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Status of the Grasshopper Sparrow (*Ammodramus savannarum*) in Quebec

Carl Savignac, Benoît Jobin and Gilles Falardeau

Quebec Region

Canadian Wildlife Service
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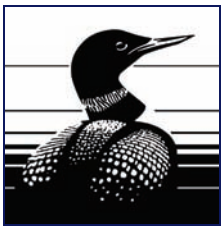

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STATUS OF THE GRASSHOPPER SPARROW (*AMMODRAMUS SAVANNARUM*) IN QUEBEC

Carl Savignac,[1] Benoît Jobin[2] and Gilles Falardeau[2]

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December 2011
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ABSTRACT

The Grasshopper Sparrow (*Ammodramus savannarum*) is a small, dull-coloured, secretive passerine found in the agricultural lowlands of southern Quebec, where it reaches its northern limits. This species breeds mainly in large hayfields, pastures and recently abandoned fields with dry, sandy soil. As elsewhere across North America, the Grasshopper Sparrow initially benefited from land clearing and agricultural development in Quebec. However, more recently, the conversion of perennial crops (forages and pastures) to intensive annual crops, habitat fragmentation and haying during the breeding season have reversed the situation, causing significant habitat loss and a marked decline in breeding success, resulting in a steep population decline of 65% in North America since 1966.

In Quebec, the species is considered a species likely to be designated threatened or vulnerable and the breeding population is estimated at 100–200 pairs. Recent data have confirmed that the species is in steep decline particularly in the Montérégie and Laurentides regions, where the species has reportedly disappeared from most occupied sites in less than 20 years due to significant habitat loss in these regions. The population in the Outaouais (Pontiac region) is currently the largest in Quebec, although it is also threatened by habitat conversion.

In Quebec, the Grasshopper Sparrow is currently found almost exclusively on private lands where the species does not benefit from any legal protection. Targeted stewardship activities would help better protect Grasshopper Sparrow habitat on private lands. Breeding habitat management and restoration activities may also benefit the species within a short period of time.

RÉSUMÉ

Le Bruant sauterelle (*Ammodramus savannarum*) est un passereau de petite taille, discret et peu coloré que l'on retrouve dans les basses-terres agricoles du sud du Québec où il atteint la limite nord de son aire de répartition. Cette espèce niche principalement dans des champs de foin, des pâturages et des jeunes friches de grande superficie au sol sec et sablonneux. Le Bruant sauterelle a bénéficié de la déforestation et du développement de l'agriculture au Québec comme ailleurs en Amérique du Nord. Plus récemment, la conversion des cultures pérennes (fourrages et pâturages) en cultures annuelles intensives, la fragmentation de l'habitat et le fauchage en période de nidification ont renversé la situation en provoquant une perte considérable de l'habitat ainsi qu'une baisse marquée du succès reproducteur, résultant en un déclin des populations de plus de 65 % depuis 1966 en Amérique du Nord.

Au Québec, l'espèce est considérée comme une espèce susceptible d'être désignée menacée ou vulnérable dont les effectifs se situeraient probablement entre 100 et 200 couples nicheurs. Des données récentes confirment que l'espèce est en déclin important notamment en Montérégie et dans les Laurentides où l'espèce aurait disparu de la plupart des sites occupés en moins de 20 ans, en raison de la perte considérable d'habitat dans ces régions. La population de l'Outaouais (région du Pontiac) est actuellement la plus importante au Québec, bien qu'elle soit également menacée par la conversion de l'habitat.

Actuellement, au Québec, l'habitat du Bruant sauterelle se trouve presque uniquement sur terres privées où il ne jouit d'aucune protection concrète. Des activités d'intendance ciblées permettraient de mieux protéger l'habitat du Bruant sauterelle sur les terres privées. L'aménagement et la restauration des habitats de nidification de cette espèce peuvent également lui être bénéfiques à court terme.

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1 INTRODUCTION

Despite a 65% decline in populations in the last 40 years (1966) in North America (Butcher and Niven 2007), the Grasshopper Sparrow (*Ammodramus savannarum)* is still only considered a candidate species[1] (intermediate priority) by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC 2010) and therefore has no legal status in Canada. In Quebec, the species has been identified as a species likely to be designated threatened or vulnerable by the ministère des Ressources naturelles et de la Faune (MRNF 2009). The purpose of this report is to provide an overview of the current status of the Grasshopper Sparrow in Quebec, with a view to a re-assessment of the species at the provincial level, as provided for under the Quebec *Act respecting threatened or vulnerable species* (R.S.Q., c. E-12.01).

2 CLASSIFICATION AND NOMENCLATURE

The Grasshopper Sparrow, first described by Johann Gmelin in 1789 from study skins from Jamaica, was initially called *Fringilla savannarum*. The Grasshopper Sparrow is a member of the order Passeriformes and the family Emberizidae which, in North America, comprises 17 genera and 49 species that include primarily dull-coloured, ground-feeding birds. The genus *Ammodramus* comprises seven species, including the Grasshopper Sparrow, one of the species of sparrows whose distribution extends over the three Americas (Rising and Beadle 1996).

There are 12 subspecies of Grasshopper Sparrow in the Americas, four of which breed north of Mexico (Vickery 1996). The eastern subspecies, *A. s. pratensis*, breeds from southern Quebec and southern Ontario south to the southern United States and from the east coast west to Wisconsin and Oklahoma. *A. s. perpallidus* (or the Western Grasshopper Sparrow) breeds, sometimes discontinuously, in western North America, from southern British Columbia and the southern Canadian Prairies south to southwestern California, central Nevada, northern Utah, central Colorado and central Texas, and possibly east to Illinois and Indiana. The Arizona Grasshopper Sparrow (*A. s. ammolegus*) breeds in southeastern Arizona, while the Florida Grasshopper Sparrow (*A. s. floridanus*) breeds in central Florida (Rising and Beadle 1996, Vickery 1996). The Grasshopper Sparrow rarely hybridizes with other species of sparrows. However, in Massachusetts, Jones et al. (2003) report a probable case of hybridization with the Savannah Sparrow (*Passerculus sandwichensis*).

[1] Candidate species are species whose status in Canada has not yet been assessed by COSEWIC but that have been identified by COSEWIC as potentially being at risk and will likely be assessed in the future (COSEWIC 2010).

3 DESCRIPTION

The Grasshopper Sparrow is a small passerine (10.5–13 cm; 15.6–20.7 g; Rising and Beadle 1996), relatively dull-coloured, with a short tail, beige-coloured bill, relatively wide pink lower mandible and rather flat head. Adults of both sexes have similar plumage, i.e. plain buff-coloured throat and breast; flanks buff and unmarked or faintly marked; underparts whitish and upperparts mottled with rust (Rising and Beadle 1996). The dark crown of the adults is divided by a pale median stripe. Lores are yellowish; supercilium grey. Cheeks are greyish-brown, and nape and sides of neck pale grey with centre of feathers rusty. Rump and uppertails are mottled with rust. Tail feathers are brown, edged in pale greyish brown, and pointed. Outer rectrices are broadly edged and tipped in white. Wing feathers are generally brown, edged in pale brown (Rising and Beadle 1996).

There are morphological differences between certain subspecies (Rising and Beadle 1996). For example, the western subspecies is more pallid than the eastern subspecies with more rusty brown and less dark brown or black on the back, and a slightly smaller bill (Rising and Beadle 1996). The Florida subspecies has a darker back and paler breast than the eastern subspecies (Rising and Beadle 1996). However, Pranty and Tucker (2006) suggest that the latter identification criteria are not always reliable in the field.

Genetic analyses of the different subspecies of Grasshopper Sparrow have demonstrated that there is little genetic differentiation among them (Pranty and Tucker 2006). The populations of Grasshopper Sparrow in North America are thought to have diverged within the past 25,000 years, too short a time period to allow for the evolution of substantial genetic differences (Pranty and Tucker 2006). Other recent analyses that sequenced thousands of base pairs of three mitochondrial genes in Emberizidae indicate that the Grasshopper Sparrow is more distantly related to the other species of the genus *Ammodramus*, but appears to be more closely related to Cassin's Sparrow (*Aimophilia cassinii*) and Bachman's Sparrow (*A. aestivalis*) because of a possible shared evolutionary history (Carson and Spicer 2003).

In Quebec, the Grasshopper Sparrow may be confused with other species of sparrows including Nelson's Sharp-tailed Sparrow (*Ammodramus nelsoni*) and Le Conte's Sparrow (*Ammodramus leconteii*). However, Nelson's Sharp-tailed Sparrow has an orange-coloured face and breast and the nape and crown are grey, while Le Conte's Sparrow can also be distinguished by its orangish face and breast and streaked flanks. However, these two species occupy very distinct habitats from those of the Grasshopper Sparrow, i.e. wet meadows. The Savannah Sparrow, which occupies the same habitat as the Grasshopper Sparrow, can be distinguished by its heavily streaked underparts and longer tail.

4 DISTRIBUTION

4.1 North America

The Grasshopper Sparrow breeds from southern Canada and the western United States to the east coast, and around the Gulf of Mexico and in Central America as far as Panama (Rising and Beadle 1996). The heart of its range is located in the Great Plains of the United States, from South Dakota to northern Texas, and east to Illinois (Sauer et al. 2003). Although widely distributed in North America, the Grasshopper Sparrow is restricted to specific habitats and is relatively scarce throughout its range (Figure 1; Vickery 1996).

In Canada, the Grasshopper Sparrow breeds in south-central British Columbia (Okanagan Valley; Campbell et al. 2001), southern Alberta (Federation of Alberta Naturalists 2007), southern Saskatchewan, southern Manitoba, southern Ontario (primarily south of the Canadian Shield; Godfrey 1986; Early 2007) and southwestern Quebec (Hainault 1996) (Figure 1; Rising and Beadle 1996; Vickery 1996).

The Grasshopper Sparrow winters from eastern North Carolina, Tennessee, Arkansas, Oklahoma, Arizona and California south to Costa Rica, including Mexico and western Central America (Rising and Beadle 1996). The species also winters in the Caribbean, from Cuba to the Bahamas. Most of the populations winter along the Gulf Coast and the Atlantic Coast from South Carolina to Florida (Rising and Beadle 1996). However, several populations of Grasshopper Sparrow are year-round residents, particularly in south-central Arizona, central Florida, Mexico, Central America (Guatemala, Belize, Honduras, Nicaragua, Costa Rica, Panama, Caribbean) and South America (Colombia, Ecuador) (Figure 1; Rising and Beadle 1996; Vickery 1996).

