COSEWIC
Assessment and Status Report

on the

Eastern Meadowlark
Sturnella magna

in Canada

THREATENED
2011

COSEWIC
Committee on the Status
of Endangered Wildlife
in Canada

COSEPAC
Comité sur la situation
des espèces en péril
au Canada

COSEWIC status reports are working documents used in assigning the status of wildlife species suspected of being at risk. This report may be cited as follows:

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Eastern Meadowlark — photo courtesy Raymond Belhumeur.

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COSEWIC
Assessment Summary

Assessment Summary – May 2011

Common name
Eastern Meadowlark

Scientific name
Sturnella magna

Status
Threatened

Reason for designation
This ground-nesting grassland specialist has seen major changes in its population size and breeding range since European settlement. Most of its native prairie habitat had fallen to the plough by the end of the 19th century. However, these habitat losses were effectively counter-balanced by the provision of large amounts of surrogate grasslands (primarily pastures and hayfields) as a result of the widespread conversion of eastern deciduous forests to agricultural land. The species initially responded with expansions in its breeding range (primarily eastward). Since the mid-20th century, however, the amount and quality of surrogate grasslands across its range have declined. Although the species' population is still relatively large, it has been undergoing persistent rangewide declines. These declines are believed to be driven mostly by ongoing loss and degradation of grassland habitat on both the breeding and wintering grounds, coupled with reduced reproductive success resulting from some agricultural practices.

Occurrence
Ontario, Quebec, New Brunswick, Nova Scotia

Status history
Designated Threatened in May 2011.

COSEWIC
Executive Summary

Eastern Meadowlark
Sturnella magna

Wildlife species description and significance

The Eastern Meadowlark is a medium-sized songbird that is a member of the blackbird family. It has a relatively long, pointed bill and short tail. Adults are patterned with brown on the back, and have a bright-yellow throat and belly with a large black 'V' pattern in the middle of the chest. The white outer tail feathers are especially visible in flight. The Eastern Meadowlark closely resembles the Western Meadowlark – a species found in similar habitat but nesting primarily in western North America. Sixteen subspecies of the Eastern Meadowlark are recognized, but only one occurs in Canada (*Sturnella magna magna*).

Distribution

Including all subspecies, the Eastern Meadowlark's global breeding range extends from central and eastern North America, south through parts of South America. However, there is only one subspecies in Canada and the neighbouring northeastern U.S. In Canada, the bulk of the population breeds in southern Ontario, becoming progressively less common through southern Quebec, New Brunswick, and southern Nova Scotia. Eastern Meadowlarks are short-distance migrants, with most of the Canadian population believed to winter in the southcentral and southeastern United States.

Habitat

Eastern Meadowlarks prefer grassland habitats, including native prairies and savannahs, as well as non-native pastures, hayfields, weedy meadows, herbaceous fencerows and airfields.

Biology

The Eastern Meadowlark employs a mixed reproductive strategy that includes both monogamy and polygyny. Polygyny is frequent. In Canada, males arrive on the breeding grounds in April, while females return about 2-4 weeks later. Nests are situated on the ground. They are well concealed in vegetation and consist of a grass cup covered by grass woven from the surrounding vegetation. Clutch size is usually four to five eggs. Up to two broods can be raised in a breeding season. Age of first reproduction is 1 year.

Population sizes and trends

In Canada, the Eastern Meadowlark population is estimated to be about 250,000 mature individuals (roughly 125,000 breeding pairs). The population size and breeding range of this species in central and eastern Canada expanded soon after European settlement, owing to the provision of large acreages of pasturelands and hayfields following the clearing of the native forests. This also roughly coincided with large declines in the availability of the species' natural habitat (e.g., native prairie). All sources of available information now demonstrate a decline of the species in Canada, which probably began sometime in the mid-20th century, concomitant with the decline in the amount of surrogate agricultural habitats and intensification of agricultural practices. Meanwhile, the Eastern Meadowlark's native prairie has not returned and remains only a fraction of its historic acreage,

Population trend information from the Breeding Bird Survey for the period 1970 to 2009 shows a statistically significant decline of 3.1% per year in Canada, which corresponds to an overall decline of 71%. Over the most recent 10-year period (1999 to 2009), there has been a statistically significant decline of 3.3% per year, which corresponds to an overall decline of 29%. Regional surveys, such as the Ontario Breeding Bird Atlas, the Maritimes Breeding Bird Atlas and the Étude des populations d'oiseaux du Québec, also indicate significant declines in recent decades.

Threats and limiting factors

The main causes of the decline in Eastern Meadowlark populations have been identified as: 1) habitat loss on the breeding grounds (and probably also on the wintering grounds) caused by large-scale conversion of forage crops to intensive grain crops and other row crops, reforestation of abandoned farmlands, and urbanization; 2) intensification and modernization of agricultural techniques promoting earlier and more frequent haying during the nesting season, which results in low breeding success; 3) a high (and probably increasing) rate of nest predation; 4) overgrazing by livestock; 5) mortality due to pesticide use on the breeding and wintering grounds; and 6) reduced reproductive output stemming from Brown-headed Cowbird nest parasitism.

Protection, status, and ranks

In Canada, the Eastern Meadowlark and its nests and eggs are protected under the *Migratory Birds Convention Act*. It is currently ranked as ‘globally secure’ by NatureServe. In Canada, it is ranked ‘secure and common’. It is ranked ‘apparently secure’ in Ontario, ‘vulnerable’ in Quebec, ‘imperiled’ in New Brunswick, and ‘critically imperiled’ in Nova Scotia.

TECHNICAL SUMMARY

Sturnella magna
Eastern Meadowlark Sturnelle des prés
Range of Occurrence in Canada: Ontario, Quebec, New Brunswick, Nova Scotia

Demographic Information

Generation time	2 to 3 yrs
Is there an observed, continuing decline in number of mature individuals? Yes, at least within the past 50 years.	Yes
Estimated percent of continuing decline in total number of mature individuals within [5 years or 2 generations]	Unknown
Estimated percent reduction in total number of mature individuals over the last 10 years. - Based on BBS data for 1999-2009 showing a statistically significant decline of 3.3% per year (95% CI = -5.2% to -1.3%).	29%
[Projected or suspected] percent [reduction or increase] in total number of mature individuals over the next 10 years, or 3 generations].	Unknown
[Observed, estimated, inferred, or suspected] percent [reduction or increase] in total number of mature individuals over any [10 years, or 3 generations] period, over a time period including both the past and the future.	Unknown
Are the causes of the decline clearly reversible and understood and ceased?	No (potentially reversible; causes are well understood but not ceased)
Are there extreme fluctuations in number of mature individuals?	No

Extent and Occupancy Information

Estimated extent of occurrence - Based on a minimum convex polygon estimate for the Canadian range depicted in Figure 2.	1,104,000 km^2
Index of area of occupancy (IAO) - IAO cannot be calculated at this time, but it undoubtedly exceeds the 2000 km^2 threshold	>2000 km^2
Is the total population severely fragmented?	No
Number of “locations” - unknown, but definitely exceeds threshold of 10 locations	Unknown (>10)
Is there an observed continuing decline in extent of occurrence?	No
Is there an observed continuing decline in index of area of occupancy? - based on declines in occupancy indicated by recent results from breeding bird atlas projects in Ontario and the Maritimes	Yes
Is there an observed continuing decline in number of populations?	Not applicable
Is there an inferred continuing decline in number of locations? - inferred based upon continuing loss in area of suitable habitat	Yes
Is there an observed continuing decline in area and/or quality of habitat?	Yes to both
Are there extreme fluctuations in number of populations?	Not applicable
Are there extreme fluctuations in number of locations?	No
Are there extreme fluctuations in extent of occurrence?	No
Are there extreme fluctuations in index of area of occupancy?	No

Number of mature individuals in each population

Population	N Mature Individuals
Canada (see **Abundance** section for details)	~250,000
Total	~250,000

Quantitative Analysis

Ex.: % chance of extinction in 50 years	Not available

Threats (actual or imminent, to populations or habitats)

- Habitat loss on the breeding grounds (and probably also on the wintering grounds) caused by conversion of forage crops to intensive grain crops and other row crops, reforestation of abandoned farmlands, and urbanization;
- Intensification and modernization of agricultural techniques promoting earlier and more frequent haying during the nesting season, causing high rates of nest failure;
- High and potentially increasing rates of nest depredation;
- Mortality from pesticide use on the breeding and wintering grounds;
- Overgrazing by livestock;
- Brown-headed Cowbird brood parasitism.

