oryzivorus*), tolerate a wider range of grassland successional stages (Dornak *et al.* 2013) and may nest in shrubby, more heavily farmed, or marshy areas within their home ranges (Owens and Meyers 1973, Vickery 1996).

Breeding site selection and settling behavior of Henslow's Sparrows also make management difficult. Annual return rates for Henslow's Sparrows often are erratic, despite breeding sites being settled the previous year and seemingly

unchanged in habitat quality (Hyde 1939, Wiens 1969, Robbins 1971, Herkert 1994). Their natal return rates to breeding sites also are less predictable from year to year, as compared to the Grasshopper Sparrow and Savannah Sparrow (Dornak 2010). Adult Henslow's Sparrows usually have annual return rates ≤ 13% (Herkert *et al.* 2002), whereas Savannah Sparrows have return rates of 46.1% (Bedard and LaPointe 1984) and Grasshopper Sparrows around 50%, depending on the location (Vickery 1996). More recently, Dornak (*et al.* 2013) found that the Henslow's Sparrow frequency of occurrence was lower, and variation in abundance was greater, than for Grasshopper Sparrows and Savannah Sparrows along Breeding Bird Survey routes in all of North America. Frequency of occurrence relates to the tendency of a species to resettle the same location over multiple years, and variation in abundance relates to population numbers across years. Dornak (*et al.* 2013) used multiple spatial resolutions overlaid on Breeding Bird Survey routes, and while Henslow's Sparrow's presence could not be predicted until a spatial resolution of 126,000 km^2, Grasshopper Sparrow and Savannah Sparrow occurrences were predictable at resolutions of 32 km^2 and 3.1 km^2, respectively. Dornak *et al.* (2013) concluded that the differences among species were not due to lower abundances or detectability, but rather to Henslow's Sparrows being more nomadic in nature than other grassland sparrows. This type of flexible behavior allows for a species to adapt to tenuous food sources or habitat type that can change on a year-to-year basis if necessary (Sinclair 1984, Dean 1997), the latter being the cause of the target species' movement patterns (Dornak *et al.* 2013).

Another behavioral condition that intensifies the difficulty in predicting Henslow's Sparrow locations from year to year is its tendency to use previously settled conspecifics as a quality habitat marker (Mazur 1996), as does the Baird's Sparrow (*Ammodramus bairdii*) (Ahlering *et al.* 2006). Because of this behavior, expansive areas and, if habitat is patchy, fields that are adjacent to each other, increase the likelihood of drawing nesting Henslow's Sparrows to managed grasslands with the territorial songs of birds who have arrived first (Hyde, 1939, Wiens 1969, Mazur 1996). Thus, absent the draw of conspecifics to trigger an initial settling pattern management may be negatively affected. Low population numbers of the Henslow's Sparrow in the St. Lawrence Plain and other parts of New York State (McGowan and Corwin 2008) may make it difficult to restore a state population if there are not enough individuals to lure additional birds to prime habitat.

Local land uses, habitat value, and challenges for grassland breeding birds:

Since the invention of the steel plow in the mid-1800s, grassland ecosystems have decreased by more than 80% throughout much of North America (Knopf 1994, Noss *et al.* 1995, Brennan and Kuvlesky 2005). Less than 0.1% of native tallgrass prairie remains in parts of North America where soils and topography are advantageous to crop farming (Sampson and Knopf 1994). Between 1980 and 1999, landscape changes due to agricultural practices in the central and eastern United States have helped cause significant negative population trends in 15 of 25 grassland

bird species; these trends averaged -1.1%/year (Murphy 2003). Murphy (2003) used annual state-level Breeding Bird Surveys and U.S. Department of Agricultural statistics to show that population declines of grassland breeding birds were linked strongly to agricultural changes, regardless of migratory status (resident, short- or long-term) or nesting habits (open cupped or cavity) of the grassland bird species. These distinctions are important because they suggest that neither declining quality of overwintering habitat nor nest predation are primarily responsible for declining populations; instead, landscape changes that affect breeding habitat are the crucial reason for population declines (Murphy 2003). For example, Illinois has seen an 85-90% increase in row cropping since the 1960s, which may be partially responsible for the decline in abundance of grassland bird populations (Warner 1994).

The intensification of row cropping through recent decades has led to the widespread steep and continuous declines in grassland bird populations (Kershner and Bollinger 1996). Converting pastureland and hayfields to row crops continues to diminish available habitat for grassland birds, in concert with the mechanized plowing and synthetic fertilizer and pesticides that became more available in the 1950s (Warner 1994). For example, an increase in corn and soybean production and decrease in pastures for livestock are associated with habitat loss and grassland fragmentation (Warner 1994). Best *et al*. (1997) compared nesting success and abundance of grassland bird species in both row cropped fields and Conservation Reserve Program (CRP) fields in six mid-western states over five years. The CRP fields were voluntarily retired agriculture fields replanted in grassland vegetation and

monitored as such for ≥ 10 years. In the study, CRP fields sustained three times more species and 13.5 times more nests as row-crop fields (Best *et al.* 1997).

Landscape-level changes in agricultural practices in Jefferson County also may have negatively affected grassland bird populations at Fort Drum. In the last 20 years, hayfield area in Jefferson County has decreased by more than 8,200 ha, and corn acreage his increased by nearly 20,000 ha (NASS 2014). Despite the extensive loss of grassland habitat over recent decades, the St. Lawrence Plain still contains large amounts of agricultural grassland that may benefit grassland-breeding birds (USFWS 2007). The St. Lawrence River Plain physiographic region encompasses nearly 12 M ha of southeastern Canada and northern portions of New York and Vermont (Ruth 2006). As of 2007, Lewis, Jefferson, and St. Lawrence counties in northern New York alone provided over 2 M ha of farmland that has grassland bird breeding habitat potential in pastures and hayfields (USDA 2014). These counties and others in the northern New York region also have a high proportion of Amish farmers who may potentially benefit grassland birds more than contemporary farmers with much more land, because they use different farming methods (personal communication, Susan Willson, St. Lawrence University, Canton, NY). The first large movement of Amish to the area was in 1974, as they sought large, affordable land parcels to support large families (Mende 2013). The Amish use older, pre-industrialization farming practices with a less intensive mowing schedule that allows nestlings to fledge, and use slower draft horses to mow fields instead of machinery, which also gives birds more time to escape the haying process (personal

communication, Susan Willson, St. Lawrence University, Canton, NY). Wilson believes the Amish and their unique farming styles create pocket refuges for grassland birds in the area that modern farming practices do not provide.