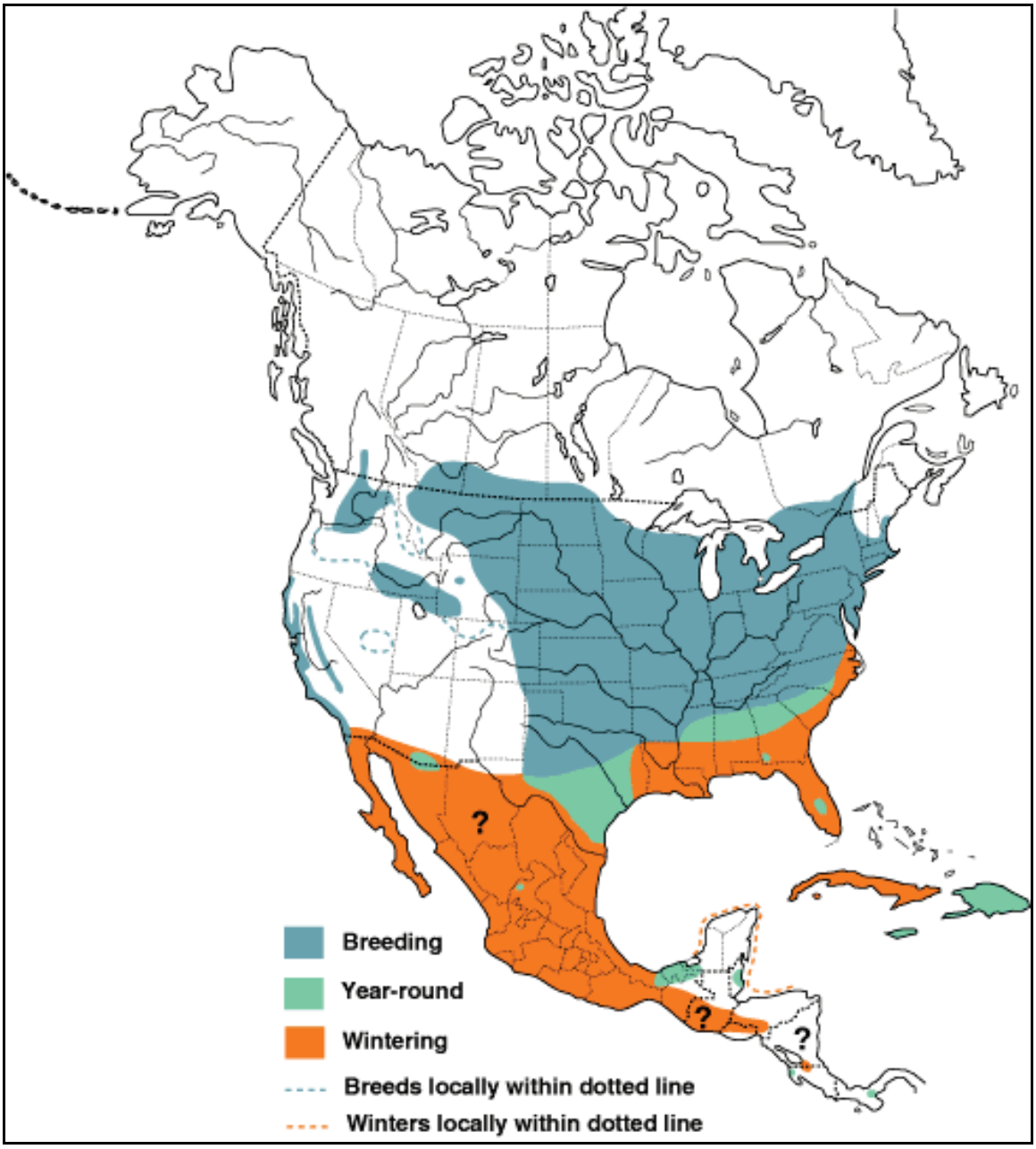

Figure 1. Distribution of the Grasshopper Sparrow in North America (from Vickery 1996, reproduced with permission from the Cornell Lab of Ornithology)

4.2 Quebec

Southern Quebec is the northeastern limit of the species' breeding grounds in North America (Figure 2; Hainault 1995). The occupied range of the Grasshopper Sparrow in Quebec since 1961 primarily includes the southern portion of the St. Lawrence Lowlands, i.e. the southeastern Laurentides region (from Lachute in the west to Saint-Jérôme in the east), the Montérégie region (from Saint-Marc-sur-Richelieu in the northeast to Powerscourt in the south and Sainte-Marthe in the west), certain areas of the Centre-du-

Québec region (Tingwick), and the southern Outaouais region (from Chichester in the west to Saint-Sixte in the east) (Figure 2; SOS-POP 2008). Males, probably unpaired, have also been observed outside the regular breeding grounds in places such as La Pocatière, in the Bas-Saint-Laurent, and near La Malbaie, in Charlevoix (not shown on the map).

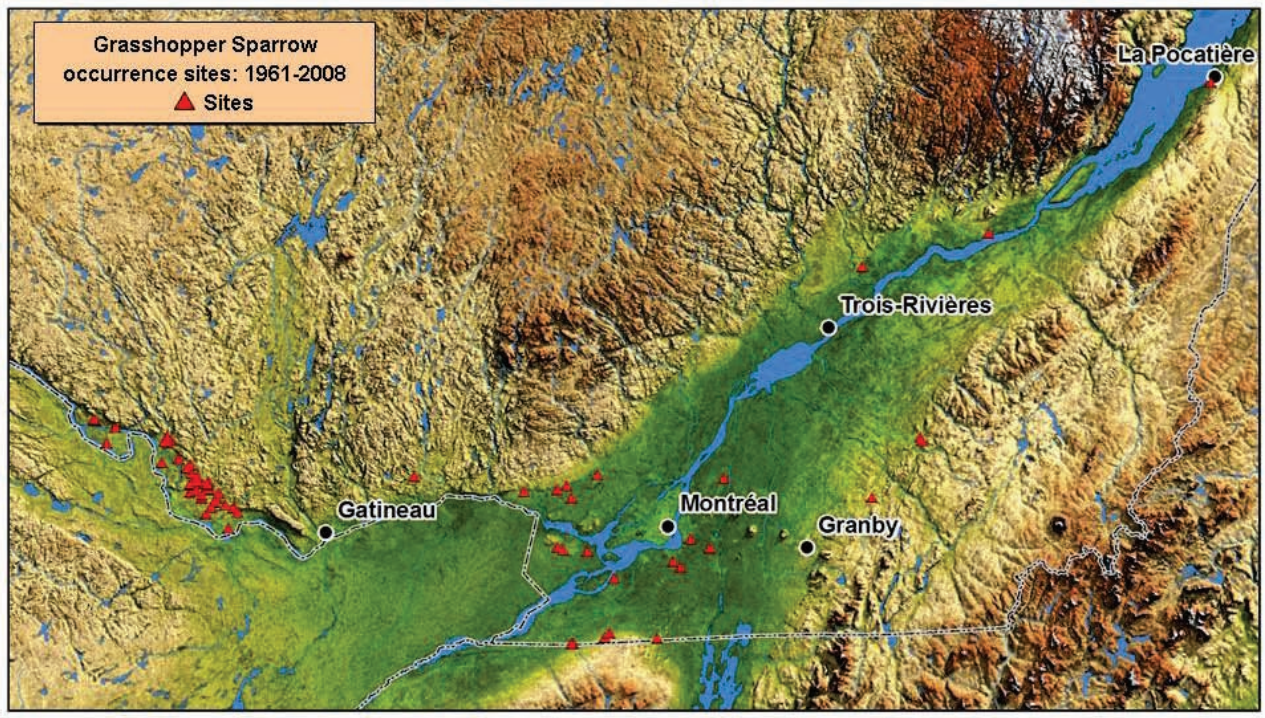

Figure 2. Distribution of Grasshopper Sparrow observations in Quebec (based on SOS-POP 2008)

5 BIOLOGY, ECOLOGY AND BEHAVIOUR

5.1 General biology

5.1.1 Diet

The Grasshopper Sparrow feeds almost exclusively on the ground in low vegetation or patches of bare ground (Vickery 1996). During the breeding season, its diet is composed primarily of grasshoppers (Orthoptera; 60%) and seeds (Vickery 1996). In Oklahoma, it feeds mainly on grasshoppers (36%), Lepidoptera larvae (20%), Coleoptera (18%), seeds (14%), Hemiptera (9%) and Araenida (4%; Wiens 1973). In the tallgrass prairies of South Dakota, its diet is composed of 31% seeds, 30% Orthoptera, 16% Lepidoptera larvae, 10% Coleoptera, 9% Hemiptera, 6% Homoptera, and less than 5% Araenida, Hymenoptera and Hemiptera (Wiens 1973). In winter, the Grasshopper Sparrow changes its diet and feeds primarily on seeds (Martin et al. 1951).

5.1.2 Breeding

In general, the Grasshopper Sparrow begins to arrive on breeding grounds in mid-April (Bent 1968; Vickery 1996), but the species arrives later in southern Canada, around mid-May (Weir 1989; Vickery 1996; Larivée 2009). Males usually arrive on breeding grounds before females, which arrive 5 to 10 days later (Vickery 1996). The males that arrive in June are possibly first-year birds migrating later than older birds or are late-arriving breeders (Wiens 1969). In the migratory subspecies, pairs form upon arrival of females on breeding grounds (Vickery 1996).

Nest building generally begins immediately after pair formation (Vickery 1996). The nest is built in two or three days by the female alone and is a simple cup on the ground covered by a dome composed of grasses or dead vegetation (Vickery 1996; Slater 2004). Mean clutch size of the Grasshopper Sparrow in North America ranges from 4.1 to 4.5 eggs (Wray et al. 1982; McNair 1987). In Ontario, the most common clutch size is 4 or 5 eggs (48 nests out of 59 nests containing eggs; Peck and James 1987). The Fichier de nidification des oiseaux du Québec (FNOQ) contains only two records of nests: one in Sainte-Marthe on May 31, 1968, which contained three eggs, and another in Saint-Lazare on June 15, 1996, which contained four young. Two other nest discoveries are recorded in the Étude des populations d'oiseaux du Québec (ÉPOQ) database (Larivée 2009), but clutch size is not mentioned. Clutch size usually decreases with nesting start date, suggesting that females lay fewer eggs following a first attempt (Sutter and Ritchison 2005; Giocomo et al. 2008).

Throughout its breeding grounds, except probably in the north, the Grasshopper Sparrow typically raises two broods a year (Wiens 1969; Vickery et al. 1992). There are no data on this subject for Quebec, but data from Ontario indicate that the species could in fact produce two broods (Peck and James 1987). First-year birds arriving later on breeding grounds (sometimes in June) usually produce only one brood (Wiens 1969). The Grasshopper Sparrow may initiate an additional brood following nest loss and may even attempt up to four broods in the same breeding season (Vickery 1996).

Incubation starts with the penultimate egg of the clutch and only the females incubate (Vickery 1996). In Ontario, viable eggs in nests have been reported between May 4 and August 12 (n = 50 dated nests; Peck and James 1987). In this province, nests with eggs found in August are probably from second clutches (Peck and James 1987). Incubation lasts 11 to 13 days in the *A. s. pratensis* subspecies (Peck and James 1987; Vickery 1996).

Nestlings are reared and fed by both adults, sometimes assisted by non-breeding adults (from neighbouring territories that have lost their broods) and unrelated juveniles (Kaspari and O'Leary 1988). The nest rearing period is relatively short and lasts about eight or nine days (Vickery 1996). In the Kingston region in Ontario, adults were reported feeding nestlings in the nest between June 5 and July 25

(Weir 1989). In New York State, the average number of nestlings produced per year was 2.3 in large fields (≥ 8 ha) and 1.3 in small fields (< 8 ha). In Tennessee, a mean number of 2.6 young fledged per nest has been reported (Giocomo et al. 2008).

In general, breeding success is highly variable and depends on predation pressure (Vickery 1996). On average, breeding success of the Grasshopper Sparrow ranges from 7% to 52% throughout its breeding grounds (Giocomo et al. 2008). In a study conducted in Tennessee and Kentucky, breeding success from egg-laying to the period of postfledging care was 41%, which is generally considered very high for this species (Giocomo et al. 2008). In Maryland, a fledging success rate of 50% to 83% was reported for the 1999–2003 period (Gill et al. 2006).

The young are unable to fly when they leave the nest, but can run through the vegetation. Both parents participate in postfledging care for a period ranging probably from 4 to 19 days (Vickery 1996). In the Kingston area in Ontario, adults feeding young barely out of nest were observed on July 7, 1985 (Weir 1989). In Quebec, young outside the nest were reported in Sainte-Marthe on June 20, 1981, as well as in Hemmingford on June 27, 2008 (accompanied by adults), and in Melboro, in the Estrie region, on July 6, 1986 (fed by an adult) (Larivée 2009). In Florida, juveniles frequently congregate in loose flocks with no parental care three or four weeks postfledging (Vickery 1996).

5.1.3 Growth, sexual maturity and longevity

There is no detailed information on the growth and adult life span of the Grasshopper Sparrow in Quebec. Elsewhere, the Grasshopper Sparrow breeds the first spring after hatching (Vickery 1996). The longevity of the Grasshopper Sparrow is generally less than three years, although a maximum longevity of 6.6 years has been reported for a bird captured in Florida (Delany et al. 1993).