Rescue Effect (immigration from an outside source)

Status of outside population(s)? USA: statistically significant decline of 2.9% per year (1966-2007); declines are pronounced for many northeastern states	
Is immigration known?	No, but likely
Would immigrants be adapted to survive in Canada?	Yes
Is there sufficient habitat for immigrants in Canada?	Yes, but declining
Is rescue from outside populations likely?	Yes, but increasingly tempered by species decline in all states bordering Canada and by continued loss of habitat in both countries

Current Status

COSEWIC: Threatened (May 2011)

Status and Reasons for Designation

Status:	**Alpha-numeric code:**
Threatened	A2b

Reasons for designation:

This ground-nesting grassland specialist has seen major changes in its population size and breeding range since European settlement. Most of its native prairie habitat had fallen to the plough by the end of the 19th century. However, these habitat losses were effectively counter-balanced by the provision of large amounts of surrogate grasslands (primarily pastures and hayfields) as a result of the widespread conversion of eastern deciduous forests to agricultural land. The species initially responded with expansions in its breeding range (primarily eastward). Since the mid-20th century, however, the amount and quality of surrogate grasslands across its range have declined. Although the species' population is still relatively large, it has been undergoing persistent rangewide declines. These declines are believed to be driven mostly by ongoing loss and degradation of grassland habitat on both the breeding and wintering grounds, coupled with reduced reproductive success resulting from some agricultural practices.

Applicability of Criteria

Criterion A (Decline in Total Number of Mature Individuals): Meets Threatened A2b based on an appropriate index of abundance. The most recent 10-year trend estimate is very close to the 30% threshold guidelines for population decline. The overall decline from 1970-2009 is estimated at 71%. Causes of population decline, while largely understood and potentially reversible, have not ceased and show little evidence of stabilization or improvement.
Criterion B (Small Distribution Range and Decline or Fluctuation): Does not meet criterion; exceeds thresholds for extent of occurrence and area of occupancy.
Criterion C (Small and Declining Number of Mature Individuals): Does not meet criterion; exceeds thresholds for population size.
Criterion D (Very Small or Restricted Total Population): Does not meet criterion; exceeds thresholds for population size, area of occupancy and number of locations.
Criterion E (Quantitative Analysis): Not done.

COSEWIC HISTORY

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) was created in 1977 as a result of a recommendation at the Federal-Provincial Wildlife Conference held in 1976. It arose from the need for a single, official, scientifically sound, national listing of wildlife species at risk. In 1978, COSEWIC designated its first species and produced its first list of Canadian species at risk. Species designated at meetings of the full committee are added to the list. On June 5, 2003, the *Species at Risk Act* (SARA) was proclaimed. SARA establishes COSEWIC as an advisory body ensuring that species will continue to be assessed under a rigorous and independent scientific process.

COSEWIC MANDATE

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) assesses the national status of wild species, subspecies, varieties, or other designatable units that are considered to be at risk in Canada. Designations are made on native species for the following taxonomic groups: mammals, birds, reptiles, amphibians, fishes, arthropods, molluscs, vascular plants, mosses, and lichens.

COSEWIC MEMBERSHIP

COSEWIC comprises members from each provincial and territorial government wildlife agency, four federal entities (Canadian Wildlife Service, Parks Canada Agency, Department of Fisheries and Oceans, and the Federal Biodiversity Information Partnership, chaired by the Canadian Museum of Nature), three non-government science members and the co-chairs of the species specialist subcommittees and the Aboriginal Traditional Knowledge subcommittee. The Committee meets to consider status reports on candidate species.

DEFINITIONS (2011)

Wildlife Species	A species, subspecies, variety, or geographically or genetically distinct population of animal, plant or other organism, other than a bacterium or virus, that is wild by nature and is either native to Canada or has extended its range into Canada without human intervention and has been present in Canada for at least 50 years.
Extinct (X)	A wildlife species that no longer exists.
Extirpated (XT)	A wildlife species no longer existing in the wild in Canada, but occurring elsewhere.
Endangered (E)	A wildlife species facing imminent extirpation or extinction.
Threatened (T)	A wildlife species likely to become endangered if limiting factors are not reversed.
Special Concern (SC)*	A wildlife species that may become a threatened or an endangered species because of a combination of biological characteristics and identified threats.
Not at Risk (NAR)**	A wildlife species that has been evaluated and found to be not at risk of extinction given the current circumstances.
Data Deficient (DD)***	A category that applies when the available information is insufficient (a) to resolve a species' eligibility for assessment or (b) to permit an assessment of the species' risk of extinction.

* Formerly described as "Vulnerable" from 1990 to 1999, or "Rare" prior to 1990.

** Formerly described as "Not In Any Category", or "No Designation Required."

*** Formerly described as "Indeterminate" from 1994 to 1999 or "ISIBD" (insufficient scientific information on which to base a designation) prior to 1994. Definition of the (DD) category revised in 2006.

Canada

The Canadian Wildlife Service, Environment Canada, provides full administrative and financial support to the COSEWIC Secretariat.

COSEWIC Status Report

on the

Eastern Meadowlark

Sturnella magna

in Canada

2011

TABLE OF CONTENTS

List of Figures

List of Tables

WILDLIFE SPECIES DESCRIPTION AND SIGNIFICANCE

Name and classification

*Sturnella magna (*Linnaeus 1758) is commonly called the Eastern Meadowlark. The French name is Sturnelle des prés. Its taxonomy is as follows:

Class: Aves
Order: Passeriformes
Family: Icteridae
Genus: *Sturnella*
Species: *Sturnella magna*

Morphological description

The Eastern Meadowlark is a medium-sized passerine (total length: 22-28 cm, body mass 100-123 g; Godfrey 1986; Lanyon 1995). It has a relatively long, pointed bill, a short tail, and long legs and toes. It has bright yellow underparts marked with a distinctive black V-shape pattern on the chest. The upperparts are composed of buffs, brown and black streaks and bars. The head pattern is characterized by a dark crown with a median light stripe and a white line over the eyes becoming yellow at the supraloral region. The sides, flanks and undertail-coverts are dull white with dusky black streaking. The wings and tail feathers are barred with black and brown, except for the white outer tail feathers, which are readily visible in flight. The sexes are similar, but females are smaller and a little less strongly marked than males.

The Eastern Meadowlark closely resembles the Western Meadowlark (*S. neglecta*), a species found mostly west of the Eastern Meadowlark's breeding range. The two species can be distinguished by the colouration of the throat; the yellow does not extend to the malar region in most Eastern Meadowlarks (Lanyon 1995). Eastern Meadowlarks are also darker and browner on the upperparts and have less barring on the wings and have more white on the tail than Western Meadowlarks. The most reliable way to differentiate the two species in the field is by their distinctive songs and calls (Lanyon 1995). The Eastern Meadowlark's song is a simple, lively, four-syllable, up-slurred whistle, whereas that of the Western Meadowlark consists of a more musical, complex series of gurgled whistles, often ending in a down-slurred note.

Population spatial structure and variability

There are currently no studies on the population spatial structure or variability of the Eastern Meadowlark in Canada.

Designatable units

There are currently 16 recognized subspecies of the Eastern Meadowlark (Lepage 2009). In Canada, only one subspecies (*S. magna magna*) is recognized (Godfrey 1986; Lanyon 1995), which is the subject of this report. There are no major range disjunctions, nor information on genetic differences, that would merit consideration of more than one designatable unit in Canada. Although an apparently isolated population occurs in the Lake of the Woods region of western Ontario, this population is connected to the species' main distribution in Canada via the U.S.

Special significance

Given that the Eastern Meadowlark feeds on a wide variety of agricultural insect pests (Lanyon 1995) and given its widespread distribution in forage crops, it is a beneficial species in agriculture. No Aboriginal Traditional Knowledge is currently available for this species.

DISTRIBUTION

Global range

The North American breeding range of the Eastern Meadowlark includes eastern Minnesota, southern Ontario, southern Quebec, parts of New Brunswick, and local areas of southern Nova Scotia, south to southern Florida and the Gulf Coast. In the west, it includes southwestern South Dakota, western Nebraska, central and southwestern Kansas, western Oklahoma and northcentral and southeastern Texas (Ridgely *et al.* 2003; Figure 1). Including all the various subspecies, its range extends south through Mexico, Central America and Cuba, as well as several South American countries, including Colombia, Venezuela, Guyana, and Suriname south to Amazonian Brazil (Lanyon 1995; NatureServe 2009). Its global breeding range is estimated at about 7.3 million km^2 (Ridgely *et al.* 2003).