Traditional Amish farming styles are reminiscent of 1940s farming practices in the St. Lawrence River Plain region. Before Fort Drum was established, the area primarily consisted of farmland maintained as the Amish do now; the military base was established by merging small farming communities that included large tracts of grasslands (personal communication, Jeff Bolsinger, Fort Drum Fish and Wildlife Management Program). Some open grassland areas remain important to the military base for training purposes and also for their value as early successional habitat (U.S. AGFD 2011). Fort Drum recognizes the ecological benefits of grassland habitat and already has taken measures to support this and other disturbance-dependent systems (U.S. AGFD 2011). In 2005, Fort Drum's Fish and Wildlife Management Program, along with the Forestry Program, began a long-term management project to sustain early successional landscape types of varying age classes in 2 ha blocks in training area 14E. Approximately one third of the 48.5 ha will be cut by the Forestry Program roughly every 30 years (U.S. AGFD 2011). The site will eventually have a parking lot and educational center added to explain the management steps and the importance of early successional management (U.S. AGFD 2011). In 2007, the same management scheme was started in training area 7A, and future plans are to include portions of training areas 3C, 6A, 7G, and 17B, which comprise about 242 ha of early

successional forests that will be managed as a mosaic of early successional habitats, each of which will begin as a clear cut (U.S. AGFD 2011).

Training areas 12 and 13 are the largest continuous grassland areas at Fort Drum; they are important for military training experience in grassland environments as well as for their ecological role in adding to the breeding grounds of grassland breeding birds in the Northeast United States. During their study of the abundance and distribution of obligate grassland breeding birds in New England and New York State, Shriver *et al.* (2005) noted that Henslow's Sparrows in the region had the greatest relative abundance and were most common in the St. Lawrence Plain. The grassland landscape on and surrounding Fort Drum in northern New York is critical for the breeding habitat of the Henslow's Sparrow and other obligate grassland breeding birds. Sustaining this large grassland and its viability as grassland bird breeding habitat is important and manageable with flexible techniques that still keep the military establishment's primary training goals in mind.

Management treatments for the Henslow's Sparrow and recommendations for Fort Drum, NY:

Disturbance regimes are necessary to preserve early successional grassland states in the northeastern United States (Shriver *et al.* 2005). The type of disturbance, intensity, and timing all factor into the resulting vegetative composition and heavily influence whether Henlsow's Sparrows will occupy the area (Reinking *et al.* 2000). In

the Midwest, warm season grassland habitat is maintained by routine burning (Dickerson *et al.* 1997, Sample and Mossman 1997) because warm season grasses evolved in a frequent-fire environment (Dickerson *et al.* 1997). Typically, an early spring (March and April) rotational burning regime of 3-5 yr is advised to keep a sound habitat structure (Sample and Mossman 1997). Burning destroys litter accumulation and extra biomass from seasons past and adds nitrogen-rich ash to the soil (Dickerson *et al.* 1997). However, this burning regime is most successful with wildlife species that possess more general habitat preferences than the Henlsow's Sparrow (Sample and Mossman 1997). It will not provide the dense litter layer or standing dead vegetation Henslow's Sparrows require for perch points (Sample and Mossman 1997). Additionally, Henlsow's Sparrows avoid recently burned areas until preferred vegetation characteristics regrow after several years (Zimmerman 1988, Reinking 2000, Walk and Warner 2000).

Grasslands dominated by native warm season grasslands occurred historically in some northeastern habitats with well-drained soils (Dickerson *et al.* 1997). However, cool season grasses currently dominate most grasslands in the northeastern United States because they do well in the cooler climates and are more resistant to wetter soils and frost heaving (Dickerson *et al.* 1997). Cool season grasses produce the most biomass when the weather is more moderate, typically in the spring and late fall, than at the height of summer (Dickerson *et al.* 1997). These grasses do not respond well to fire, so using prescribed spring burn to promote cool season grasses would have a negative effect on grassland management (Mitchell and Malecki 2000).

Specifically, spring burns do not promote the growth of cool season grasses as intended and do not kill shrubs or reduce their height or frequency. Norment (1999) and Mitchell and Malecki (2000) found that spring burns of cool season grasslands promote goldenrod (*Solidago spp.*) and invading shrub growth after the burn treatment in old fields in central and western New York. Hanson (1994) hypothesized that high densities of *Solidago* tend to create patches of homogeneous vegetation that have no ground cover for many nesting obligate grassland breeding birds. Mazur's (1996) research supported this idea; Henslow's Sparrows were absent from any fields overrun with *Solidago* spp. in Central New York. Because Henslow's Sparrows seem to be very sensitive to fire-management treatments (Zimmerman 1993, Norment 1999, Reinking 2000), this type of treatment should especially be avoided in cool season grasslands.

Grazing is another management tool used to maintain early successional grassland environments. Moderate to heavy grazing results in some woody vegetation control, litter removal, reduced density of vegetation, and a more varied vegetation structure because cattle graze unevenly (Sample and Mossman 1997). Typical grazing in the Midwest is focused on the animals eating their fill and getting as much forage as possible (Walk and Warner 2000). Habitat resulting from this type of grazing can be tolerated by habitat generalists, but more sensitive species like the Henslow's Sparrow can tolerate only low-intensity grazing (Skinner *et al.* 1984, Sample and Mossman 1997). Walk and Warner (2000) observed that five grassland bird species, including the Henslow's Sparrow, responded well to light, short

duration, late season grazing. Smith (1997) found that Henlsow's Sparrows responded well to a stocking rate of 0.12 to 0.25 head of cattle per ha in the Finger Lakes National Forest in Central New York.