5.1.4 Behaviour

Although the rate varies by region, Grasshopper Sparrows generally exhibit fairly high site fidelity (Gill et al. 2006; Jones et al. 2007). The adult return rate for all of North America ranges from 0% to 57% (Kaspari and O'Leary 1988; Vickery 1996; Balent and Norment 2003; Gill et al. 2006). The return rate is probably higher east of the Prairies (e.g. Kentucky = 15.4% [Sutter and Ritchison 2005]; New York = 33% [Balent and Norment 2003]; Maryland = 57% [Gill et al. 2006]) than in the western portion of the species range (Nebraska = 0% [Kaspari and O'Leary 1988]; Montana = 8.9% [Jones et al. 2007]). In New York State, return rates of males (29%) and females (27%; Balent and Norment 2003) are similar. In Maryland, the return rate is 57% for adult males and 41% for females (Gill et al. 2006). Finally, a lower return rate is reported for year-old birds compared to older adults, ranging from 0% to 12% (Balent and Norment 2003; Gill et al. 2006; Jones et al. 2007).

During the breeding season, males sing from exposed perches to defend their territory. Females, on the other hand, are very secretive and difficult to spot, remaining most of the time on the ground or hidden in the vegetation (Pranty and Tucker 2006). In the presence of potential predators, Grasshopper Sparrows stay close to the ground and take flight only when approached within a few metres or less. When flushed, they usually fly a short distance before dropping back to the ground. Breeding females remain on the nest and take flight only when approached within 30 cm of the nest (Pranty and Tucker 2006). When flushed, nesting females run along the ground while performing an injury distraction display (Vickery 1996). When nestlings are in the nest, adult sparrows generally land in vegetation near the nest, run to the nest and feed the young and then quickly move away again, presumably to deter predators from following them directly to the nest (Pranty and Tucker 2006).

The Grasshopper Sparrow is apparently one of the only species of Emberizidae to have two distinct songs: a primary song and a sustained song (Proppe and Ritchison 2008). The primary song is a very high, hissing, insect-like buzz preceded by two weak notes: *tik tuk tikeeeeeeeeeeeez* (Sibley 2003). This type of song is used mainly before pairing and possibly plays a role in mate attraction. This type of song usually diminishes during the breeding season (Proppe and Ritchison 2008). The sustained song, a rolling jumble of high, buzzy, slurred phrases that may last up to 15 seconds (Vickery 1996; Sibley 2003), serves primarily to alert females to the presence of potential predators and also to draw predators away from the nest. The sustained song is not heard during the period preceding pairing and usually increases during nest building. The primary song is more frequent than the sustained song (Proppe and Ritchison 2008). Finally, between March and July, the Grasshopper Sparrow regularly sings at night (Rising and Beadle 1996).

The Grasshopper Sparrow is considered a semi-colonial species (Cannings 1995; Vickery 1996). The average size of a Grasshopper Sparrow's territory is usually small (< 2 ha), and can vary depending on the type of habitat and the region (Delany et al. 1993). In British Columbia, two active nests located less than 7 m from each other have been reported (Cannings 1995). There are no precise data on territory size in Quebec. However, in the Outaouais, the density of territorial males ranges from 0.06 to 0.94 male/ha (Jobin and Falardeau 2010). These data are comparable to those obtained elsewhere in eastern North America (e.g. 12 pairs/10 ha in West Virginia [Whitmore 1981] and 3.9 to 10.2 males/10 ha in Ontario [Kennedy et al. 1999]). Breeding pair density varies significantly from year to year for the same site (e.g. 2–12 pairs/10 ha in West Virginia; Whitmore 1981). Territory size decreases during the breeding season as a result of late-arriving males establishing new territories (Wiens 1969). Territories are apparently no longer defended after the end of the last brood (Vickery 1996).

The behaviour of the Grasshopper Sparrow on wintering grounds has been studied by telemetry in the Florida subspecies (Dean 2001). According to this author, there is no territoriality among adults in winter, with males and females having common home ranges. Home ranges in winter are larger than during the

breeding season (mean size of 29.0 ha ± 5.78; range: 1.0–173.6 ha, $n = 44$). The distance covered by individuals varies considerably, up to 3.8 km, and was greater for males than for females (Dean 2001).

5.1.5 Movements

The Grasshopper Sparrow is a short-distance migrant, generally arriving on breeding grounds around mid-April and leaving in the fall, beginning in late August (Vickery 1996). In Quebec, the species arrives on breeding grounds slightly later, i.e. between early and mid-May (the earliest reported date being May 1, 1982, in Howick; Larivée 2009), and fall migration begins in early August and may be observed until October (several late observations have been reported between October 9 and 15, with the latest report being December 20, in Gatineau; Larivée 2009). Observations made in the Kingston area in Ontario also suggest that the fall migration can extend until mid-October (Weir 1989).

The Grasshopper Sparrow migrates at night and in the morning in small numbers or singly (Vickery 1996). During migration, the Grasshopper Sparrow may join mixed-species flocks with other sparrows (Vickery 1996). Orientation mechanisms used during migration are not known, but are probably similar to those used by the Savannah Sparrow, which include magnetic, stellar and solar compasses (Able and Able 1990a, b).

5.2 Habitat

5.2.1 Breeding habitat

Throughout its range, the species generally breeds in open areas with well-drained, often poor, dry soil (with bare patches), with relatively low perennial vegetation cover with few shrubs (Wiens 1969; Whitmore 1981; Peck and James 1987; Bollinger 1995, Vickery 1996; Delisle and Savidge 1997; Dechant et al. 1998; Ribic and Sample 2001; Scott et al. 2002; Balent and Norment 2003; Scheiman et al. 2003; Chapman et al. 2004; Thogmartin et al. 2006; Jobin and Falardeau 2010). In the Lake Simcoe-Rideau area in Ontario, the species primarily occupies sites on sandy moranic soil or shallow soil on limestone beds, often used as pasture (Early 2007).

The Grasshopper Sparrow occupies various types of habitats such as native and tame grasslands (Madden 1996), pastures, hayfields, grassy fields of airports, young coniferous plantations and former mining sites that have been restored to grassland (Wiens 1973; Whitmore 1981; Kantrud 1981; Peck and James 1987; Bollinger 1988; Best et al. 1995; Hull et al. 1996; Patterson and Best 1996; Delisle and Savidge 1997; Galligan et al. 2006; Jobin and Falardeau 2010). The Grasshopper Sparrow may also nest in annual row crops such as corn, wheat and barley, although densities are clearly lower than in uncultivated habitats (Basore et al. 1986; Dechant et al. 1998; McMaster and Davis 1998). The species can also be found in lands managed under the Conservation Reserve Program (CRP) in the United States and the Permanent

Cover Program (PCP) in Canada (Dechant et al. 1998; McMaster and Davis 1998). In southern Quebec, this passerine inhabits former pastureland, recently abandoned fields, hayfields and meadows located near well-drained sites, therefore often on poor, sandy soil (Hainault 1995; Jobin and Falardeau 2010).

The Grasshopper Sparrow selects its breeding habitat primarily at the landscape scale (Ribic and Sample 2001; Bakker et al. 2002; Thogmartin et al. 2006; Renfrew and Ribic 2008). In fact, fields used by the Grasshopper Sparrow are generally surrounded by grasslands and pastures with sparse forest cover; as shown in southern Quebec and Ontario as well as elsewhere in North America (Ribic and Sample 2001; Bakker et al. 2002; Grant et al. 2004; Hamer et al. 2006; Veech 2006; Thogmartin et al. 2006; Early 2007; Renfrew and Ribic 2008; Jobin and Falardeau 2010). Thogmartin et al. (2006) conclude that although the Grasshopper Sparrow responds to several landscape-scale habitat variables, climate variables such as mean annual precipitation appear to be the most important in predicting abundance of the species in the U.S. Midwest.

Within a given landscape, the Grasshopper Sparrow selects its breeding site based on various habitat components: moderate height vegetation (< 0.5 m) (Rotenberry and Wiens 1980; Patterson and Best 1996; Davis 2004; Pranty and Tucker 2006), moderate litter depth (Wiens 1969; Rotenberry and Wiens 1980; Schneider 1998; Madden et al. 2000) and high herbaceous vegetation cover (Rotenberry and Wiens 1980; Patterson and Best 1996). The Grasshopper Sparrow also requires sites with a high proportion of bare ground (between 2% and 34%; Slater 2004; Pranty and Tucker 2006) as well as sparse high plant and shrub cover used as song perches during territory establishment and defence. The species generally avoids fields where the density of vegetation (Schneider 1998; McCoy et al. 2001; Slater 2004) and the density of small shrubs (Wiens 1969) are too high. Finally, in some parts of its range, the species responds negatively to high densities of tall, dead plants (Davis 2004) and appears to prefer fields sowed with introduced forage plants (Schneider 1998; McCoy et al. 2001).

In southern Quebec, good quality habitats are generally fields with poor, dry soil, sometimes recently abandoned, that are not regularly grazed or mowed, with a sparse heterogeneous vegetation structure (Hainault 1995; Jobin et al. 2008). Perches such as mullein (*Verbascum thapsus*) stalks and shrubs are often present, although several sites used by the species in the Outaouais were regularly mowed and were lacking perches (Jobin and Falardeau 2010). More specifically, medium-height vegetation (25 cm), relatively large cover of bare soil (17%) and dead (46%) and live (36%) herbaceous vegetation, as well as moderately thick litter (4 cm) are reported. All these measurements are within the values reported by other studies carried out in North America (Jobin and Falardeau 2010). In southern Quebec, the vegetation at sites occupied by the species is often dominated by plants that prefer poor, dry environments

such as *Poa* spp., *Elytrigia repens*, *Potentilla* spp. (*argentea* and *reptans*), *Danthonia spicata*, *Fragaria virginiana* and *Phleum pratense* (Jobin and Falardeau 2010).

5.2.2 Wintering habitat

The Grasshopper Sparrow's wintering habitat is generally similar to its breeding habitat, i.e. arid grasslands with reduced vegetation cover (Vickery 1996; Gordon 2000).

5.3 Population dynamics

There is currently little information about the factors that affect the regulation and dynamics of Grasshopper Sparrow populations under natural conditions (Slater 2004). During the breeding season, food availability and interspecific competition do not appear to affect Grasshopper Sparrow populations (Slater 2004). However, predation appears to severely reduce this species' breeding success, although the long-term effects of predation are still unknown (Vickery 1996). Finally, the lack of information from the wintering grounds on winter mortality hampers our ability to understand population regulation in this species (Slater 2004).

Balent and Norment (2003) studied a fragmented population in ten habitat patches of various sizes (1.8–13.2 ha) in western New York State between 1996 and 2000. At the start of the study, eight out of ten patches were occupied by Grasshopper Sparrows. By 2000, local extinction had occurred in five of these patches (mainly the populations of the smallest patches), while colonizations occurred in two medium-sized patches (Balent and Norment 2003). In the study area, the average annual survival rate of adults in this fragmented landscape was 28%, and was more than twice as high in the large patches ($\geq$ 8 ha; 33%) compared to the smallest patches (< 8 ha; 16%; Balent and Norment 2003). These authors estimated the finite rate of increase (λ) of the Grasshopper Sparrow in a fragmented landscape at 0.46 for large fields and 0.23 for small fields, values below the critical threshold for population viability (λ=1).

A detailed analysis of the viability of Grasshopper Sparrow populations was recently conducted in one of the world's largest remaining areas of tallgrass prairie located in Kansas and Oklahoma (With et al. 2008). The seasonal fecundity rate of a population (*b*: production of female young per adult female in a given season) varied depending on the type of grassland management. This rate was significantly higher in native hayfields with prescribed burning ($b = 0.96 \pm 0.86$; n = 34 nests), but was nevertheless below the critical threshold of 1.33 required in order for a population to remain stable. The fecundity rate was low in the other types of management such as unburned native hayfields ($b = 0.43 \pm 0.50$; n = 32 nests), and was 0.59 ± 0.55 (n = 128 nests) in pasture with an intensive grazing regime and frequent prescribed burning (With et al. 2008). The estimated growth rate in this region was below the critical threshold

(λ = 0.73–0.84, n = 2 years), suggesting that this region does not support a viable Grasshopper Sparrow population (With et al. 2008).