The species' wintering range includes Texas, Kansas, Nebraska, Minnesota, Wisconsin, Michigan, southern Ontario (rare and irregular; James 1991), New York and New England, south through its U.S. breeding range (Lanyon 1995; American Ornithologist's Union 1998). The precise limit of its winter range in the mid-western states is currently not known with precision due to the difficulty in distinguishing it from the Western Meadowlark (Lanyon 1995). Most Eastern Meadowlarks breeding in Canada likely winter in the southeastern U.S., but there are few recoveries of banded birds to substantiate this (Brewer *et al.* 2000).

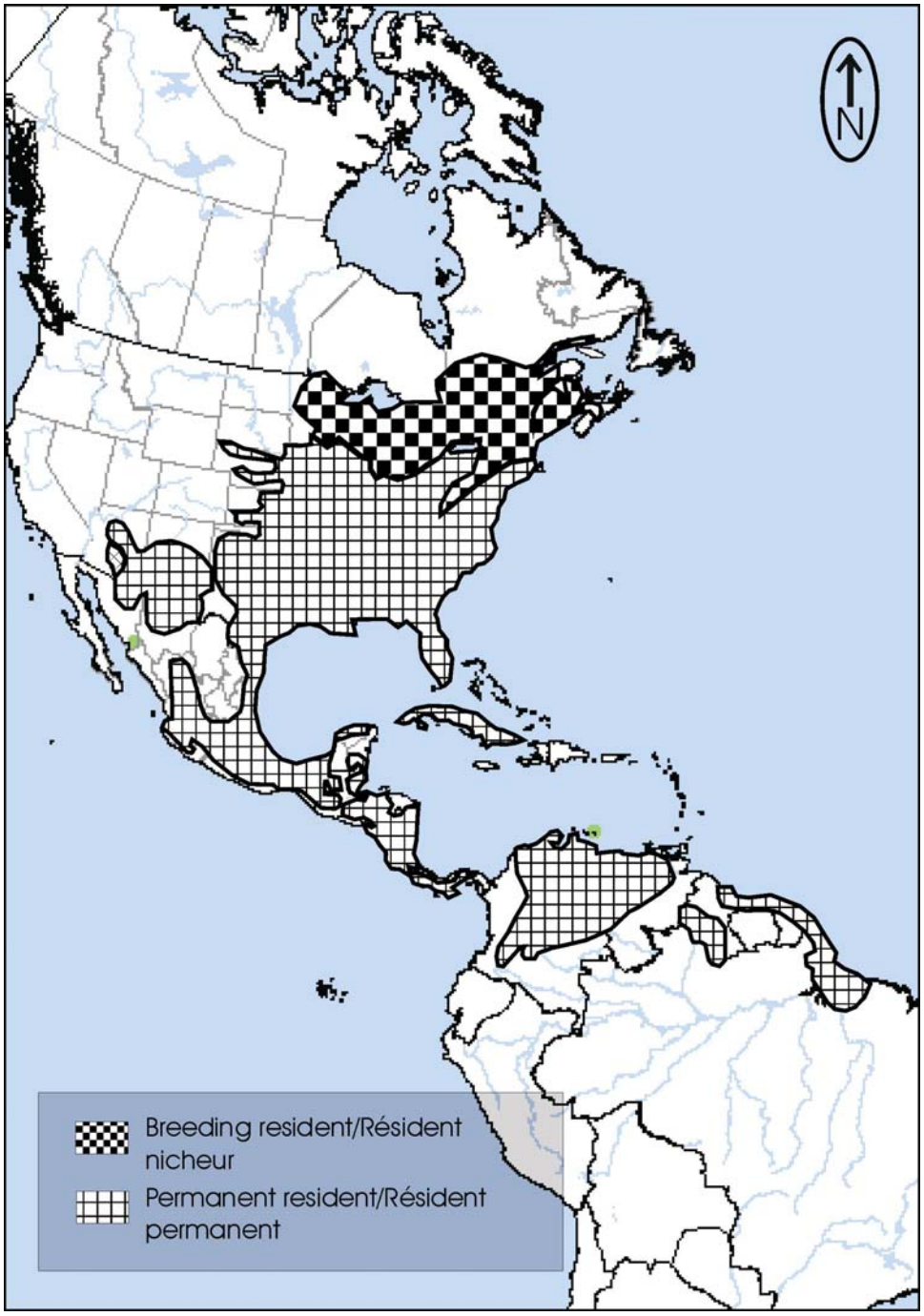

Figure 1. Current global range of the Eastern Meadowlark, including all subspecies (modified from Ridgely *et al.* 2003).

Canadian range

The Eastern Meadowlark currently breeds in southeastern Canada including southern Ontario, southern Quebec, New Brunswick and Nova Scotia (Figure 2; Godfrey 1986). It is impossible to reconstruct the species' breeding range prior to European settlement. The Eastern Meadowlark likely occurred across much of its present-day range at that time, albeit in smaller numbers and in more scattered areas in the east (Askins 1999). Following European settlement, its population in eastern Canada undoubtedly increased with the creation of large amounts of surrogate grasslands habitat (i.e., pastures, hayfields). As with most species of grassland birds over the past half century or more, Eastern Meadowlark populations have since been experiencing rangewide declines. Range contractions *per se* are not clearly evident in Canada, but there have been losses in area of occupancy (see **Habitat trends** and **POPULATION SIZE AND TRENDS**).

In Ontario, the Eastern Meadowlark's current breeding range extends from the southwestern part of the province more or less continuously north to include southern Algoma, Sudbury and Nipissing districts. It also occurs in a northern pocket of agricultural lands associated with the Little Clay Belt in Timiskaming District. In northwestern Ontario, it is uncommon in the Lake of the Woods area, particularly in agricultural areas of western Rainy River District. Its range is not, however, continuous across the north shore of Lake Superior (Cadman *et al.* 2007; Figure 2).

In Quebec, it nests in most of the St. Lawrence Valley Lowlands from Matane and Saguenay-Lac-St-Jean to the north, and in the Laurentian, Outaouais and Abitibi regions, and on the Magdalen Islands (Gauthier and Aubry 1995).

In New Brunswick, it breeds locally in the main agricultural areas of the southern and western parts of the province, but it also appears sporadically in the northeast (Christie *et al.* 2004; BSC 2010).

In Nova Scotia, it currently occurs in only a few scattered areas (BSC 2010). It does not appear to breed regularly in Nova Scotia; breeding was confirmed during the first Maritimes Breeding Bird Atlas about 20 years ago (in the Annapolis-Minas lowlands), but was not confirmed in the province during the present-day atlas project (P. Thomas and B. Whittam pers. comm. 2010).

Based on the range provided in Figure 2 and the minimum convex polygon method, the Eastern Meadowlark's extent of occurrence in Canada is estimated at 1,104,000 km^2 (A. Filion pers. comm. 2011). The index of area of occupancy (IAO) based on a 2 x 2 km^2 grid intersecting known areas of occupancy for the species cannot be calculated due to lack of detailed information on the locations of all breeding sites, but it undoubtedly exceeds COSEWIC's minimum threshold of 2000 km^2.