Grazing may be a useful tool for slowing shrub growth within the grasslands if the right livestock is used. Smaller ungulates like sheep and goats have less impact on the soils by being lighter and having smaller hooves than cattle and causing less damage to grasses by trampling. Unlike cattle, goats are browsers and prefer woody vegetation and forbs to grasses (Squires 1982, Bull 2000). They are easier to transport than cattle and can be confined to specific locations with portable electric fencing. Removing the animals quickly and easily would be a benefit to a multi-use facility like Fort Drum if both vegetation management and training schedules were on a rotational basis and using the same lands. Experimental plots could be manned by an intern from a local agricultural college or a local farmer interested in using livestock as a means of vegetation control. However, grazing livestock on an active military installation such as Ft. Drum would probably introduce logistical issues and added responsibility to the Environmental Division.

Mowing is one of the most common forms of vegetation manipulation and is used to maintain grasslands and other early successional environments (Walsh 2003). It affects the ecology of the environment by changing the natural succession pattern and preventing or retarding invasive woody vegetation (Walsh 2003). For grassland birds, care must be taken to mow in a timely manner to avoid destroying nests or fledglings (Walsh 2003). Considerations include timing of mowing, pattern of

cutting, height of blade (Walsh 2003, Ochterski 2006), and percentage of habitat mowed per season (Herkert 1994). The earliest and latest breeding dates for Henslow's Sparrows in New York State are 17 May to 5 July for egg laying and 19 June to 30 July for fledglings in nests (McGowan and Corwin 2008). Krebs (2002) found that the breeding season for Henslow's Sparrows at Fort Drum extended from 20 May to 30 July but noted that one pair of Henslow's Sparrows extended the breeding season to 10 August with a second brood. Therefore, grassland birds, and especially Henlsow's Sparrows, need time when fields are left undisturbed for the entire breeding season, making second broods possible. Many obligate grassland breeding birds settle and fledge young in the same general time period from May through June, but Henslow's Sparrows encompass them all by arriving on the nesting grounds in mid- to late-April and potentially having a second brood that might not fledge until mid-August (Krebs 2002, Herkert 2003). Given these observations, mowing should be withheld from April 15 to August 15 to account for grassland birds settling before breeding and the possibility of a late season second brood (Smith 1992, Mazur 1996, Herkert 2003).

Landscape managers have a few options with mowing patterns and equipment that may protect grassland birds and their nests (Ochterski 2006). A minimum mower bar height of at least 15 cm reduces the chance of nest destruction and still provides a bit of cover for grassland birds (Ochterski 2006). A flushing bar can also be attached to the mower to encourage birds to vacate the grasses in front of the mower, but this has been more effective for gamebirds than grassland passerines that are more

affected by the destruction of adequate cover (Ochterski 2006). To maintain cover for flushing songbirds, managers can mow an area starting from the center of the field and working toward the outside edges. This allows birds and other animals to escape outward and still be protected by cover from predators (Ochterski 2006). If there is adjacent grassland habitat, managers can also work from the outer edge toward this untouched area to encourage birds to flush to this unmanaged portion of habitat (Ochterski 2006).

It is important to consider field size, shape, and mowing frequency when developing a mowing plan for manage for obligate grassland breeding birds. Mazur (1996) observed that at Saratoga National Historical Park in New York, where fields ranged from 3 to 20 ha, most Henlsow's Sparrows nested in fields greater than 8 ha, but individuals first established residence in larger fields. This behavior is consistent with other studies (Smith and Smith 1992, Herkert 1994) and shows that while larger habitat expanses are preferred by Henslow's Sparrows, smaller fields of 8 ha can still sustain successful breeding pairs (Mazur 1996). Henslow's Sparrows occupy fields of ≥ 30 ha in Central New York (Smith 1997) and 30 ha is the minimum suggested size for maintaining Henslow's Sparrow habitat based on occupancy rates (Zimmerman 1988, Smith and Smith 1990, Lazazzero 2006). Managers that use mowing in large continuous areas can mow patches of 8 ha blocks in a patchwork pattern that allows for different vegetation ages to grow. Lazazzero and Norment (2006) described one CRP field in which this approach was used successfully. The patchwork consisted of a 58 ha field with alternating sections of four mowed and

three unmowed areas. Each unmowed area was last mowed three years earlier, allowing for preferred grassland bird habitat for many species. Obligate grassland breeding bird richness was relatively high compared to other fields in the study and eight Henslow's Sparrows were located within the older, three year's growth blocks (Lazzazero and Norment 2006).

Square or circular fields are more successful breeding sites than irregularly shaped areas because they have less edge effect and lower predator abundance (Winter and Faaborg 1999, Hill and Diefenbach 2014). Fields that are next to each other or close enough for birds to hear competing territorial song are beneficial because Henslow's Sparrows exhibit clustering behavior (Hyde, 1939, Wiens 1969, Mazur 1996). I recommend that Fort Drum's LRAM (Land Rehabilitation and Maintenance) Program mow in broad rectangular, square, or circular shapes in a center-to-perimeter mowing pattern. These specifications are particular to Henslow's Sparrow's response to habitat manipulation, but can also aid or not adversely affect other obligate grassland breeding birds in the same habitat.