Demographic models of Grasshopper Sparrow population including various analyses (sensitivity analysis, elasticity analysis) and stochastic models have demonstrated that annual adult survivorship is the most important parameter for population viability (Slater 2004). In south-central United States, the annual adult apparent survival probability is 44% (DeSante et al. 2006). The annual adult survivorship of Grasshopper Sparrows is generally very low and varies between 48% and 60% for the Florida subspecies (Pranty and Tucker 2006). This low rate reflects various factors including the significant increase in mortality from avian predators in this region (Pranty and Tucker 2006). The reported juvenile survivorship in a Florida population is 35.1%, while survivorship of at least 38.4% is necessary in order to maintain this population (Perkins and Vickery 2001). A second study conducted in Florida dealing with 48 males from a resident population that were captured and banded shows an annual survivorship of 60% with a mean longevity of 2.9 years (Delany et al. 1993).

5.4 Limiting factors

5.4.1 Human activities

5.4.1.1 Habitat loss

Like many other species of farmland birds, the primary cause of the decline of the Grasshopper Sparrow in North America is linked to habitat loss following cultivation of the U.S. Great Plains since the mid-19th century and the introduction of new agricultural techniques since the 1950s (Brennan and Kuvleski 2005). Habitat losses are estimated at between 88% and 99% in the tallgrass prairies in the U.S. Midwest (Samson and Knopf 1994), at 99% in native prairies in eastern Washington, Oregon and Idaho (Slater 2004), at 81% in Florida since 1950 (Pranty and Tucker 2006), and at 80% in the shortgrass prairies of Saskatchewan since the start of colonization (Davis 2004). New irrigation technologies and the introduction of new varieties better adapted to poorer soils that allow large-scale agriculture could considerably reduce the still uncultivated area of mixed shortgrass prairie in Western North America (Slater 2004). The wintering populations of Grasshopper Sparrow in Arizona are also affected by the conversion of grasslands to pasture and intensive crops over the last 120 years (Gordon 2000). Finally, in northeastern North America, the decline in Grasshopper Sparrow populations is believed to be partially attributable to plant succession following the abandonment of cultivated fields (Brennan and Kuvleski 2005). This situation is also observed in Ontario, where unproductive land is often abandoned, resulting in loss of habitat for the Grasshopper Sparrow (Early 2007).

Grasshopper Sparrow habitat trends in Quebec are essentially the same as for North America as a whole. In the Outaouais region and especially in the Montérégie and Laurentides regions, significant habitat and nesting site losses have been observed since the 1980s owing primarily to the conversion of suitable habitats to annual crops such as corn and soybeans or to coniferous plantations. More details are provided in sections 7.1.2.1 and 7.2 , which deal, respectively, with the history of the status of the Grasshopper Sparrow in Quebec and threats to its survival in Quebec.

5.4.1.2 Habitat fragmentation

Habitat fragmentation is defined as the division of large contiguous areas of habitat into smaller patches isolated from one another (Johnson 2001). Fragmentation effects fall into three main categories: patch size and number, edge effects, and patch isolation and connectivity (Forman 1995; Johnson 2001). The Grasshopper Sparrow appears to be sensitive to all three types of habitat fragmentation effects, although habitat size appears to be the most critical, i.e. the smaller the habitat patch, the less likely it is to contain breeding individuals (Herkert 1994; Bollinger 1995; Helzer and Jelinski 1999; Arguedas-Negrini 2001; Johnson and Igl 2001; Bakker et al. 2002; Balent and Norment 2003; Herkert et al. 2003; Davis 2004; Pranty and Tucker 2006; Thogmartin et al. 2006; Jobin and Falardeau 2010). The species is generally found in sites of at least 6 ha (Vickery et al. 1994; Helzer 1996; Helzer and Jelinski 1999), although the minimum size of patches used in some regions is more than 30 ha (Askins 1993; Herkert 1994), or even 100 ha (Vickery et al. 1994; Davis 2004). In New York State, breeding success is clearly higher in fields of more than 8 ha (59%) than in smaller fields (< 8 ha; 25%; Balent and Norment 2003). In the Pontiac region in Quebec, the density of territorial males is correlated with the size of the fields occupied, and the fields used by the species were generally larger than unused fields (Jobin and Falardeau 2010).

The Grasshopper Sparrow appears to be negatively associated with the presence of forest edges near its habitat (Johnson and Temple 1990; Vickery 1996; Herkert et al. 2003). The breeding success of the Grasshopper Sparrow generally increases with greater distance from forest edges and appears to be higher in the centre of grassland patches (Wiens 1969; Johnson and Temple 1990; Delisle and Savidge 1997; Bock et al. 1999; Helzer and Jelinski 1999; Balent and Norment 2003), because of a higher rate of predation near forest edges (Bock et al. 1999; Renfrew and Ribic 2003; Renfrew et al. 2005). The nest predation rate is also believed to be higher in small patches (16 to 32 ha) than in larger patches (130 to 486 ha), also owing to a higher incidence of predation near edges (Johnson and Temple 1990), which are closer in small patches. In Wisconsin, the density of Grasshopper Sparrow nests increases linearly with the distance from a forest edge (≥ 50 m) (Renfrew et al. 2005) because of the presence of common predators such as the racoon (*Procyon lotor*) which destroy a larger quantity of nests located at the edge of forest patches than within pastures (Renfrew et al. 2005).

The third effect of habitat fragmentation is patch isolation, which affects Grasshopper Sparrow breeding populations by increasing the probability of local extinction, which simultaneously reduces the likelihood of recolonization by birds from other populations (Balent and Norment 2003; Slater 2004).

5.4.1.3 Impact of livestock grazing

The Grasshopper Sparrow generally responds negatively (reduced abundance or local disappearance) to intensive livestock grazing, particularly in more arid grasslands (Bock et al. 1993; Saab et al. 1995). Intensive grazing not only reduces the abundance and height of the plants used as nesting cover, but also alters the composition and structure of grassland vegetation (Kantrud and Kologiski 1982; Holechek et al. 1989). Intensive grazing also changes the diversity and availability of insects on which many bird species feed (Quinn and Walgenbach 1990). It has also been observed that breeding success (estimated using the Mayfield method) and clutch size are higher in ungrazed grassland (70%) than in grazed grassland (25%) because of the higher biomass of insects, thicker litter, and the presence of small shrubs and denser vegetation (Sutter and Ritchison 2005). Finally, trampling by livestock is a cause of significant nest destruction for this species, ranging from 7% to 12%, depending on the stage of reproduction (Jensen et al. 1990; Renfrew and Ribic 2003; Renfrew et al. 2005).

However, the Grasshopper Sparrow responds positively to light to moderate grazing, since low grazing pressure can create habitats with a more horizontally and vertically diversified plant structure, favourable to the Grasshopper Sparrow (Kantrud 1981; Whitmore 1981; Kantrud and Kologiski 1982; Patterson and Best, 1996; Delisle and Savidge, 1997; Powell 2008).

5.4.1.4 Haying

For a number of farmland bird species that inhabit forage crops such as hayfields, haying during the breeding season is one of the main threats affecting survival of eggs, nestlings and adults (Vickery 1996). The modernization of agricultural techniques as well as a generally warmer climate promote earlier and more frequent hay cutting during the breeding season (up to two weeks earlier in some areas of northeastern North America; Martin and Gavin 1995; Jobin et al. 1996; Nocera et al. 2005). In the case of the Bobolink (*Dolichonyx oryzivorus*), Bollinger et al. (1990) have demonstrated that egg and nestling mortality can be as high as 51% in hayfields cut during the breeding season in New York State. Added to this is mortality due to nest abandonment, predation and subsequent weeding and baling operations, which increased the mortality rate to 94% (Bollinger et al. 1990). Deferring haying activities until after the breeding season appears to increase breeding pair density of the Grasshopper Sparrow at certain airports in the eastern United States (Melvin 1994 cited in Vickery 1996).

Despite the negative effects of hay cutting during the breeding season, the Grasshopper Sparrow may respond positively to hay cutting before or after this period because of the similarity of the vegetation structure with the species' preferred habitat (Ingold 2002). Haying may even be preferable to controlled burning (Bollinger 1988). In Missouri, the number of birds increased the year following hay cutting, but decreased in subsequent years due to the increase in vegetation density (Winter 1998). In Nebraska, the species occupies primarily fields that are mowed three years out of four (Delisle and Savidge 1997). In Ohio, densities are higher on restored grassland that were cut compared to other uncut grasslands (Ingold 2002).

5.4.1.5 Suppression of grassland fires

The suppression of grassland fires throughout the Grasshopper Sparrow's range since colonization has significantly reduced the quality of the habitat available for this species (Arguedas-Negrini 2001; Pranty and Tucker 2006). In addition to recycling the nutrients trapped in the plant biomass, fire shapes the structure of the vegetation by reducing, among other things, the thickness of the litter, and creates bare patches, two components of Grasshopper Sparrow breeding habitat (Vickery 1996). In addition, the suppression of natural fires in grasslands promotes forest regeneration and increases the number and size of forest patches, which adversely affect the Grasshopper Sparrow (Samson and Knof 1994; Cerovski et al. 2001).

5.4.2 Predation

Numerous studies carried out throughout the species' range indicate that predation is the greatest cause of Grasshopper Sparrow nest failure. The predation rate generally ranges from 29% to 89% according to studies (Patterson and Best 1996; Renfrew et al. 2005; Pranty and Tucker 2006; Giocomo et al. 2008).

As mentioned earlier, predation appears to be strongly associated with the degree of habitat fragmentation (Patterson and Best 1996; Herkert et al. 2003; Renfrew and Ribic 2003; Slater 2004; Renfrew et al. 2005; Galligan et al. 2006; Pranty and Tucker 2006; Giocomo et al. 2008). For instance, for five states in the U.S. Great Plains, Herkert et al. (2003) report that predation is higher in fragments of less than 100 ha than in large prairie fragments (more than 1,000 ha). Similar findings are reported from the State of Washington, where the predation rate of artificial nests and natural nests by corvids was higher in the fragmented landscapes than in the continuous landscapes (Vander Haegen et al. 2002).

Throughout its range, the Grasshopper Sparrow has varied types of predators, both terrestrial and avian. In Florida for example, the primary predatory species of the Grasshopper Sparrow is the Loggerhead Shrike (*Lanius ludovicianus*; Slater 2004). In Wisconsin, racoons and ground squirrels (*Citellus* spp.) are believed to be the main predators (Renfrew and Ribic 2003; Renfrew et al. 2005). Other predators documented throughout its range include: skunks (*Mephitis mephitis*), weasels (*Mustela* spp.), foxes

(*Vulpes* spp.), domestic cats (*Felis silvestrus*), crows (*Corvus* spp.) and several species of snakes (Vickery 1996; Herkert et al. 2003; Renfrew and Ribic 2003; Renfrew et al. 2005; Galligan et al. 2006). In Quebec, there are no detailed studies on the types of predators that may attack the Grasshopper Sparrow. However, species associated with agricultural areas such as racoons, skunks, the Red Fox (*Vulpes vulpes*) and the American Crow (*Corvus brachyrhynchos*) are probably frequent nest predators (Jobin and Picman 2002).

5.4.3 Environmental contamination

Few studies have been carried out on the potential effects of pesticides on the Grasshopper Sparrow during the breeding season. However, it has been observed that the density of Grasshopper Sparrow territories in the State of Maine declined over a period of two to five years following application of the herbicide hexazione (4 kg/ha) on low-bush blueberry (*Vaccinium angustifolia*; Vickery 1993). It is also recognized that there is a direct link between the decline in several species of farmland birds, including the Grasshopper Sparrow, and wide-scale spreading of granular pesticides in agricultural areas (Potts 1986; Mineau 2005; Mineau and Whiteside 2006). It is also generally acknowledged that although the various types of agricultural pesticides used in North America aim to eliminate insect pests such as several species of Orthoptera (Vickery 1996), they also affect several species of pollinating insects such as Lepidoptera (Cane and Tepedino 2001), which comprise major insect groups in the Grasshopper Sparrow diet.