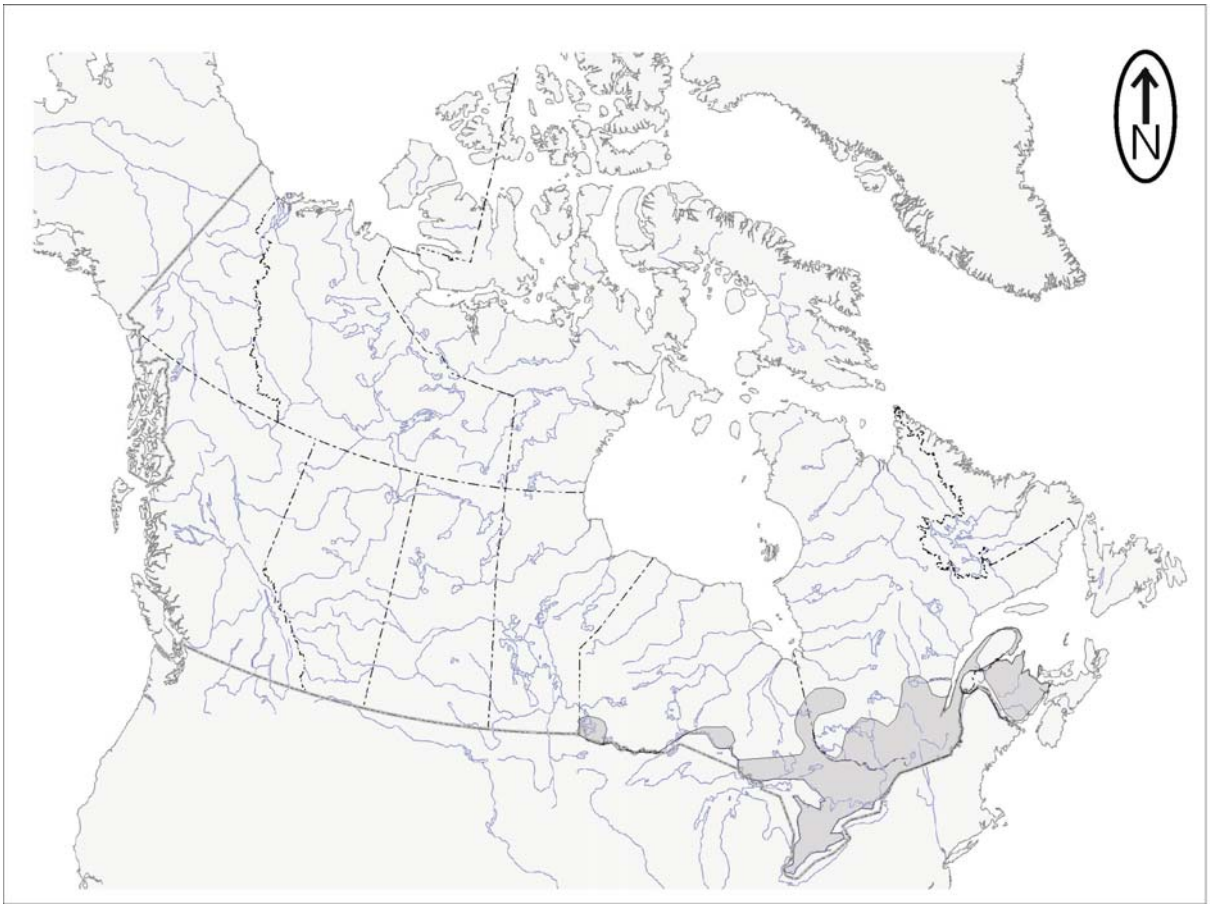

Figure 2. Current Canadian breeding range of the Eastern Meadowlark (based on Cyr and Larivée 1995; Gauthier and Aubry 1995; Cadman *et al.* 2007; Bird Studies Canada 2009). Note that the species' occurrence is not necessarily continuous within the broad range depicted; it is absent from regions that do not provide suitable grassland habitat.

Search effort

Distributional data for the Eastern Meadowlark mainly come from breeding bird atlas work conducted in the 1980s and in the 2000s in Ontario (Cadman *et al.* 1987; 2007), Quebec (Gauthier and Aubry 1995), and the Maritimes (Erskine 1992; BSC 2010). Recent distributional data are also provided by published summaries of historical observations from checklists in Quebec (Cyr and Larivée 1995) and Nova Scotia (Tufts 1986).

HABITAT

Habitat requirements

Few studies have been conducted on Eastern Meadowlarks in Canada, but a substantial amount of research has occurred in the United States. The Eastern Meadowlark is most common in native grasslands, pastures and savannahs (Lanyon 1995). It also uses a wide variety of other anthropogenic grassland habitats, including hayfields, weedy meadows, young orchards, golf courses, restored surface mines, grassy roadside verges, young oak plantations, grain fields, herbaceous fencerows, and grassy airfields (Boyer and Devitt 1961; Peck and James 1987; Bryan and Best 1991; Warner 1992; Lanyon 1995; Kershner and Bollinger 1996; Hull 2000; DeVault *et al.* 2002). Eastern Meadowlarks occasionally nest in row crop fields such as corn and soybean, but these crops are considered low-quality habitat (Cadman *et al.* 2007).

In hayfields, it prefers older sites due to the availability of short, sparse, patchy stands of grass-dominated vegetation. As fields age, litter cover, plant diversity and vegetation patchiness increase, whereas total plant cover, legume cover, and vegetation height decrease (Zimmerman 1992; Bollinger 1995).

As with other grassland bird species, the suitability of grassland habitat for Eastern Meadowlark involves a combination of landscape and patch characteristics (Herkert 1991; Vickery *et al.*1994; Renfrew and Ribic 2008). Large tracts of grasslands are preferred over smaller fragments (Herkert 1991; Vickery *et al.*1994), and breeding densities are positively associated with grassland area (Herkert 1991). The minimum area required is estimated at 5 ha (Herkert 1994). In Wisconsin, core area (areal extent of grassland located >25 m from the edge of a patch) of pastures was an important predictor of relative abundance, and composition of the landscape (grassland vs. row crops) was more important than habitat patch configuration (Renfrew and Ribic 2008). Relative abundance was frequently greater in pastures with more core area and in landscapes with more grassland and less wooded area.

However, there appear to be regional differences in the degree of sensitivity of Eastern Meadowlarks to habitat fragmentation. For example, in Illinois, the species was considered moderately sensitive to grassland habitat fragmentation attributes (O'Leary and Nyberg 2000; Hull 2000). Studies conducted in Missouri and New York suggest that the species is not especially area-sensitive, because breeding density was not influenced by patch size and because the species was not found to be affected by attributes such as edge density, distance to another patch of grassland or forest, or by cover, patch size or core area (>50 m from an edge) of grassland or forest (Bollinger 1995; Winter 1998; Horn *et al.* 2000).

At the field scale, the response of Eastern Meadowlarks to vegetation structure varies among studies (Hull 2000). Generally, optimal habitat contains moderately tall (25 to 50 cm) grass with abundant litter cover, a high proportion of grass, moderate to high forb density, low shrub and woody vegetation cover (<5%; >35% is too dense) and

low percent cover of bare ground (Wiens 1969; Roseberry and Klimstra 1970; Rotenberry and Wiens 1980; Schroeder and Sousa 1982; Askins 1993; Vickery *et al.* 1994; Granfors *et al.* 1996; Warren and Anderson 2005; Coppedge *et al.* 2008). Grass cover is important for breeding habitat because females build nests at the base of grass clumps and use litter to construct a roof and two side walls (Lanyon 1995). Scattered trees, shrubs, telephone poles, and fence posts are frequently used by Eastern Meadowlarks as elevated song perches (Wiens 1969; Sample 1989; Hull 2000).

Winter habitat is generally similar to that used during the breeding season, but also includes cultivated fields, feedlots and marshes. The species' wintering range is limited by cold temperatures, being generally absent from regions having an average minimum January temperature below -9ºC (Root 1988).

Habitat trends

Prior to European settlement, much of central and eastern Canada was forested and hence unsuitable for Eastern Meadowlarks. Nevertheless, its breeding range was firmly established in eastern North America at least as early as the mid-1700s (Askins 1999), where it would have occupied pockets of native prairie, savannah and alvar, as well as areas periodically cleared by First Nations communities for agriculture and areas that were exposed to fire. Falling to the plough, these natural habitats experienced major declines following European settlement in the 1800s. However, at roughly the same time as these losses were occurring, there was widespread conversion of the eastern forests to agricultural land. The Eastern Meadowlark responded by colonizing the burgeoning supply of forage crops (pastures and hayfields), the structure of which is similar to natural grasslands (Graber and Graber 1963; Herkert 1991).

This early period of expansion was subsequently followed by declines in the amount and quality of surrogate grassland habitat, which began in the 1940s in the United States (and likely Canada), with the intensification of agriculture (Herkert 1991; Martin and Gavin 1995; Rodenhouse *et al.* 1995; Granfors *et al.* 1996; Jones and Vickery 1997; Murphy 2003; Podulka *et al.* 2004). In Canada, similar declines in forage crops have occurred. Meanwhile, the decline in surrogate grassland habitat has not been offset by increases in the extent of native prairie that Eastern Meadowlarks originally occupied.

Recent trends in agricultural landuse in Ontario for the period 1981 to 2006 from Statistics Canada's Census of Agriculture (2006) show that total farm acreage declined by about 11%; the amount of land used for improved and unimproved pasture decreased by about 54% and 28%, respectively; the amount of land in summer fallow decreased by 81%; and the amount of farmland used for crops increased by about 1%.