Grasslands like those at Fort Drum, which are dominated by cool season grasses, may benefit from a 2-3 year mowing rotation, which usually is enough to halt woody vegetation overgrowth and still allow other vegetation to proliferate (Byre 1997). However, Henslow's Sparrows will abandon fields that are mowed during the breeding season or have been mowed the previous fall because the vegetation lacks sufficient height and density and litter accumulation (Herkert 1994, Sample and Mossman 1997). Henslow's Sparrows typically return to mowed sites 3 to 4 years

after treatment when the habitat regains its litter layer and tall, dense configuration of grasses (Mazur 1996). Bollinger (1995) found that five grassland breeding birds, including Henslow's Sparrows, selected more mature hayfields. These older fields gave thicker litter cover and more vegetation diversity and richness, with grass-dominated habitat, although sometimes in patchy stands (Bollinger 1995).

Fort Drum personnel regularly use a 3- to 4- year mowing scheme and find that, by the third breeding season following mowing, the litter layer is appropriate and Henslow's Sparrows will nest (personal communication, Jeff Bolsinger, Fort Drum Fish and Wildlife Management Program). Currently, there are approximately 1557 ha of grassland within training areas 12 and 13 (personal communication, Ian Warden, Fort Drum Land Rehabilitation and Maintenance (LRAM) Program), and this continuous grassland area is most important to grassland breeding birds (Figure 2). Over the last three years (2011-2013), LRAM personnel have mowed approximately 832 ha/yr (personal communication, Ian Warden, Fort Drum Land Rehabilitation and Maintenance (LRAM) Program). If the staff at Fort Drum used a similar patchwork mowing method as stated earlier, a rotational 3-year mowing plan could be implemented the sections of area planned with future military training projects in mind. This alternating and less intense management scheme may free up time and financial resources in more expensive endeavors, such as transitioning some shrubland to grassland in the most overgrown areas. The cost to maintain grassland habitat at Fort Drum is approximately $250/ha, whereas converting shrubland to grassland increases to $488/ha, and forested area to grassland costs $750/ha,

respectively (personal communication, Ian Warden, Fort Drum Land Rehabilitation and Maintenance (LRAM) Program).

Herbicides are also a useful, and potentially very precise, management tool to control individual vegetation types in early successional environments (Walsh 2003). Persistent and expanding shrub clumps can be controlled by mowing plants in the late fall when energy stores are already within the roots, and immediately spraying the cut stems with herbicide to kill the remaining underground biomass (Walsh 2003, Ferrell *et al.* 2013). Targeting the unwanted vegetation by selecting a narrow spectrum herbicide and treating specific plants in specific locations limits the chances of other plants and animals in the same environment being harmed (Walsh 2003) and allows managers to decide which individual plants will remain, if wanted, for perch points or vegetation diversity (Norment 1999). It is important to note the active ingredient in herbicides and choose one that will be the least harmful to neighboring vegetation and wildlife. Amphibians are greatly affected by pesticides, and toxins are found in individuals when the habitat is contaminated (Sparling *et al.* 2001). Decreased populations of amphibians are connected with agricultural pesticide use on sites upwind from amphibian habitat (Davidson *et al.* 2001, 2002). Both direct and community-wide implications occur with pesticide contamination (Relyea *et al.* 2005). Relyea *et al.* (2005) found that Roundup, a common agricultural pesticide with a toxic surfactant, created a 40% reduction in tadpole survival. Fortunately, managers at Fort Drum spot-treat shrubs and use Garlon 4 Ultra, which has triclopyr

as an active ingredient, which is a non-endocrine disrupting chemical (Durkin and Diamond 2002).

In summary, Fort Drum's location in the St. Lawrence River Valley and its large grasslands on the installation make it valuable for grassland breeding birds. In order to protect Ft. Drum's grassland habitat, I recommend mowing as the best method to reduce invasion by forbs such as goldenrod and woody plants and to keep the area open for Henslow's Sparrows and other obligate grassland breeding birds.

If management for Henslow's Sparrows is desired, I recommend:

1). Managing grasslands by using a 3- to 4-year mowing cycle. By doing this, the vegetation will be in various stages throughout the breeding season and will be inviting to many grassland breeding birds with varying habitat preferences (Herkert *et al.* 1996). Initiating a patchwork pattern with specific sections mowed and others unmowed will facilitate species richness and provide desirable habitats for habitat specialists like the Henslow's Sparrow in the older plot segments (Lazzazero and Norment 2006).

2). Ideally, the size of mowed patches should not be smaller than 8 ha, a relatively small size for area-sensitive grassland birds, but which sometimes supports breeding Henslow's Sparrows (Mazur 1996, Lazazzero and Norment 2006).

3). The shape of mowed patches should either be circular or as square as possible to increase potential nesting area and reduce edge effect (Winter and Faaborg 1999, Hill and Diefenbach 2014). Some grassland birds and Henslow's Sparrows, especially, are sensitive to edge effect, which can potentially increase predation (Helzer and

Jelinski 1999, Winter and Faaborg 1999, Herkert *et al.* 2003) or lead to edge avoidance.

3). Mowing should start in the center of the area and move outward. This allows for birds already in the area to flush to other grassland habitat with a lower chance of mortality (Ochterski 2006).

4). The height of the mowing bar should stay above 15 cm to reduce the chance of nest destruction and still allow for some cover for grassland birds (Ochterski 2006).

5). Timing of mowing: Ideally, mowing would not occur between April 15 through August 15 to allow for Henslow's Sparrows to nest and to accommodate a second brood (Smith 1992, Mazur 1996, Herkert 2003). However, management and military activities may necessitate mowing outside of these dates. If this is necessary, it would be best to refrain from mowing between about May 20 and July 15, to allow for settled Henslow's Sparrows and other grassland birds to raise their young.

6). For shrub management, spot-treating woody vegetation with Garlon 4 Ultra as managers have been doing is a good option, as it is one of the least destructive to non-target organisms. Keeping some shrubs is encouraged because they are used as perch points for Henslow's Sparrows and are used by other grassland birds (Sample and Mossman 1997, Norment 1999). It is possible to manage for Henslow's Sparrows while maintaining varied habitat for grassland generalists, and preserving species richness.