5.4.4 Other limiting factors

5.4.4.1 Climatic variation

There are no data on the effects of climatic variation on Grasshopper Sparrow populations in Quebec. However, in the U.S. Midwest, Grasshopper Sparrow abundance is strongly influenced by climatic variation such as annual precipitation, which apparently affects the availability of food (insects), the proportion of vegetation cover and the distribution of predators and competing species (Thogmartin et al. 2006). According to these authors, climatic variables are more important than variables linked to vegetation cover composition. Assuming that there is less precipitation and more periods of drought, as predicted by climate models for the Great Plains (Knapp et al. 2002), the populations of farmland passerines such as the Grasshopper Sparrow could be directly affected (With et al. 2008).

5.4.4.2 Nest parasitism

There are no data for Quebec concerning the effect of parasitism of Grasshopper Sparrows nests by the Brown-headed Cowbird (*Molothrus ater*). However, throughout its range, the Grasshopper Sparrow is considered an infrequent host of Brown-headed Cowbird, with the rate of parasitism ranging from 0% to

8% (Peck and James 1987; Vickery 1996; Dechant et al. 1998; Peer et al. 2000; Herkert et al. 2003; Renfrew et al. 2005; Galligan et al. 2006; Giocomo et al. 2008).

5.4.4.3 Parasites and diseases

There are no data on parasites and diseases for Grasshopper Sparrow populations in Quebec. However, it is known that various species of ticks such as *Ptilonyssus sairae* (Delany et al. 2007), *Amblyomaq maculatum* and *Haemaphysalis chordeillis* (Vickery 1996) can parasitize the Grasshopper Sparrow. A rate of parasitism by *A. maculatum* of the Grasshopper Sparrow in Florida of 2.7% (n = 73 birds) was also reported for the 1989–1992 period. For the 1996–1997 period, significantly higher rates were reported in two Florida populations, i.e. 19% (n = 16) and 67% (n = 12) respectively (Delany et al. 2007). Other parasites found in the Grasshopper Sparrow in Florida include intestinal parasites (helminths) and feather mites.

5.5 Adaptability

5.5.1 Prescribed burning

The Grasshopper Sparrow responds positively to prescribed burning in its habitat and these fires could be considered an effective method for restoring the habitat of this species outside the breeding season (Coppedge et al. 2008; With et al. 2008). Frequent fires help maintain optimal vegetation cover for nesting of the Grasshopper Sparrow (Powell 2008). In Florida, Perkins et al. (2008) demonstrated that a prescribed burning regime is essential to increase the quality of the habitat of the Florida subspecies. In areas subject to prescribed burning, the Grasshopper Sparrow avoids breeding in the year of a fire, but generally increases in abundance in the two to four years after a fire, following the appearance of more suitable vegetation structure (moderate height and cover) (Huber and Steuter 1984; Johnson 1997; Madden et al. 1999; Powell 2008). However, if the fire occurs during a year of drought or in shortgrass prairies, the abundance of Grasshopper Sparrow declines, since the vegetation becomes too short to be suitable for nesting (Zimmerman 1992; Vickery et al. 2000).

5.5.2 Land conversion programs

The Grasshopper Sparrow adapts well to activities aimed at restoring soil productivity of marginal agricultural land, also called land conversion programs, such as the CRP and the PCP (Patterson and Best 1996; Dechant et al. 1998; McMaster and Davis 1998). In Saskatchewan, the Grasshopper Sparrow is more abundant in grazed fields than in mowed fields enrolled under the PCP (McMaster and Davis 1998). In Iowa, the species is 50 times more abundant in CRP converted fields than in annual row-crops (Patterson and Best 1996). In Minnesota, the species achieves its highest abundance in CRP fields compared to grasslands bordering wetlands preserved for waterfowl reproduction (Koford 1999). The fecundity of the species is also higher in CRP fields in Missouri and Kansas (Hull et al. 1996; McCoy et

al. 1999). In Maryland, the Grasshopper Sparrow colonizes grasslands restored under the CRP beginning in the first month following treatment (Gill et al. 2006). In Missouri, the rate of increase in Grasshopper Sparrow populations in CRP fields is generally high, ranging from 2.51 to 2.61, suggesting that these restored habitats are home to source populations (McCoy et al. 2001). However, three years after controlled burning, the vegetation in CRP fields becomes too dense and the species ceases to use these habitats (Gill et al. 2006). According to these authors, a combination of these land conversion programs and a controlled burning program could help maintain Grasshopper Sparrow habitat in the longer term. To date, more than 14.6 million hectares of farmland have been converted under the CRP in the United States, including 11.5 million hectares of grassland.

5.5.3 Reclamation of surface mines as grassland habitats

The reclamation of surface mines as grassland habitats in several states in the U.S. Midwest is beneficial to the Grasshopper Sparrow (Galligan et al. 2006). These restored sites are often large (> 2,000 ha) and can become high-quality habitats for the Grasshopper Sparrow. In Ohio, the Grasshopper Sparrow is nine times more abundant on reclaimed surface mines than on native prairies (Ingold 2002). However, in Quebec, the potential for restoration of this type of habitat is negligible given the small area occupied by surface mines in the species' range.

5.5.4 Restoration of agricultural land

It appears to be possible to restore land used for certain types of crops to suitable habitat for the Grasshopper Sparrow. In fact, Jobin and Falardeau (2010) observed in the Outaouais that the Grasshopper Sparrow re-occupied sites only two or three years following abandonment of corn and strawberry crops, suggesting that habitat management and restoration activities may benefit the Grasshopper Sparrow within a short period of time. In Ontario, the species uses fields sown to winter grains such as wheat and rye (Early 2007). Once mature, these crops, which are frequently grown on sandy deposits, are characterized by sparse vegetation, thus becoming a suitable habitat for the Grasshopper Sparrow.

6 SPECIAL SIGNIFICANCE OF THE SPECIES

The high abundance of the Grasshopper Sparrow in forage crops and native prairies of the Great Plains is beneficial to agriculture and to natural ecosystems since this species is a significant predator of agricultural insect pests (Vickery 1996). However, in Quebec, this species is not very important from the perspective of controlling insect pests because it is extremely rare. Nevertheless, the Grasshopper Sparrow is a species highly sought after locally by amateur ornithologists.

7 CURRENT STATUS

7.1 Status of the populations and trends

7.1.1 North America

Historically, the Grasshopper Sparrow bred primarily in the Great Plains of the United States. Following colonization by the Europeans, this species, like many other species of grassland passerines, benefited from land clearing and the development of large-scale agriculture in eastern North America and significantly expanded its breeding grounds (Vickery 1996; Brennan and Kuvlesky 2005; Early 2007). For example, it is reported that the Grasshopper Sparrow was very rare in Ontario in the 19th century, but that the species has expanded its range northward by 330 km since 1900 following intensive clearing of forests to make way for agriculture (Weir 1989). However, the intensification of agriculture and habitat loss and fragmentation as well as large-scale urban development since the mid-20th century have reversed the trend, and the Grasshopper Sparrow has become one of the farmland species that has experienced the greatest decline in its populations in North America (Sauer et al. 2008)

According to Rich et al. (2008), the worldwide population of the Grasshopper Sparrow is thought to be 15 million breeding birds, or 7.5 million breeding pairs. These authors estimate that 93% of the worldwide population breeds in the United States and Canada, with the rest in Latin America. According to the Rocky Mountain Bird Observatory (RMBO 2007) database, the source of the data in Rich et al. (2008), the breeding population in Canada is only about 212,000 birds, just over half of which are in Alberta. In Ontario, where the population is one of the largest in Canada, Blancher and Couturier (2007) estimate the number of adult breeders at 50,000, 80% of which are in the Lake Simcoe-Rideau region (including the Ottawa River Valley), while the RMBO (2007) suggests an estimate of 32,000 breeding individuals in Ontario.

Mapping of the relative abundance of the Grasshopper Sparrow in North America from North American Breeding Bird Survey (BBS) data indicates that, between 1987 and 2006, the centre of abundance of the species was located primarily in the central United States, between North Dakota and Kansas, where the mean number of birds detected per 50-station route was higher than 13 birds per route (Figure 3). Species abundance in all the Canadian provinces, including Quebec, is generally less than one bird per route (Figure 3).

The demographic trends for the entire continent according to the BBS indicate that the Grasshopper Sparrow has declined significantly, with an annual decrease of –3.6% from 1966 to 2007 and of –3.3% in the most recent period from 1980 to 2007 (Figure 4; Sauer et al. 2008). In the United States, the decline is identical to that observed at the continental scale (–3.6%/year between 1966 and 2007 and –3.3% for the 1980–2007 period) (Sauer et al. 2008), which is hardly surprising considering that approximately 98% of

the North American breeding population is in the United States. Significant downward population trends are evident in 20 American states and the decline is observed throughout the United States, except in certain states such as Montana and Texas where the species has been increasing by 1.5% per year (Figure 4; Sauer et al. 2008). The demographic trends calculated for highly integral habitats, i.e. tallgrass prairies in the Flint Hills region in Kansas and Oklahoma, indicate that the species has declined at an annual rate of 16% to 27% in only two years (2004–2005), significantly larger than the decrease estimated by the BBS in this region for the same period (With et al. 2008). By combining data from the Christmas Bird Count with the BBS for all of North America, Butcher and Niven (2007) also demonstrated a sharp drop of 65% in 40 years.

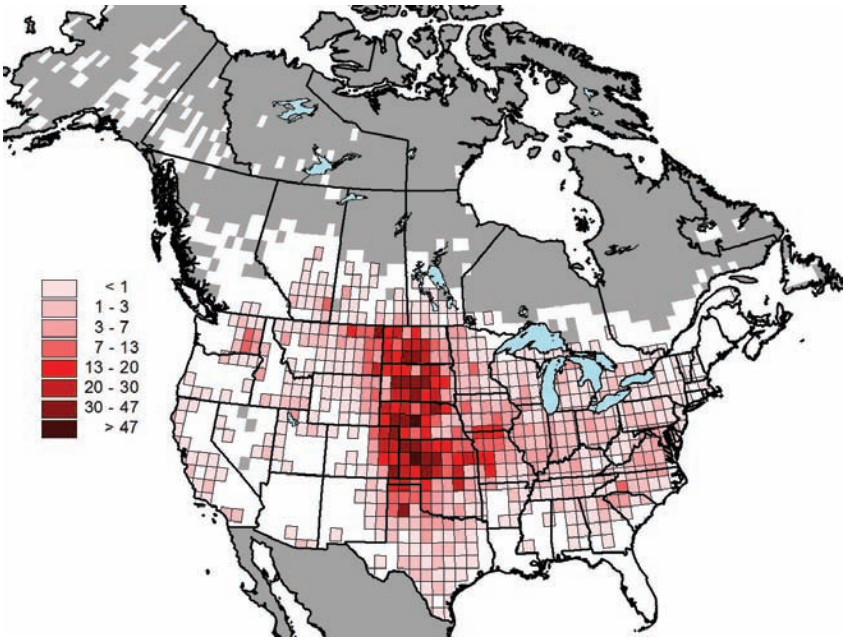

Figure 3. Relative abundance of the Grasshopper Sparrow calculated for each square of latitude and longitude between 1987 and 2006 during the breeding season according to the North American Breeding Bird Survey (BBS). Grey areas = not sampled by the BBS; white areas = areas sampled but no Grasshopper Sparrows found (P. Blancher, unpublished data, 2009)

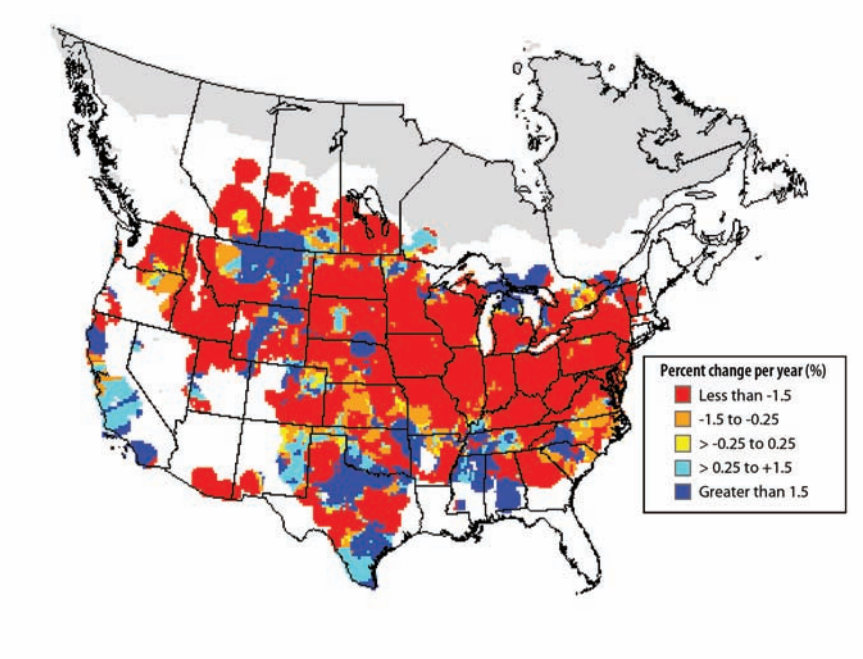

Figure 4. Mean annual change (%) in Grasshopper Sparrow abundance according to BBS data for the 1966–2003 period (from Sauer et al. 2008)

In Canada, the BBS data show a significant decline of -5.7% per year between 1968 and 2007 (Figure 5; Downes and Collins 2008). The long-term trends for Ontario, Manitoba, Saskatchewan and Alberta are all negative, although not as significant, except for Saskatchewan, where Grasshopper Sparrow populations fell sharply by –10.4% per year between 1968 and 2007 (Downes and Collins 2008). In Quebec, there is insufficient data to calculate trends based on the BBS.