In the St. Lawrence Lowlands of Quebec the number of dairy farms fell by half between 1971 and 1988 due to farm abandonment, industrialization and urbanization (Jobin *et al.* 1996). Over the same period, the total area planted to corn, soybeans and wheat, which are generally not used by Eastern Meadowlarks, increased by 23% due,

among other things, to new policies favouring grain production for livestock (Jobin *et al.* 1996; Bélanger and Grenier 2002; Jobin *et al.* 2007). According to Latendresse *et al.* (2008), this pattern of land use change in the St. Lawrence Lowlands began at least as far back as 1950.

Suitable breeding habitat across the species' range is also now declining due to substantial reforestation of abandoned farmlands and urbanization (Askins 1993; Brennan and Kuvlesky 2005). In parts of Ontario, the natural succession of abandoned agricultural fields is thought to be largely responsible for the species' decline (Cadman *et al.* 2007).

Within the remaining breeding habitat, there have also been rangewide trends toward earlier and more frequent mowing of hay crops, which reduces habitat quality directly because it results in large reductions in nest productivity (e.g., Lanyon 1995; Granfors *et al.*1996; With *et al.* 2008; see **Threats and Limiting Factors**).

Few studies exist on habitat trends of the Eastern Meadowlark on its wintering grounds, but intensification of agriculture and the conversion of forage crops to row crops are likely to have reduced the amount of winter habitat (Rodenhouse *et al.* 1995; Murphy 2003).

BIOLOGY

The most complete sources of information on the species' biology are provided by Lanyon (1995) and Hull's (2000) literature review.

Reproduction

Age of first reproduction is 1 year (Lanyon 1995). Generation time is likely 2-3 years.

The Eastern Meadowlark has a mixed reproductive strategy (monogamy and polygyny), with polygyny being frequent (Knapton 1988). Males can mate with up to three females over the breeding season (Knapton 1988; Lanyon 1995).

In Canada, males arrive on the breeding grounds in April, while females generally return 2-4 weeks later (Cadman *et al.* 2007). Pair bonds are established as soon as females arrive; courtship displays consist of song duets and aerial chases (Lanyon 1995). Breeding males exhibit strong territoriality; aerial pursuits and direct contact fights are frequent (Lanyon 1995). Nest building starts about 1 week after pair bonds are established (Lanyon 1995). Within a polygynous male's territory, several nests can be built simultaneously by females (Lanyon 1995). Nests are situated on the ground. They are well concealed in the vegetation and consist of a grass cup covered by grass woven from the surrounding vegetation (Bent 1958; Wiens 1969; Roseberry and Klimstra 1970).

Unsuccessful females will attempt to renest, often many times, within a single season (Lanyon 1957). Two broods can be produced per breeding season (Lanyon 1957, 1995; Wiens 1969; Peck and James 1987; Kershner *et al.* 2004), but the frequency with which this occurs in Canada is unlikely to be high given the short breeding season at northern latitudes. In two studies in the U.S., 17-37% of females attempted second nestings (Lanyon 1957; Kershner *et al.* 2004). Second clutches are laid in a new nest 2-3 days after young have fledged from the first nest (Bent 1958).

Four to five eggs per clutch is typical (Rosemary and Klimstra 1970; Knapton 1988; Peck and James 1987). The eggs are incubated by the female; incubation lasts 13-15 days (Lanyon 1995). In Illinois, the average number of eggs hatched per nest was 3.87 ± 0.18 SE (n = 23; Kershner *et al.* 2004). Nestlings fledge after 10-12 days (Lanyon 1995). Nest success (the proportion of nests producing at least one hatchling) is generally low (Lanyon 1957; Knapton 1988). Examples are 33% in Illinois (Lanyon 1957); 30% for monogamous females and 52% for females paired with polygynous males in Ontario (Knapton 1988); and 53% and 62% for the incubation and the nestling stage respectively in Wisconsin (Lanyon 1995).

After fledging, young continue to be fed by the adults for 2 weeks or more (Bent 1958). Males may take over feeding of fledged young if the female renests (Lanyon 1995). In Illinois, the average number of fledglings/nest was estimated at 1.97 ± 0.33 (n = 34); the average number of fledglings/successful nest (i.e., those that fledged at least one young) was estimated at 3.53 ± 0.21 (n = 23 nests; Kershner *et al.* 2004).

Fecundity and population growth

Studies on fecundity and population growth come exclusively from the midwestern United States. In southeastern Illinois, Kershner *et al.* (2004) reported that given that few females were successfully double-brooded (owing to a large proportion of nest failures in second clutches) and that unsuccessful females did not always renest, annual fecundity for females was between 1.27 ± 0.38 and 1.36 ± 0.37 female young/year.

Regional demographic analysis of Eastern Meadowlarks in the largest remaining tall-grass prairies in North America (Flint Hills in Kansas and Oklahoma: 2 million ha) indicates a negative population growth rate (ranging between 0.76 ± 0.096 in 2004 to 0.88 ± 0.17 in 2005; With *et al.* 2008). In this region, Eastern Meadowlarks are predicted to decline by 16-27%/yr and the probability that this region supports a viable population is $<$15% (With *et al.* 2008). Therefore, despite its large size, this region appears to be a population sink for Eastern Meadowlarks (With *et al.* 2008). It is suggested that habitat degradation due to intensive livestock grazing, combined with extensive and intensive fire management regimes, is responsible for the species' decline in this large grassland complex (With *et al.* 2008).

Survival

No data on survival exist for Eastern Meadowlarks in Canada. In the United States, Lanyon (1995) reported cases of adult banded birds recaptured at the age of 5 years. He also cites a longevity record of 9 years. Captive birds live 3-5 years (Lanyon 1995).

Recent radio-telemetry monitoring on post-fledgling movements in the United States has revealed a cumulative probability of survival of juvenile Eastern Meadowlarks of 0.63 (95% CI: 0.54-0.74) in Missouri (Suedkamp Wells *et al.* 2007) and a similar value of 0.69 (95% CI: 0.54-0.83) in Illinois (Kershner *et al.* 2004). In southeastern Illinois, based on fecundity information, Kershner *et al.* (2004) suggested that an annual adult survival rate of 59-61% was necessary for the maintenance of a stable population ($\lambda = 1.0$)

Movements/dispersal

The Eastern Meadowlark is a short-distance migrant (Lanyon 1995; Cadman *et al.* 2007). It is a diurnal migrant and starts its fall migration at the beginning of September (Bent 1958). The Canadian Atlas of Bird Banding reported a fall migration movement of a bird banded in Ontario that was recovered 1020 km to the south (Brewer *et al.* 2000). In fall and winter, Eastern Meadowlarks congregate in flocks of up to 200 birds in preferred habitat (Bent 1958).

Some detailed studies of post-breeding movements of Eastern Meadowlarks (using telemetry) come from the United States. In Illinois, 44% of females emigrated from the nest field following nesting (Kershner *et al.* 2004). A study of post-breeding movements of adult females in southwestern Wisconsin revealed that the majority moved outside the fields where their nests were located (on average, 590 ± 80 m, 95% CI = 419-759 m, n = 18; Guzy and Ribic 2007). Successful and unsuccessful breeders moved the same average distances.

Post-fledgling dispersal by juvenile Eastern Meadowlarks in Illinois occurred in an area averaging 80.9 ± 13.9 ha, and were characterized by larger movements (>600 m) occurring 28 days after fledgling (Suedkamp Wells *et al.* 2008). In another study, juveniles (after 3 weeks of age) had maximum dispersal distances ranging between 0.5 and 12.8 km (Kershner *et al.* 2004). In Wisconsin, the average distance moved by juveniles was 526 ± 107 m (n= 10 juveniles, 95% CI= 285-768m; Guzy and Ribic 2007).

Diet and foraging behaviour

Most Eastern Meadowlark foraging activities occur on or near the ground (Lanyon 1995). During the breeding period, they feed mainly on insects (74%) and plant matter (26%; Lanyon 1995). Crickets and grasshoppers comprised 26% of the annual diet, but were especially important in August (72% of the diet; Lanyon 1995). In spring, caterpillars, cutworms and grubs are preferred (Lanyon 1995). The species will also feed on bird eggs (Lanyon 1995). In an artificial nest experiment conducted near

Ottawa, Eastern Meadowlarks were responsible for more than 20% of all predation on quail eggs, suggesting that they could significantly affect the reproductive success of co-occurring bird species (Picman 1992).