7). Do not manage with fire to promote cool-season grassland habitat. Henslow's Sparrows avoid habitat that has been burned within two years, because it lacks the

dense litter and standing vegetation characteristics of breeding habitat (Zimmerman 1988, Reinking 2000, Walk and Warner 2000). Also, burning is not a good control method for shrubs and will not promote cool-season grass growth (Mitchell and Malecki 2000). Spring burns of cool season grasslands in New York promote goldenrod (*Solidago spp.*) and invading shrub growth (Norment 1999, Mitchell and Malecki 2000).

8). Coordination among all land management entities is key to creating a scheme that will suit the needs of the military base for both training and environmental purposes.

9). Since Henslow's Sparrows are drawn to breeding sites by the presence of conspecifics, managers could attempt using song playback to lure initial males into breeding grounds in the beginning of the season.

10). Monitor managed areas regularly during the breeding season and collect pertinent data for future progress reports.

The above comments are my suggestions for managers at Fort Drum on the most effective way to manage for the Henslow's Sparrow. However, Henlsow's Sparrows populations are low throughout New York State, including in Jefferson County, have low natal return rates, are very specialized in their grassland habitat preferences, and are nomadic. These characteristics do not lend themselves well to a long-term management scheme. Additionally, Fort Drum itself is continually adjusting its land management needs to support training activities. While it is feasible to create this species-specific management plan for Henslow's Sparrows, I would recommend opting for a guild-wide approach and managing for grassland bird species

richness and diversity and a healthy grassland system. Managing the entire continuous grassland area in Training Areas 12 and 13 for Henslow's Sparrows and other grassland birds is not practical for a multi-use facility such as Fort Drum. However, implementing an experimental plot with a multi-aged patchwork treatment area would potentially provide Henslow's Sparrows with patches of high-quality habitat, as well as areas for more generalist obligate grassland bird species.

Literature Cited:

Ahlering, M.A., D.H. Johnson and J. Faaborg. 2006. Conspecific attraction in a grassland bird, the Baird's Sparrow. Journal of Field Ornithology. 77: 365-371.

Bedard, J. and G. LaPonte. 1984. Banding returns, arrival times, and site fidelity in the Savannah Sparrow. Wilson Bulletin. 96: 196-205.

Best, L. B., H. Campa III, K. E. Kemp, R. J. Robel, M. R. Ryan, J. A. Savidge, H. P. Weeks, and S. R. Winterstein. 1997. Bird abundance and nesting in CRP fields and cropland in the Midwest: A regional approach. Wildlife Society Bulletin. 25: 864-877.

Bollinger, E.K. 1995. Successional changes and habitat selection in hayfield bird communities. Auk. 112: 720-730.

Bollinger, E.K. and T.A. Gavin. 2004. Responses of nesting Bobolinks (*Dolichonyx oryzivorus*) to habitat edges. The Auk. 3: 767-776.

Brennan, L.A. and W.P. Kuvlesky. 2005. North American grassland birds: An unfolding conservation crisis? The Journal of Wildlife Management. 69:1-13.

Bull, B. 2000. Using goats for vegetation management. [Online.] The Samuel Roberts Noble Foundation, Inc., Ardmore, Oklahoma. Available at: http://www.noble.org/ag/livestock/goatvegetation/

Byre, V. J. 1997. Birds *in* The Tallgrass Restoration Handbook: For Prairies, Savannas, and Woodlands. Island Press, Washington, D.C. 327–338.

Coppedge, B.R., D.M. Engle, R.E. Masters, and M.S. Gregory. 2001. Avian response to landscape change in fragmented southern Great Plains grasslands. Ecological applications. 11: 47-59.

Davidson, C., H.B. Shafer, and M.R. Jennings. 2001. Declines of the California red-legged frog: climate, UV-B, habitat, and pesticides hypotheses. Ecological Applications. 11: 464-479.

Davidson, C., H.B. Shafer, and M.R. Jennings. 2002. Spatial tests of the pesticide drift, habitat destruction, UV-B, and climate-change hypotheses for California amphibian declines. Conservation Biology. 16: 1588-1601.

Dean, W.R.J. 1997. The distribution and biology of nomadic birds in the Karoo, South Africa. Journal of Biogeography. 24: 769-779.

Dickerson, J., B. Poole, B. Wark, D. Burgdorf, T. Bush, C. Miller, and R. Maher. 1997. Vegetating with native grasses in Northeastern North America. Natural Resource Conservation Service. 1-63.

Dornak, L.L. 2010. Breeding patterns of Henslow's Sparrow and sympatric grassland sparrow species. Wilson Journal of Ornithology. 122: 635–645.

Dornak, L.L., Barve, N, and A.T. Peterson. 2013. Spatial scaling of prevalence and population variation in three grassland sparrows. Condor. 115: 186-197.

Durkin, P and G. Diamond. 2002. Neurotoxicity, immunotoxicity, and endocrine disruption with specific commentary on glysophate, triclopyr, and hexazinone: final report. Syracuse Environmental Research Associates, Inc. USGS Forest Service, BPA: 01-3187-0150. Fayetteville, New York.

Ferrell, J, K. Langeland, and B. Sellers. 2013. Herbicide application techniques for woody plant control. Florida Cooperative Extension Service, Institute of Food and Agricultural Science, SS-AGR-260. University of Florida. [Online.] Available at: http://edis.ifas.ufl.edu/ag245

Fritzell, E.K. 1978. Habitat use by prairie raccoons during the waterfowl breeding season. Journal of Wildlife Management. 42: 118-127.

Gates, J.E. and L.W. Gysel. 1978. Avian nest dispersion and fledging success in field-forest ecotones. Ecology. 59: 871–883.

Graves, B.M., A.D. Roderwald, and S.D. Hull. 2010. Influence of woody vegetation on grassland birds within reclaimed surface mines. Wilson Journal of Ornithology. 122: 646-664.

Hanson, L. 1994. The Henslow's Sparrow (*Ammodramus henslowii*) of Minnesota: population status and breeding habitat analysis. Thesis, Central Michigan University, Mount Pleasant. 1-39.