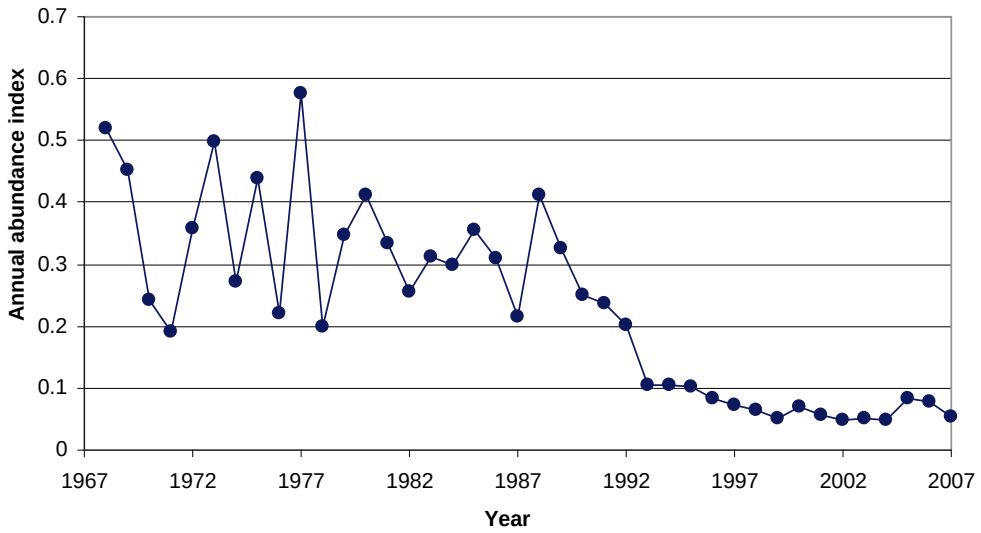

Figure 5. Annual abundance index of the Grasshopper Sparrow in Canada according to BBS data for the 1968–2007 period (from Downes and Collins 2008)

In certain regions of Ontario, significant declines in Grasshopper Sparrow populations since the 1980s are also reported (Early 2007). When compared with the distribution of the species between the first (1981–1985) and second (2001–2005) period of the Atlas of Breeding Birds of Ontario, there was no significant change in the probability of observation for Ontario as a whole; however, a steep decline in the species (48%) has been observed in the Carolinian region (Early 2007). At a more local scale, the species appears to be stable in the Ottawa River Valley, in Renfrew County (west of Ottawa) as well as in the south as far as Kingston (e.g. Lanark County), but appears to have decreased east of Ottawa, in Prescott-Russell County (Early 2007).

7.1.2 Quebec

7.1.2.1 History

In Quebec, the Grasshopper Sparrow is considered a rare migratory breeder (David 1996). As in Ontario, this species appears to have benefited from land clearing and agricultural development. However, it has never been abundant in Quebec, remaining restricted primarily to the Montreal, Montérégie and Outaouais regions (Hainault 1995). The first two records of Grasshopper Sparrow in Quebec date from June 24, 1898, in Hull and from June 26, 1920, in Chambly (Ouellet 1974; Hainault 1995). The frequency of records of the species in southern Quebec has become more regular since the 1940s, primarily in Montérégie: Chambly (five birds on July 5, 1920); Saint-Lambert (1942), Côte-Saint-Luc (1945), Hudson (1947–1965); Choisy and Sainte-Marthe (a nest with five eggs on May 31, 1968; Ouellet 1974).

In 2009, the ÉPOQ database contained 313 records of observations of the species between 1962 and 2008 (Larivée 2009) and the SOS-POP database (2008) contained a total of 72 known sites where the species had been reported during the breeding season (Appendix 1). Figure 6 shows the number of annual records of Grasshopper Sparrow in Quebec found in the ÉPOQ database. It is very important to bear in mind that these data are more reflective of the Grasshopper Sparrow search effort than any real change in its populations in Quebec, since the search effort varied significantly from year to year. Annual observations start in 1969 (Figure 6) when amateur ornithologists began to regularly visit breeding sites in southern Quebec (mainly in Montérégie). Subsequently, the surveys carried out for the Atlas of Breeding Birds of Quebec in the 1980s resulted in the discovery of numerous sites in the Outaouais region (Hainault 1995).

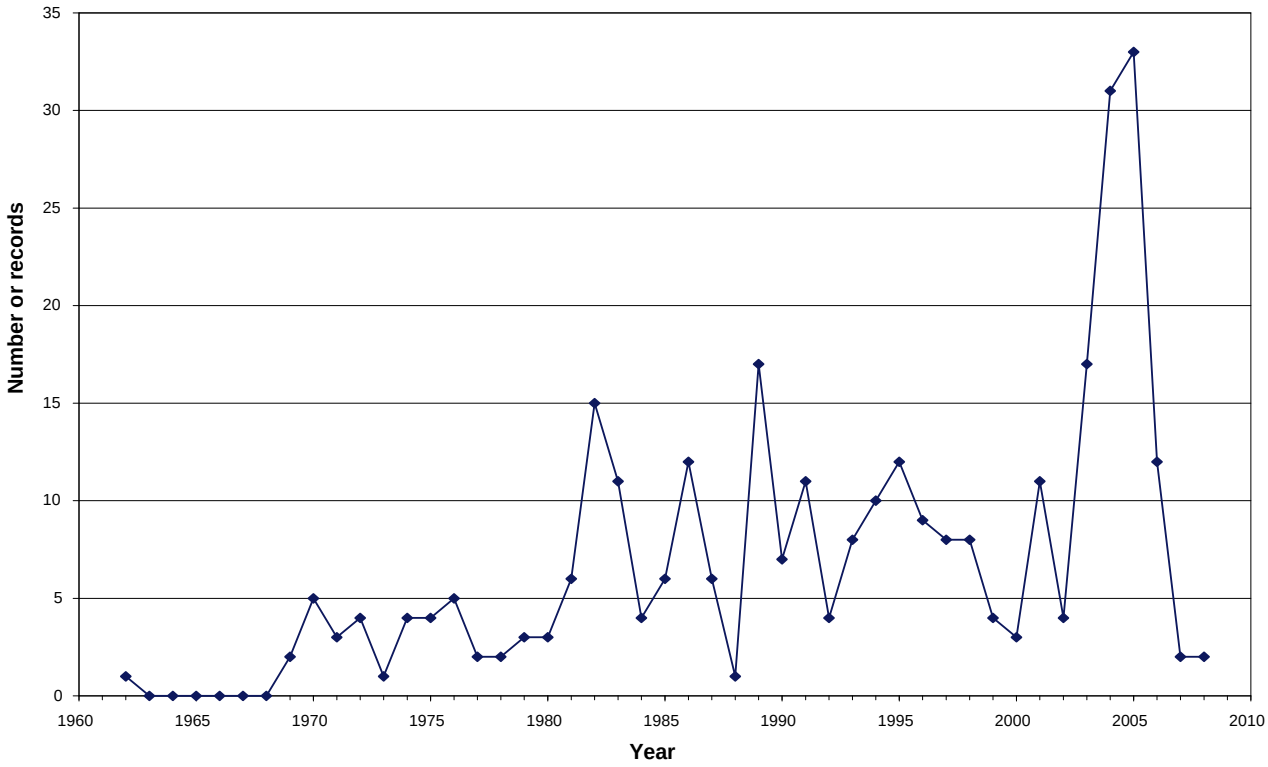

Figure 6. Number of Grasshopper Sparrow records on ÉPOQ count sheets in Quebec between 1962 and 2008 (from Larivée 2009)

The discovery of these numerous sites in the Pontiac region (between Fort-Coulonge and Quyon) in the Outaouais was followed by several surveys specific to this species in this region and in Montérégie (Hainault and St-Hilaire 1989; St-Hilaire 1990, 1991, 1992). The surveys carried out between 1989 and 1992 were conducted using the roadside survey system in order to verify the presence of the species in five counties in southern Quebec, since the use of Landsat satellite images beginning in 1990 made it possible to locate many additional sites with a high potential for breeding of the species. During the 1990–1992 survey period, the occupancy rate of potential sites was significantly higher in the Outaouais (41%–67%) than in the Laurentides and Montérégie regions (18%; Table 1). Only three sites were occupied in the Montérégie region in 1992, while 20 sites were occupied in the Outaouais region in 1991 (Table 1). During this period, the highest number of birds in southern Quebec, i.e. 52, was detected in 1989 (Table 1). During these four survey years, the majority of the sites occupied by the species were located in the Pontiac region in the Outaouais and only a few sites were regularly occupied in Montérégie (Mont Rigaud and Saint-Constant areas). In 1992, the area of occupancy of the Grasshopper Sparrow in Quebec (St-Hilaire 1992) was estimated at 1,710 ha.

Table 1. Summary of the results of Grasshopper Sparrow surveys in Quebec between 1989 and 2005

Year	Region	Total number of sites visited	Number of new sites visited	Number of sites occupied	Number of adults detected (males)	% occupancy	Source
1989	Outaouais Montérégie Laurentides	34	_	17	52 (29)	50	1
1990	Outaouais	32	15	13	22 (21)	41	2
1991	Outaouais	30	18	20	17	67	3
1992	Montérégie Laurentides	17	17	3	_	18	4
2004	Outaouais	36	21	20	68 (62)	56	5
2004	Montérégie Laurentides Estrie	23	0	3	7	13	5
2005	Outaouais	29	2	16	49 (42)	55	5.6

1: Hainault and St-Hilaire 1989; 2: St-Hilaire 1990; 3: St-Hilaire 1991; 4: St-Hilaire 1992; 5: Jobin and Falardeau 2005, 2010; 6: Jobin and Falardeau, unpublished data.

In order to assess the status of the Grasshopper Sparrow in Quebec at the sites occupied in the 1990s, the Canadian Wildlife Service initiated a survey of the species in the Pontiac region in 2004 (Jobin and Falardeau 2005, 2010; Jobin and Falardeau unpublished data). A total of 36 sites (including known and potential sites) were selected and surveyed twice in June 2004 using transects covering the whole area of these sites and using song playback. These surveys detected 68 Grasshopper Sparrows, including 62 males (Table 1). Of this number, 43 birds were found at 11 known sites and 25 others were found at nine new sites. In addition, three other singing males were found from the roadside of three sites that had not been selected for regular surveys, for a total of 71 Grasshopper Sparrows (65 singing males). The number of Grasshopper Sparrows counted in 2004 far exceeds the highest number previously recorded in a single year in the Pontiac region, i.e. 52 birds in 1989 (St-Hilaire 1989). In 2005, 27 of the 36 sites visited in 2004 that were still suitable (nine sites had been converted and no longer offered any potential) and two new sites were surveyed twice and 49 individuals, including 42 singing males, were counted (Table 1). Four additional males were found at three sites not selected for regular surveys, for a total of 53 birds, including 46 males, which represents a 25% decline from the number of birds detected in 2004. The higher numbers of singing males obtained during these more recent surveys compared to the roadside surveys carried out in the early 1990s can be explained by the use of more effective survey techniques, i.e. transect surveys with playback stations within suitable habitats instead of roadside surveys (Jobin and Falardeau 2005, 2010), and do not necessarily reflect an increase in the Grasshopper Sparrow population. These surveys are also responsible for the high numbers of records found in the ÉPOQ database in 2004 and 2005 (Figure 6).