During migration and on the wintering grounds, the Eastern Meadowlark's diet consists primarily of plant seeds; some waste grain and berries are also consumed (Bent 1958).

Interspecific interactions

Morphologically, the Eastern Meadowlark closely resembles the Western Meadowlark and hybridization, although rare, has been reported in regions of sympatry (Szijj 1963, 1966; Cadman *et al*. 2007). Male Eastern Meadowlarks defend their territories against Western Meadowlarks with the same intensity as with conspecifics (Lanyon 1957; Szijj 1966). When hybridization occurs in birds, hatching probability of eggs is reduced and nestlings have a lower rate of fledgling and the offspring are probably sterile at the adult stage (Welty 1975).

As a ground nester, the Eastern Meadowlark is vulnerable to predation by a variety of predators, including raptors, reptiles and mammals (Renfrew and Ribic 2003). In Wisconsin pastures, Eastern Meadowlark nests are depredated by at least 11 different species, including Raccoons (*Procyon lotor*), ground squirrels (*Spermophilus* spp.), feral cats (*Felis catus*) and several species of snakes (*Thamnophis* spp. and *Elaphe* spp.; Renfrew and Ribic 2003). In the St. Lawrence lowlands of southern Quebec, known and potential predators on Bobolink (*Dolichonix oryzivorus*) and probably on Eastern Meadowlarks include Northern Harriers (*Circus cyaneus*), Short-eared Owls (*Asio flammeus*), American Crows (*Corvus brachyrhynchos*), Ring-billed Gulls (*Larus delawarensis*), Raccoons, Striped Skunks (*Mephitis mephitis*), and Red Fox (*Vulpes vulpes*; Jobin and Picman 2002; Lavallée 1998).

Home range and territory

Both sexes exhibit site fidelity to previous breeding areas (Lanyon 1957, 1995). Eastern Meadowlarks have multipurpose territories in which feeding, mating, and rearing of young occur (Lanyon 1995), but prefer large grassland areas over small ones for breeding (Herkert 1994; Vickery *et al.* 1994; O'Leary and Nyberg 2000). In Wisconsin, territory size ranged from 1.2 to 6.1 ha, but was commonly 2.8-3.2 ha (Lanyon 1995). In New York, territories averaged 2.8 ha (Saunders 1932 in Lanyon 1995). Territory size and shape can change during the course of the breeding season, as habitat changes and the use of space changes (Lanyon 1995).

Behaviour and adaptability

The Eastern Meadowlark is well amenable to land management that promotes and maintains grassland habitat. The species is well adapted to low-moderate rotational grazing by cows (Jones and Vickery 1997; Risser *et al.* 1981 in Granfors *et al.* 1996) that maintains density and grass heights of about 10-30 cm. It also responds positively to prescribed burning conducted at 2-4 year intervals (Skinner 1975 in Lanyon 1995; Jones and Vickery 1997; Hull 2000; Walk and Warner 2000; Powell 2008; Coppedge *et al.* 2008). Generally, Eastern Meadowlark populations decline 1 year post-burn and increase the following years when grass cover reaches optimal height and density (Hull 2000). The species' response to fire varies, however, with factors such as soil type, climate, grassland type (native vs non-native), fire frequency, and time elapsed after burns take place (Zimmerman 1992; Hull 2000).

The species does not tolerate repeated hay cutting that is carried out throughout the breeding season but will respond positively to hay mowing that is conducted at intervals of 1-5 years (Hays and Farmer 1990; Granfors *et al.* 1996; Jones and Vickery 1997).

In the southern United States, the Eastern Meadowlark responds positively to the presence of large areas of restored grasslands using mining residue (DeVault *et al.* 2002; Galligan *et al.* 2006). These large artificial grasslands (often >2000 ha) are usually larger than surrounding pastures and hayfields and are not grazed or mowed and therefore represent important habitat for grassland bird species, including Eastern Meadowlarks (Galligan *et al.* 2006). The Eastern Meadowlark has also been shown to respond positively to the Conservation Reserve Program in the United States, where large areas of marginal agricultural lands are seeded with grasses and left idle (McCoy *et al.* 2001).

POPULATION SIZES AND TRENDS

Sampling effort and methods

<u>North American Breeding Bird Survey (BBS)</u>

The BBS is a program that surveys North American breeding bird populations (Sauer *et al.* 2011; Environment Canada 2010). Breeding bird abundance data are collected by volunteers at 50, 400-m radius stops spaced at 0.8 km intervals along permanent 39.2 km routes on roadsides (Sauer *et al.* 2011). In Canada, the surveys are generally conducted in June (i.e., during the breeding period of most bird species). Surveys start one half hour before sunrise and last 4.5 hours.

The BBS has several strengths. Data from a large number of routes across much of North America are collected annually according to a standardized method. BBS surveys employ random start points, thus enhancing regional representation of the avifauna (roadside-bias notwithstanding). Finally, the data are readily available for the bulk of North American landbirds (Blancher *et al.* 2007). In the case of Eastern Meadowlark, due to its loud distinctive song, its habit of singing from prominent perches, and its association with human-modified habitat (Cadman *et al.* 2007), it should be detected wherever it occurs along BBS routes. One short-coming of the BBS is that it extends no further back than 1968.

The Christmas Bird Count (CBC)

The Christmas Bird Count is a program that tracks North American bird populations in winter, and has been providing estimates of wintering population trends for several decades (Sauer *et al.* 1996; Audubon 2009). Each year, volunteers record all species found within a 24-km diameter circle on a single day between 14 December and 5 January (Sauer *et al.* 1996). The main advantage of this method is that it samples Eastern Meadowlark populations throughout their wintering range in the U.S. (Sauer *et al.* 1996). It is also possible now to combine data from the CBC and the BBS, two surveys conducted at different times of the year, to estimate seasonal components of population change (Link *et al.* 2008). Combining information from these surveys permits estimation of seasonal population variance components and improves estimation of long-term population trends (Link *et al.* 2008).

Several caveats exist with the CBC. First, because count effort is not uniform or standardized, the proportion of the true population that is counted each year and in each location is highly variable. Also, count circles are not randomly selected, but rather are purposefully chosen (Francis *et al.* 2004; Niven *et al.* 2004). Another issue with CBC data is that it includes counts of wintering birds that originate from across their breeding range. Hence, it is not possible to geographically distinguish between Eastern Meadowlarks that originate in Canada from those that originate in the United States. In addition, the CBC has difficulty in distinguishing between the two meadowlark species in zones where their wintering ranges overlap.

Étude des populations des oiseaux du Québec (ÉPOQ) / Study of Quebec Bird Populations (SQBP)

In Quebec, the SQBP database, which has been managing bird checklists submitted by thousands of volunteers since 1969 (> 200,000 checklists to date), is an additional survey program that is capable of monitoring Eastern Meadowlark population trends in this province (Cyr and Larivée 1995; Larivée 2009). The SQBP database covers all regions south of the 52nd parallel, especially the St. Lawrence Lowlands where the Eastern Meadowlark is most abundant, and in all seasons (Cyr and Larivée 1995). The abundance index produced by SQBP is a measure of the number of birds observed based on the number of checklists submitted.

The strength of this survey lies in the fact that it covers the entire breeding range of the species in Quebec and involves a large number of records (Cyr and Larivée 1995). However, as noted by Dunn *et al.* (1996), there is no element of standardization in the program (e.g., observers opportunistically select sites to visit and the dates of their visits, which can introduce positive biases in trend estimates). Also, the current analysis method does not take observation effort (i.e., the number of observers per checklist), weather conditions, or spatial variation in observation effort into account, but simply the number of hours of observation (Cyr and Larivée 1995). Nonetheless, the trends produced by SQBP are significantly correlated with those of the BBS, which is an indication that SQBP is generating adequate trend assessments (Cyr and Larivée 1995; Dunn *et al.* 1996).