Helzer, C.J. and D.E. Jelinski. 1999. The relative importance of patch area and perimeter-area ratio to grassland breeding birds. Ecological Applications. 9:1448–1458.

Herkert, J.R. 1994. Status and habitat selection of the Henslow's Sparrow in Illinois. Wilson Bulletin. 106: 35-45.

Herkert, J. R. 2003. Effects of management practices on grassland birds: Henslow's Sparrow, Version 12DEC2003. Northern Prairie Wildlife Research Center, Jamestown, ND. Northern Prairie Wildlife Research Center. [Online.]

Available at:

http://www.npwrc.usgs.gov/resource/literatr/grasbird/hesp/hesp.htm.

Herkert, J.R., D.W. Sample, and R.E. Warner. 1996. Management of Midwestern grassland landscapes for the conservation of migratory birds. Pages 89-116 *in* F.R. Thompson III, editor, Managing Midwest landscapes for the conservation of Neotropical migratory birds. General Technical Report NC-187. USDA Forest Service, Washington, DC.

Herkert, J.R., P.D. Vickery, and D.E. Kroodsma. 2002. Henslow's Sparrow (*Ammodramus henslowii*). In A. Poole and F. Gill, eds. The birds of North America,number 672. Philadelphia, Pennsylvania.

Herkert, J. R., P. D. Vickery, and D. E. Kroodsma. 2013. Henslow's Sparrow (*Ammodramus henslowii*), The Birds of North America Online. Ithaca: Cornell Lab of Ornithology, Ithaca, New York. Available at: http://bna.birds.cornell.edu/bna/species/672doi:10.2173/bna.672

Hill, J.M. and D.R. Diefenbach. 2014. Grassland sparrow populations in a forested Pennsylvania landscape. Conservation Biology. 00:1-10.

Hyde, S. 1939. The life history of Henslow's Sparrow, *Passerherbulus henslowii.* (Audubon). Miscellaneous publication No. 41, Museum of Zoology. University of Michigan Press, Ann Arbor, Michigan.

Kahl, R.B., T.S. Baskett, J.A. Ellis, and J.N. Burroughs. 1985. Characteristics of summer habitats of selected nongame birds in Missouri. University of Missouri-Columbia, College of Agriculture, Agriculture Experiment Station,

Research Bulletin 1056.

Kershner, E.L. and E.K. Bollinger. 1996. Reproductive success of grassland birds at east-central Illinois airports. American Midland Naturalist. 136: 358-366.

Knopf, F.L. 1994. Avian assemblages on altered grasslands. Studies in Avian Biology. 15: 247-257.

Krebs, R. 2002. The breeding ecology of, and effects of military activity on, the Henslow's Sparrow at Fort, Drum, New York. Masters Thesis. The College at Brockport, Brockport, New York.

Lazazzaro, S. 2006. A multi-scale analysis of grassland bird habitat relationships in the St. Lawrence River Valley, NY. Thesis. State University of New York at The College at Brockport, Brockport, New York.

Lazazzero, S and C.J. Norment. 2006. A multi-scale analysis of grassland bird habitat relations in the St. Lawrence River Valley. The Nature Conservancy and The Research Foundation of the State University of New York, No. NYHER 031008. The College at Brockport, State University of New York, Brockport, New York.

Martin, T.E. 1993. Nest predation and nest sites. BioScience. 43: 523-532.

Mazur, R. 1996. Implications of field management for Henslow's Sparrow habitat at Saratoga National Historical Park, New York. Thesis. State University of New York College of Environmental Science and Forestry, Syracuse, NY.

McGowan, K. J. and K. Corwin. 2008. Henslow's sparrow. Pages 558-559 *in* K. J.

and K. Corwin, editors. The second atlas of breeding birds in New York State. Comstock Publishing Associates. Ithaca, New York.

Mende, S. 2013. Faith, food, fellowship: A rare glimpse of Amish life in the north country. Watertown Daily Times. Johnson Newspaper Corporation, Watertown, New York.

Mitchell, L. R. and R. A. Malecki. 2000. Use of prescribed fire for management of old fields in the Northeast. 000-000, L.A. Brennan, editor. National Congress on Fire Ecology, Prevention, and Management Proceedings, No. 1. Tall Timbers Research Station, Tallahassee, Florida.

Monroe, M.S. and G. Ritchison. 2005. Breeding biology of Henslow's Sparrow on reclaimed coal mine grasslands in Kentucky. Journal of Field Ornithology. 76: 143-149.

Murphy, M.T. 2003. Avian population trends within the evolving agricultural landscape of Eastern and Central United States. The Auk. 120:20-34.

NASS (National Agricultural Statistics Service). 2014. [Online.] United States Department of Agriculture. Available at: http://www.nass.usda.gov/Statistics_by_Subject/Environmental/index.asp

Norment, CN. 1999. Effects of grassland bird management on nongame bird community structure and productivity. U.S. Fish and Wildlife Service and the Research Foundation of State University of New York. Agreement No. 14-48-0005-94-9055.

Noss, R.F., E.T. Laroe, and J.M. Scott. 1995. Endangered ecosystems of the United

States: a preliminary assessment of loss and degradation. Report No. 0611-R-01 (MF). National Biological Service, Washington, D.C., USA.

Ochterski, J. 2006. Hayfield management and grassland bird conservation. Cornell Cooperative Extension of Schuyler County, New York.

Owens, R.A., and M.T. Myers. 1973. Effects of agriculture upon populations of native passerine birds of an Alberta fescue grassland. Canadian Journal of Zoology. 51: 697–713.

Reinking, D.L., D.A. Wiedenfeld, D.H. Wolfe and R.W. Rohrbaugh, Jr. 2000. Distribution, habitat use, and nesting success of Henslow's Sparrow in Oklahoma. Prairie Naturalist. 32: 219-232.