Visits were also conducted in 2004 at 23 other known sites in Quebec outside the Pontiac region (Table 1). However, in most cases, these were only roadside surveys. Only seven singing males were

observed at only three of these sites (13% of the sites): three singing males near Saint-Lazare and Powerscourt in Montérégie, and one singing male near Tingwick in Estrie (Jobin and Falardeau 2005).

These field studies also noted a rapid rate of land use conversion resulting in habitat loss for this species. For instance, in the Outaouais, habitat loss rates of 57% (4/7) of the sites between 1988 and 1989 (Hainault and St-Hilaire 1989), and of 34% (11/32 sites) between 1989 and 1990 (St-Hilaire 1990) (Table 1) were reported, owing to a change in the type of land use (i.e. conversion of the habitat to cropland and pastures). Habitat losses were also high in the 2000s during which, as mentioned earlier, 25% (9/36) of the suitable sites in the Pontiac region were reported as converted to other uses between 2004 and 2005 (Jobin and Falardeau, unpublished data). A field visit to the known historic sites in the SOS-POP database (2008) also revealed a high rate of conversion of Grasshopper Sparrow habitat. In 2008, 36% of the 72 known historic sites in Quebec had been converted to cropland resulting in habitat quality rated as poor to nil, while the quality of 15% of the sites was rated as moderate (e.g. recent conversion to pine plantations [still of low density] or hayfields cut in June and July), while 49% of the sites were still rated as high quality for the Grasshopper Sparrow (Appendix 1). At the southern Quebec regional scale, losses of occupied sites for the 1989–2004 period were 80% (4/5 sites) in the Laurentides region, 75% (9/12 sites) in Montérégie and 54% (17/31 sites) in the Pontiac region in the Outaouais (Figure 7; Jobin and Falardeau, unpublished data).

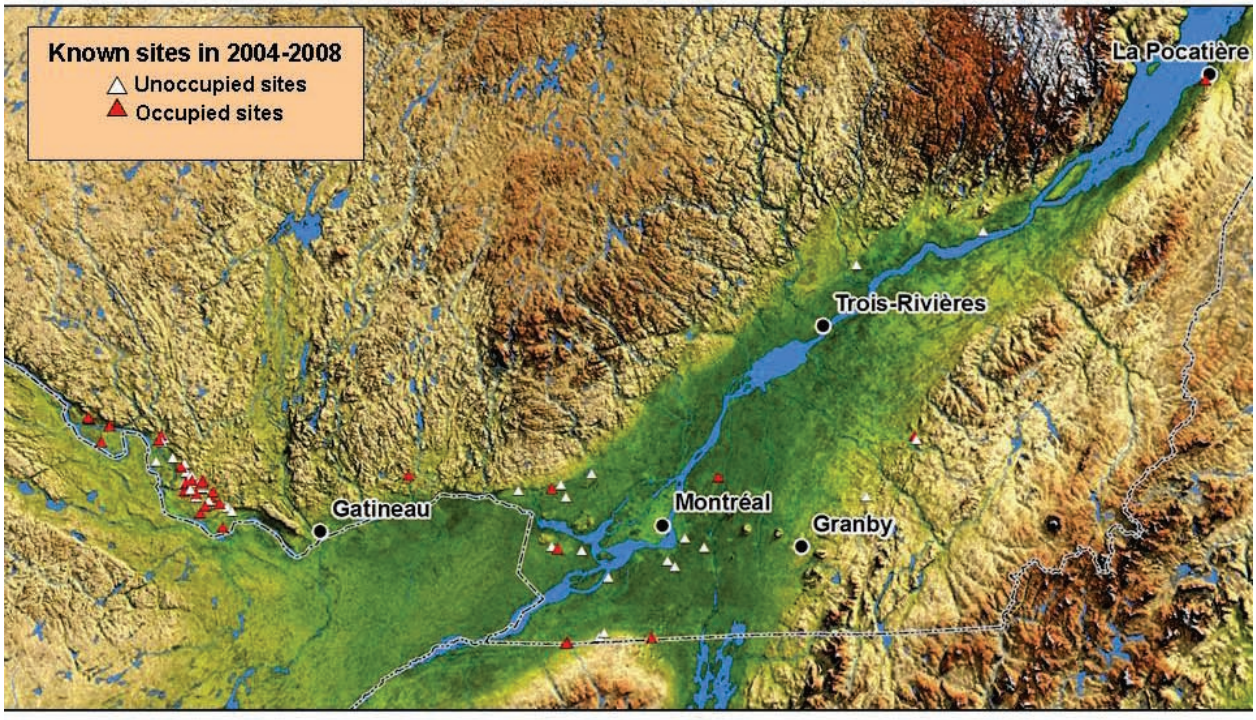

Figure 7. Changes in Grasshopper Sparrow occurrence at 72 known sites in Quebec since 1961 visited during the 2004–2008 period (from SOS-POP 2008)

Finally, in 2008, the Regroupement QuébecOiseaux (RQO) analyzed aerial photographs of an area of the Montérégie region, south of Montreal, in an effort to find new sites occupied by the Grasshopper Sparrow. Surveys conducted in potential habitats identified in this analysis found a total of 13 Grasshopper Sparrows at three new sites (not shown on the map) located less than 1 km west of the site known to be occupied by this species since 1992 near Powerscourt in the Montérégie region (SOS-POP 2008). Subsequent surveys confirmed that some birds were still using some of these sites in 2009 and 2010 (RQO, pers. comm.).

7.1.2.2 Abundance

In the late 1980s, the number of breeding pairs of Grasshopper Sparrow in Quebec was estimated at less than 50 (Robert 1989). Recent surveys carried out in southern Quebec since 1989 suggest that the number of pairs may be higher. For instance, the number of singing males reported during 2004 surveys in the Pontiac region (Jobin and Falardeau 2005, 2010) suggests the presence of at least 65 pairs (assuming that all 65 males detected during these surveys were paired to females). To this are added seven additional pairs (seven singing males) at three other sites detected in Montérégie and in Estrie in 2004, bringing the total of known pairs for the species' entire range in Quebec in 2004 to 72 (Jobin and Falardeau 2005).

Moreover, this total is undoubtedly somewhat underestimated considering the fact that roadside surveys were used for certain sites in the Outaouais and for all the sites visited in Montérégie, and that a full survey of these sites may well have detected a larger number of singing males out of the range of the roadside surveys. In addition, some birds present in suitable habitats are not detected during surveys but this proportion of undetected birds was not estimated. Finally, an unknown number of sites not visible from the roadside, but possibly used by the Grasshopper Sparrow, could not be surveyed. Considering all these factors, it can be assumed that the Grasshopper Sparrow population in southern Quebec in the mid-2000s is probably between 100 and 200 breeding pairs.

7.1.2.3 Demographic trend in Quebec

The BBS data from Quebec cannot be used to assess the population trend of the species because of the small number of Grasshopper Sparrows reported on the routes surveyed in Quebec (Downes and Collins 2008). However, an analysis of SOS-POP data (2008) for 39 sites where Grasshopper Sparrows were detected in the past in southern Quebec and for which visits were carried out at least once during the 1989–1998 and 1999–2008 periods indicate that the habitat is no longer suitable and is no longer used by the species at many sites (Figure 8). In fact, during the 1999–2008 period, the Grasshopper Sparrow was detected at only 36% (14/39 sites) of these known sites (Figure 8). In addition, the mean maximum number of birds observed per site declined significantly between the 1989–1998 period (2.67 ± 2.08, $n = 39$) and the more recent 1999–2008 period (1.49 ± 2.62; Mann-Whitney $U = 370.5$; $P < 0.001$, $n = 39$). The maximum number of birds per site was also higher during the first period, for 85% of the

known sites (Figure 8). All these comparisons therefore suggest a sharp decline in the Quebec population of the Grasshopper Sparrow. It should also be pointed out that the search effort was higher during the 1999–2008 period (surveys along transects and song playback) than during the 1989–1998 period (passive roadside count stations), providing further evidence for the decline observed.

7.2 Threats to the survival of the species

The threats to the survival of the Grasshopper Sparrow in Quebec are primarily habitat loss due to conversion of perennial crops (forages, pastures) to intensive annual crops, habitat fragmentation and hay cutting during the breeding season. The poor fields preferred by this species are also sometimes converted to coniferous plantations. See section 5.4 for details concerning these threats.

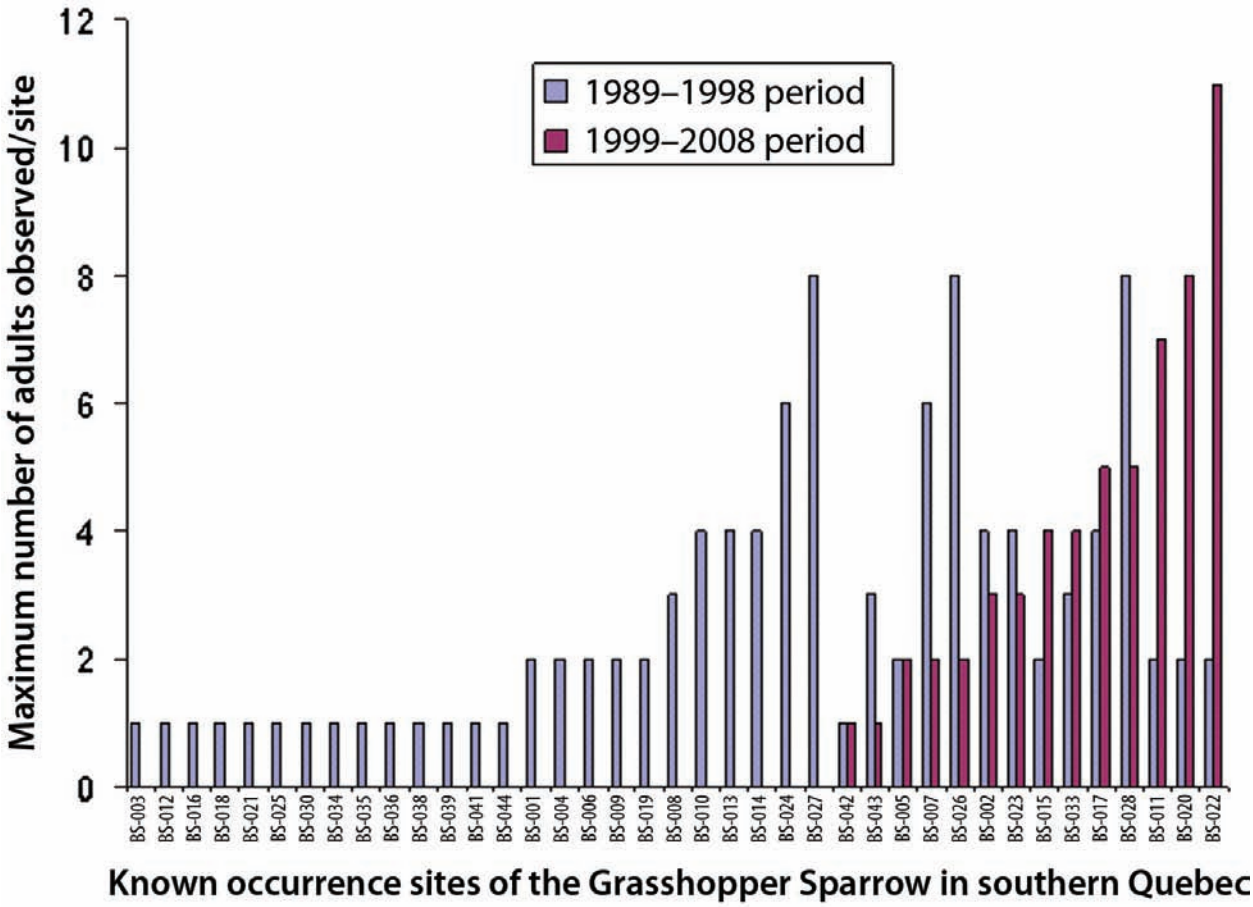

Figure 8. Maximum number of adult Grasshopper Sparrows surveyed at 39 historic sites during the last two decades (1989–1998 and 1999–2008) in southern Quebec (SOS-POP 2008)

Habitat loss appears to be directly related to the intensification of agriculture characterized by the development of synthetic chemicals, surface drainage techniques, more efficient machinery and new varieties of faster-growing plants which have accelerated the conversion of perennial crops to annual crops (Jobin et al. 2007). The intensification of agriculture in southern Quebec is particularly significant in the Montérégie region, where the species was historically relatively frequent. In this region, the area sown to intensive crops (corn, soybeans and grains) increased in 80% of the regional county municipalities (RCMs) between 1993 and 2001 (Jobin et al. 2007). This increase has been to the detriment of perennial crops (pastures, hayfields), which have significantly declined in these RCMs. Besides, recent satellite imagery analyses performed to identify new Grasshopper Sparrow potential breeding habitat in Montérégie resulted in no new potential sites being identified owing to the high conversion of forage crops to grain crops (Jobin et al. 2008). In the southern Outaouais, however, the conversion of perennial crops to annual crops was less significant than in Montérégie (Jobin et al. 2007).