Breeding Bird Atlas projects

The Ontario Breeding Bird Atlas compared the distribution of breeding birds between 1981-1985 and 2001-2005, and is an important source of information on the status of the Eastern Meadowlark in Ontario (Cadman *et al.* 2007). The data were gathered by volunteers who visited representative habitats within 10 x 10 km squares for at least 20 hours during the breeding period (Cadman *et al.* 2007). The percent change in the distribution of the Eastern Meadowlark over a period of 20 years was then calculated by comparing the percentage of squares with breeding evidence in the first atlas period to the percentage in the second atlas period, adjusting for observation effort (Cadman *et al.* 2007; Blancher *et al.* 2007). Because this method simply compares presence/absence data between two time periods, it is apt to underestimate the amount of change in actual population size, especially for common species like the Eastern Meadowlark (Francis *et al.* 2009). Differences in the type of effort between the two atlases may also have led to some biases in estimating change (Blancher *et al.* 2007), because there can be important differences in efficiency of effort that cannot be captured by simply adjusting for quantity of effort. Another major limitation of atlases is that they are typically repeated only at 20-year intervals, which means they cannot detect changes in population status during intervening periods (Francis *et al.* 2009).

Following a similar methodology as that in Ontario, a second breeding bird atlas was completed in the Maritimes in 2010 (Bird Studies Canada 2010). Preliminary results from that project are available for this status report. A second 5-year atlas project was also launched in Quebec in 2010, but it will take several years of data collection before analyses can be performed.

Abundance

Based on BBS data from 1990-99, the global population size for Eastern Meadowlark (all subspecies) was estimated at 10 million adults (Rich *et al.* 2004). At that time, the Canadian population was estimated at about 250,000 adults (roughly 125,000 breeding pairs), which represents about 2.5% of the global population. Based on breeding bird atlas data from 2001-05, the Ontario population was estimated at 150,000 birds (Blancher and Couturier 2007). The bulk of the Canadian population breeds in Ontario (about 70%), followed by Quebec (about 25%). Few breed in New Brunswick and Nova Scotia.

Fluctuations and trends

Prior to European settlement, the Eastern Meadowlark was most common in midwestern North America, where it occurred in native grasslands and savannahs and in open areas created around Aboriginal settlements. As such, it was probably formerly uncommon and rather scattered throughout much of its current range in Canada. Although there was a massive loss of its native habitat following European settlement, the species increased noticeably in the northeastern U.S. and eastern Canada during the 19th century, benefiting from deforestation and the widescale spread of early agricultural practices that provided ample surrogate grassland habitat (Bent 1958; Tufts 1986; Cadman *et al.* 1987; Christie *et al.* 2004; Brennan and Kuvlesky 2005). The native mid-western prairie habitat has not been restored. These earlier range and population expansions have been undergoing a reversal since the 1950s, following agricultural modernization, abandonment of marginal farmlands and subsequent forest succession, and the large-scale conversion of forage crops into row crops. Populations in Canada, and indeed across the Eastern Meadowlark's current and historical breeding range, have shown a decline since then (see below).

North American Breeding Bird Survey (BBS)

In North America, the BBS is regarded as the most robust program for monitoring trends of Eastern Meadowlarks (P. Blancher pers. comm. 2010). In Canada, long-term BBS data show a statistically significant population decline of 3.1% per year between 1970 and 2009 ($P < 0.001$; 95% CI = -4.1% to -2.0%; n = 167 routes), which corresponds to an overall decline of 71% over 40 years (Figure 3; Environment Canada 2010). For the most recent 10-year period (1999 to 2009), Canadian BBS data show a significant decline of 3.3% per year ($P < 0.001$; 95% CI = -5.2% to -1.3%; n = 156 routes), which represents a 29% decline over the last 10 years.[1]

[1] BBS data for Canada have recently been reanalyzed by the United States Geological Survey using a hierarchical approach (Sauer *et al.* 2011). This analysis method results in a significant decline of 3.1% per year for the most recent 10-year period (27% overall). The 95% Confidence Intervals around this estimate are -4.3% to -1.8%. The lower value produces an overall 10-year decline of 36%.

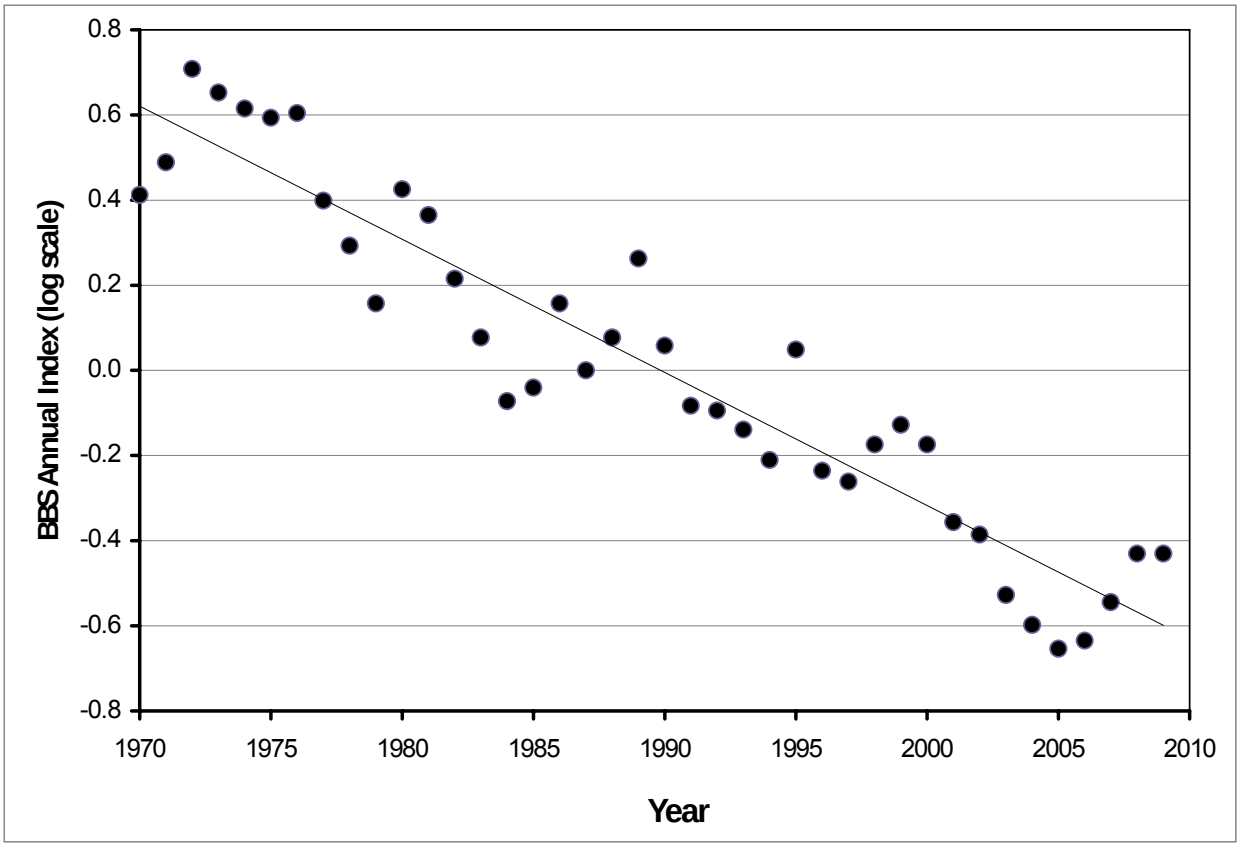

Figure 3. Eastern Meadowlark annual abundance indices and linear trend plotted on a log scale for Canada between 1970 and 2009, based on Breeding Bird Survey data (Environment Canada 2010).

The Christmas Bird Count (CBC)

Using a sophisticated hierarchical model for the years 1965-66 to 2004-05, Butcher and Niven (2007) estimated a trend of -3.35% per year (95% CI = -3.8% to -2.8%; n =1492) across an area in the U.S. that represents about 58% of the Eastern Meadowlark's wintering range. This translates to a 74% loss over the entire 39-year period (Figure 4). These results do not suggest signs of levelling off. It is important to point out that the CBC does not sample a sizable fraction (about 40%) of the species' wintering range, nor is there a good understanding of where Canadian birds are actually wintering.