Renfrew, R. and C.A. Ribic. 2003. Grassland passerine nest predators near edges based on video footage. Auk. 120: 371-383.

Relyea, R.A, N.M. Schoeppner and J.T. Hoverman. 2005. Pesticides and Amphibians: The importance of community context. Ecological Applications. 15: 1125-1134.

Ricklefs, R. E. 1969. An analysis of nesting mortality in birds. Smithsonian Contributions to Zoology. 9: 1-48.

Robbins, J.D. 1971. A study of Henlsow's Sparrow in Michigan. Wilson Bulletin. 83: 39-48.

Robinson, S.K., F.R. Thompson, T.M. Donovan, D.R. Whitehead, and J. Faaborg. 1995. Regional forest fragmentation and the nesting success of migratory birds. Science. 267: 1987–1990.

Ruth, J. M. 2006. Partners in Flight - U.S. Website. Version 1/4/2013. Served by the USGS Patuxent Wildlife Research Center, Laurel, Maryland, USA. Available at: http://www.partnersinflight.org

Sample, D. W. 1989. Grassland birds in southern Wisconsin: habitat preference, population trends, and response to land use changes. Thesis. University of Wisconsin, Madison, WI.

Sample, D.W and M.J. Mossman. 1997. Managing habitat for grassland birds, a guide for Wisconsin. Bureau of Integrated Science Services, Department of Natural Resources. Madison, Wisconsin.

Sampson, F. and F. Knopf. 1994. Prairie conservation in North America. Bioscience. 44:418-421.

Sauer, J. R., J. E. Hines, and J. Fallon. 2013. The North American Breeding Bird Survey, Results and Analysis 1966-2007. Version 5.15.2008. USGS Pautuxent Wildlife Research Center, Laurel, Maryland. Available at: http://www.mbrpwrc.usgs.gov/bbs/bbs.html

Shriver, G.W., A.L. Jones, P.D. Vickery, A. Weik, and J. Wells. The distribution and abundance of obligate grassland birds breeding in New England and New York. 2005. USDA Forest Service Gen. Tech. Rep. PSW-GTR-191.

Sinclair, A.R.E. 1984. The function of distance movement in vertebrates. Pages 240-258 *in* I.R. Swingland and P.J. Greenwood, editors. The ecology of animal movement. Clarendon Press, Oxford, England.

Skinner, R.M., Baskett, T.S., and M.D. Blenden. 1984. Bird Habitat on Missouri

Prairies. Terrestrial Series #14. Missouri Department of Conservation, Jefferson City, Missouri.

Smith, C.R. 1997. Use of public grazing lands by Henslow's Sparrows, Grasshopper Sparrows, and associated grassland birds in New York State. 171-186 *in* P.D.

Smith, C.R. 1992. Henslow's Sparrow, *Ammodramus henslowii*. Pages 315-330 *in* K. J. Schneider and D.M. Pence, editors. Migratory nongame birds of management concern in the Northeast. U.S. Fish and Wildlife Service, Newton Corner, Massachusetts.

Smith, D.J. and C.R. Smith. 1990. Summer bird species diversity and use of pastures by summer birds of the Finger Lakes National Forest. U.S. Department of Agriculture. Forest Service, Green Mountain National Forest, 40-1681-9-0470. Middlebury, Vermont.

Smith, D.J. and C.R. Smith. 1992. Henslow's Sparrow and Grasshopper Sparrow: a comparison of habitat use in Finger Lakes National Forest, New York. Bird Observer. 20: 187-194.

Sparling, D.W., G.M. Fellers, and L.S. McConnell. 2001. Pesticides and amphibian population declines in California, USA. Environmental Toxicology and Chemistry 20: 1591- 1595.

Squires, V.R. 1982. Dietary overlap between sheep, cattle, and goats when grazing in common. Journal of Range Management. 35:116-119.

US AGFD (US Army Garrison Fort Drum). 2011. Integrated Natural Resources

Management Plan. Natural Resources Branch, Environmental Division, Directorate of Public Works and Integrated Training Area Program, Range Branch, Training Division, Directorate of Planning, Training, Mobilization & Security, Fort Drum, New York.

USDA (USDA Census of Agriculture). 2014. United States Census of Agriculture. [Online.] United States Department of Agriculture, USA. Available at: http://www.agcensus.usda.gov/Publications/2007/index.php

USFWS (U.S. Fish and Wildlife Service). 2007. Bird conservation plan for the Lower Great Lakes/St. Lawrence Plain bird conservation region (BCR 13). Mitch Hartley, contact. U.S. Fish and Wildlife Service, Atlantic Coast Joint Venture, Sunderland, Massachusetts, USA.

Vickery, P. D., M. L. Hunter, and J. F. Wells. 1992. Evidence of incidental nest predation and its effect on nests of threatened grassland birds. Oikos. 63: 281–288.

Vickery, P.D. 1996. Grasshopper Sparrow (*Ammodramus savannarum*). *In* The birds of North America, No. 239. The Academy of Natural Sciences, Philadelphia, Pennsylvania, and The American Ornithologists' Union, Washington, DC.

Vickery, P.D., P.L. Tubaro, J.M. Cordoso da Silva, B.G. Peterjohn, J.R. Herkert, and R.B. Cavalcanti. 1999. Conservation of grassland birds in the Western Hemisphere. Studies in Avian Biology. 19:2-26.

Vickery, P.D. and J.R. Herkert. 2001. Recent advances in grassland bird research: Where do we go from here? Auk. 118: 11-15.

Vickery, P.D, J.R. Herkert, F.L. Knopf, J. Ruth and C.E. Keller. 2000. Grassland birds: An overview of threats and recommended management strategies. USDA Forest Service Proceedings RRX-P016. 74-77.

Vickery, P.D., B. Zuckerberg, A.L. Jones, W.G. Shriver, A.P. Weik. 2005. Influence of fire and other anthropogenic practices on grassland and shrubland birds in New England. Pages 139-146 *in* V. Saab, H. Powell, eds. Fire and Avian Ecology in North America. Studies in Avian Biology No. 30. Camarillo, CA: Cooper Ornithological Society.