7.3 Protection and conservation measures

Currently in Quebec, Grasshopper Sparrow habitat is found almost exclusively on private lands. Consequently, stewardship activities should be initiated on these lands in order to protect the species and its habitat (Jobin et al. 2008). There are various funding programs aimed at the protection of habitats on private lands including Environment Canada's Habitat Stewardship Program for Species at Risk and the "Faune en danger" program of the Fondation de la faune du Québec. At present, only one project of this type has been initiated in southern Quebec, in the Montérégie region, where one farmer has agreed to delay the first cutting of hay in one of his fields for several weeks in order to reduce disturbance to Grasshopper Sparrow pairs during the breeding season (Bussière 2008). The number of stewardship projects aimed at protection of Grasshopper Sparrow habitat is expected to increase significantly if the species is granted legal designated status by the federal and provincial authorities.

7.4 Current statuses, legal or other

7.4.1 International legislation

NatureServe (2009) assigns the Grasshopper Sparrow a global rank of G5 (Secure) and a national rank of N5 (Secure) for the United States, owing primarily to its large range in North America. Similarly, the species is considered a species of least concern according to the IUCN Red List (NatureServe 2009) and is not on the Watch List of the North American Landbird Conservation Plan (Rich et al. 2008). However, the species is considered "Vulnerable – S3" and "Apparently Secure – S4" (NatureServe, 2009) in several American Great Plains states which represent the centre of the species distribution (Table 2). It is on the list of priority species of the Partners in Flight conservation plan in Wyoming and Colorado (Slater 2004).

In addition, the U.S. Fish and Wildlife Service considers the Grasshopper Sparrow a species of conservation concern in the following Bird Conservation Regions (BCRs): Prairie Potholes (BCR 11), Badlands and Prairies (BCR 17), and Eastern Tallgrass Prairie (BCR 22) (U.S. Fish and Wildlife Service 2002). The species is also recognized as a moderate conservation priority in BCR 13 (Lower Great Lakes/St. Lawrence Plain) (Hartley 2007). The Grasshopper Sparrow has also been identified as a priority species in the Quebec portion of BCR 13 (CWS, in prep.). The U.S. Fish and Wildlife Service has also designated the Florida subspecies endangered at the federal level (Federal Register 1986).

7.4.2 Canadian legislation

In Canada, the Grasshopper Sparrow as well as its nests and eggs are protected under the federal *Migratory Birds Convention Act, 1994* (Environment Canada 2010). NatureServe (2009) assigns the Grasshopper Sparrow in Canada the rank of N4 (Apparently Secure) and the species has no federal status since no national status report has ever been produced. However, it is considered an intermediate priority candidate species by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC 2010).

Table 2. Ranks and statuses assigned to the Grasshopper Sparrow by American state and Canadian province (Source: NatureServe 2009)

State/Province	Rank/Status
United States	Alabama (S3), Arizona (S3), Arkansas (S3B), California (S2), North Carolina (S3B,S1N), South Carolina (SNRB,SNRN), Colorado (S3S4B), Connecticut (S1B), North Dakota (SNRB), South Dakota (S4B), Delaware (S3B), District of Columbia (S3N), Florida (SNRN), Georgia (S4), Idaho (S3B), Illinois (S5), Indiana (S4B), Iowa (S4B,S4N), Kansas (S4B), Kentucky (S4B), Louisiana (S3N), Maine (S1B), Maryland (S4B), Massachusetts (S3B), Michigan (S3S4), Minnesota (SNRB), Mississippi (S3B,S3N), Missouri (S3S4), Montana (S3B), Navajo Nation (SNA), Nebraska (S4), Nevada (SU), New Hampshire (S2B), New Jersey (S2B), New York (S4), New Mexico (S3B,S3N), Ohio (S5), Oklahoma (S4B), Oregon (S2B), Pennsylvania (S4B), Rhode Island (S1B,S1N), Tennessee (S4), Texas (S3B), Utah (S1B), Vermont (S2B), Virginia (S4), West Virginia (S3B), Washington (S3B), Wisconsin (S4B), Wyoming (S4)
Canada	Alberta (S3S4), British Columbia (S1S2B), Manitoba (S2B), Ontario (S4B), Quebec (S2), Saskatchewan (S4B)

In British Columbia, the species is considered "Critically imperiled – S1" (Cannings 1995; Table 2) and is provincially protected under the 1982 *Wildlife Act* as well as under the *Forest Practices Code of British Columbia Act* (Cannings 1995). The species is considered "Imperiled – S2" in Quebec and Manitoba and "Vulnerable – S3" in Alberta. It is also considered "Sensitive" in Alberta (Federation of Alberta Naturalists 2007).

7.4.3 Quebec legislation

Under the *Act respecting threatened or vulnerable species* (R.S.Q., c. E-12.01), the Grasshopper Sparrow has been identified as a species likely to be designated threatened or vulnerable by the ministère du Développement durable, de l'Environnement et des Parcs (MDDEP) and the ministère des Ressources

naturelles et de la Faune (MRNF). This Act provides for the designation and protection of threatened or vulnerable wildlife and plant species which live in Quebec, as well as the conservation of their habitats. In addition, pursuant to the *Act respecting the conservation and development of wildlife* (R.S.Q., c. C-61.1), it is prohibited to hunt, capture, keep in captivity or sell this species. Pursuant to this Act, it is also prohibited to disturb, destroy or damage the nests or eggs of this species.

8 CONCLUSION

The Grasshopper Sparrow is a species of concern in Quebec owing to the small size of its population, the decline in its numbers as well as the rapid conversion of its habitat in southern Quebec. In fact, conversion of the perennial crops used by the species to annual crops in areas where the quality of the soil encourages tilled cropland has been observed, whereas marginal land often suitable for the species is frequently abandoned or converted to coniferous plantations, habitats rarely used by the Grasshopper Sparrow. Local extinctions of the species have already been observed in Montérégie, where virtually all of the sites previously occupied by the species have disappeared. In the Outaouais, where the population is still relatively large, habitat losses are also increasing significantly.

Considering that Grasshopper Sparrow populations are currently declining throughout the species range in Canada, it is unlikely that outside immigration can maintain the Quebec population in the long term. In addition, given the substantial reduction in the short and medium terms of the Ontario and New York State populations, the degree of isolation of the southern Quebec population can be expected to increase, thus making it vulnerable to a high risk of extinction (as is the case with the Florida population). Ongoing Grasshopper Sparrow habitat protection activities in southern Quebec are therefore justified.

9 ACKNOWLEDGEMENTS

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APPENDIX Description of the habitat at known Grasshopper Sparrow sites in Quebec (based on SOS-POP 2008)

Site	Site name	Area (ha)	Current quality of the habitat*	Site	Site name	Area (ha)	Current quality of the habitat*
BS-001	Bristol Ridge (south)	30	poor	BS-037	Franklin Centre #2	–	nil
BS-002	Bristol Ridge (north)	45	good	BS-038	Brome Road (Brome Lake)	–	nil
BS-003	North Onslow (east)	4	poor	BS-039	Chambly	–	poor
BS-004	North Onslow (west)	–	nil	BS-040	Brownsburg	–	poor
BS-005	O'Brien Lake	60	good	BS-041	Brossard	–	poor
BS-006	Weirstead	35	moderate	BS-042	Rivière du Nord	–	good
BS-007	Bristol Ridge	16	good	BS-043	Charteris #2	–	poor
BS-008	Charteris (south)	55	poor	BS-044	Saint-Étienne-de-Beauharnois	–	?
BS-009	McCord Lake	3.5	good	BS-045	Montée Cadieux	–	moderate
BS-010	Yarm / race track	63	poor	BS-046	Yarm (Green Lake Road)	–	good
BS-011	Richardson Lake #1	60	good	BS-047	Caldwell	–	good
BS-012	Towell Lake (north)	15	moderate	BS-048	Ruisseau à McCord	–	good
BS-013	Lac à Martin	15	good	BS-049	Richardson Lake #2	–	moderate
BS-014	Lawn	20	poor	BS-050	Barry River	–	good
BS-015	Vinton (dump)	8	nil	BS-051	Saint-Prosper (Saint-Charles Range)	–	moderate
BS-016	Leclair (south)	23	good	BS-052	Tingwick (Chemin de l'Aqueduc)	–	good
BS-017	Coulonge River falls	40	good	BS-053	Tingwick Estate (Kingsey Road)	–	poor
BS-018	Spink Lake (west)	–	nil	BS-054	Saint-Augustin-de-Desmaures	–	moderate
BS-019	Charteris #1	70	good	BS-055	Charteris #3	–	good
BS-020	Lac à Daly	60	good	BS-056	Charteris #4	–	good
BS-021	Stell Line (road)	14	moderate	BS-057	North Clarendon	–	poor
BS-022	McKee (south)	48	good	BS-058	Doherty	–	poor
BS-023	Bristol Mines (east)	26	good	BS-059	Campbell's Bay	–	good
BS-024	Lac à Horner	25	poor	BS-060	Fort-Coulonge	–	good
BS-025	Lawless Lake	22	nil	BS-061	Carroll	–	good
BS-026	Sainte-Marthe	–	poor	BS-062	Ranger Lake	–	good
BS-027	Saint-Constant	–	nil	BS-063	Dennie Lake #1	–	good
BS-028	Saint-Lazare	–	nil	BS-064	Dennie Lake #2	55	good
BS-029	Durham South	–	poor	BS-065	Île aux allumettes/Demers Centre	–	good
BS-030	Saint-Hermas	–	nil	BS-066	Saint-Marc-sur-Richelieu (Rg des Soixante)	–	good
BS-031	Franklin Centre #1	–	poor	BS-067	La Pocatière	–	good
BS-032	Saint-Colomban	–	poor	BS-068	Valencay	–	good
BS-033	Powerscourt #1	33	good	BS-069	Nichols Road	–	good
BS-034	Domaine Val-Boisé/Saint-Philippe	–	?	BS-070	Powerscout #2	–	good
BS-035	Saint-Antoine	60	poor	BS-071	Powerscout #3	–	good
BS-036	La Malbaie	–	?	BS-072	Powerscout #4	–	good

*Nil = habitat permanently destroyed; Poor = conversion to intensive crops (corn, soybeans, grains); Moderate = pastures and cut hayfields, young coniferous plantations; Good = poor hayfields, regenerating abandoned fields

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Additional information can be obtained at:

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