Walk, J.W. and R.E. Warner. 2000. Grassland management for the conservation of songbirds in the Midwestern USA. Biological Conservation. 94: 165-172.

Walsh, J.A. 2003. Grassland management plan World's End, Hingham, Massachusetts. The Trustees of Reservations. 1-55.

Warner, R.E. 1994. Agricultural land use and grassland habitat in Illinois: Future shock for Midwestern birds? Conservation Biology. 8:147-156.

Weatherhead, P.J. and G.B. Blouin-Demers. 2004. Understanding avian nest predation: why ornithologists should study snakes. Journal of Avian Biology. 35: 185-190.

Wiens, J.A. 1969. An approach to the study of ecological relationships among grassland birds. Ornithological Monographs. 8: 1-93.

Wilcove, D.S. 1985. Nest predation in forest tracts and the decline of migratory

songbirds. Ecology. 66: 1211–1214.

Winter, M. 1998. Effect of habitat fragmentation on grassland-nesting birds in southwestern Missouri prairie fragments. Ph.D. dissertation. University of Missouri, Colombia, MO.

Winter, M. and J. Faaborg. 1999. Patterns of area sensitivity in grassland-nesting birds. Conservation Biology. 13: 1424-1436.

Zimmerman, J.L. 1988. Breeding season habitat selection by the Henslow's Sparrow (*Ammodramus henslowii*) in Kansas. Wilson Bulletin. 100: 17-24.

Zimmerman, J.L. 1992. Density-independent factors affecting the avian diversity of the tallgrass prairie community. Wilson Bulletin. 104: 85-94.

Zimmerman, J.L. 1993. The birds of Konza: the avian ecology of the tallgrass prairie. University Press of Kansas, Lawrence, Kansas.

Tables and Figures:

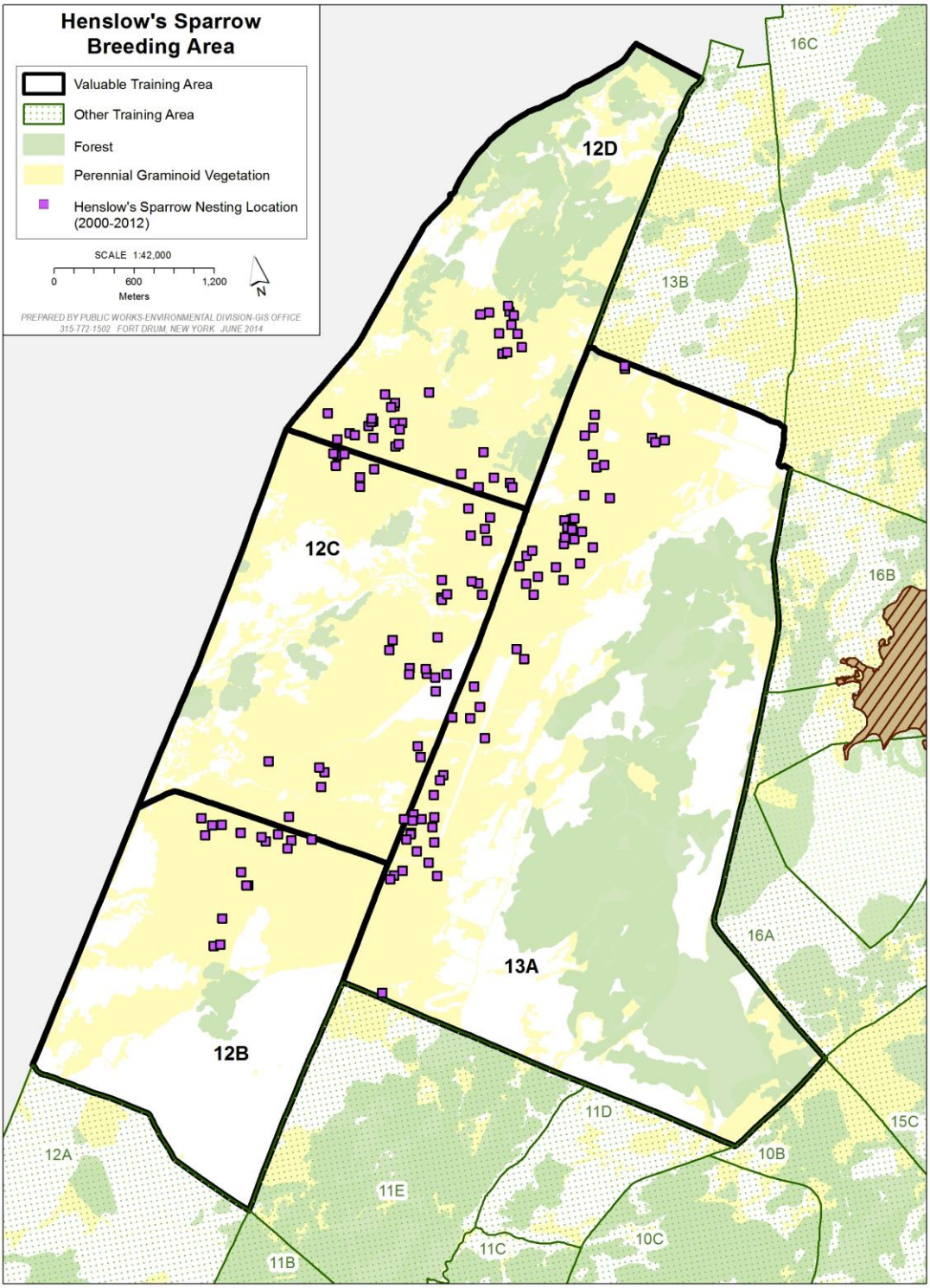

Figure 1: Important continuous grassland area within training areas 12 and 13 at Fort Drum, NY.