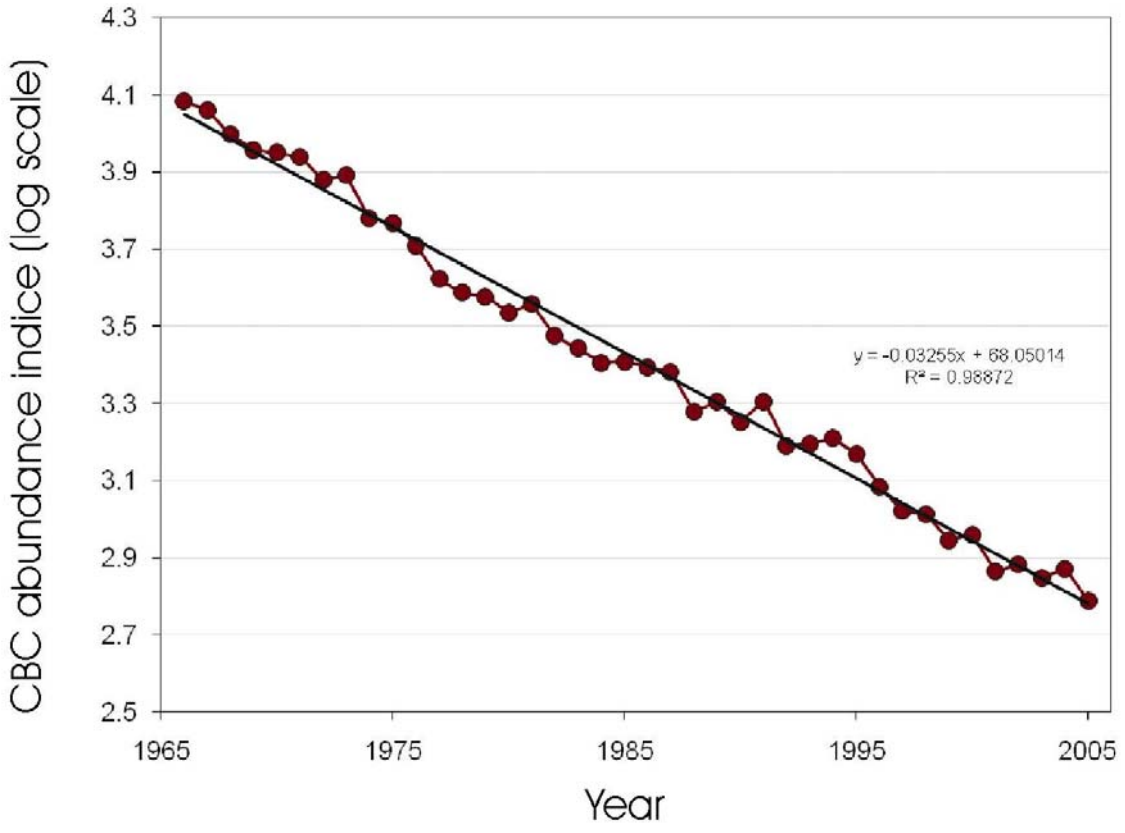

Figure 4. Population trend (hierarchical model) of wintering Eastern Meadowlarks between 1965 and 2005, based on the Christmas Bird Count (from Butcher and Niven 2007).

Ontario Breeding Bird Atlas

A comparison of the species' probability of detection in Ontario from the first (1981-1985) to the second (2001-2005) atlas period showed an overall significant decline of 13% in occupancy across the province as a whole, with significant regional declines ranging from 9 to 17% in the Southern Shield, Lake Simcoe-Rideau and Carolinian regions (Cadman *et al.* 2007; Figure 5). A non-significant decline was found for the Northern Shield region (Cadman *et al.* 2007). As noted earlier, atlas distributional changes in occupancy underestimate change in actual abundance for widespread common birds like Eastern Meadowlarks (Francis *et al.* 2009).

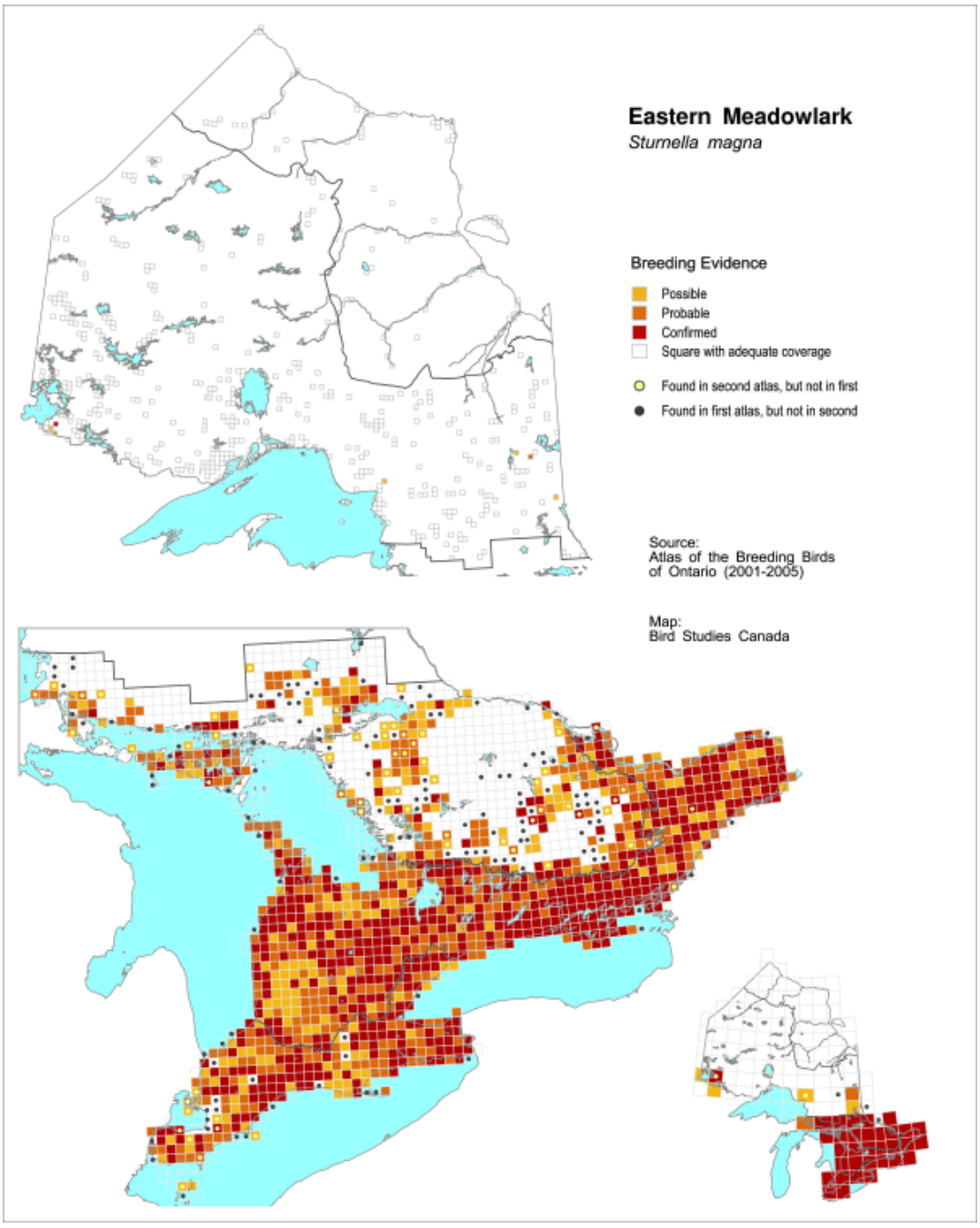

Figure 5. Ontario distribution of the Eastern Meadowlark during the period 2001-2005, based upon atlas data (reproduced with permission from Cadman *et al.* 2007). Squares with black dots are those in which the species was found in the first atlas period (1980-1985), but not in the second (2001-2005).

Maritimes Breeding Bird Atlas

Sample sizes are rather small in the Maritimes. Still, a comparison of the raw counts of occupied squares during the first breeding bird atlas (1986-1990) with the second atlas 20 years later (2006-2010) suggests a decline in occupancy of about 55% – from 29 10x10 km squares in the first atlas to 13 in the second (BSC 2010). A somewhat more refined estimate that takes observer effort into account yields a change of about -45% between the two atlas periods (B. Whittam pers. comm. 2011). The 10-year change is about -23%.

Étude des populations des oiseaux du Québec (ÉPOQ) / Study of Quebec Bird Populations (SQBP)

The ÉPOQ/SQBP database shows a significant long-term decline in Eastern Meadowlark records in Quebec of 2.4% per year (R^2= 0.81; P ≤ 0.001; Figure 6) between 1970 and 2008, representing a 60% decline over 38 years. There is an indication that the long-term negative trend in Quebec may be showing recent signs of reversal (Figure 6). Whether this is sustained can only be confirmed with additional years of data.

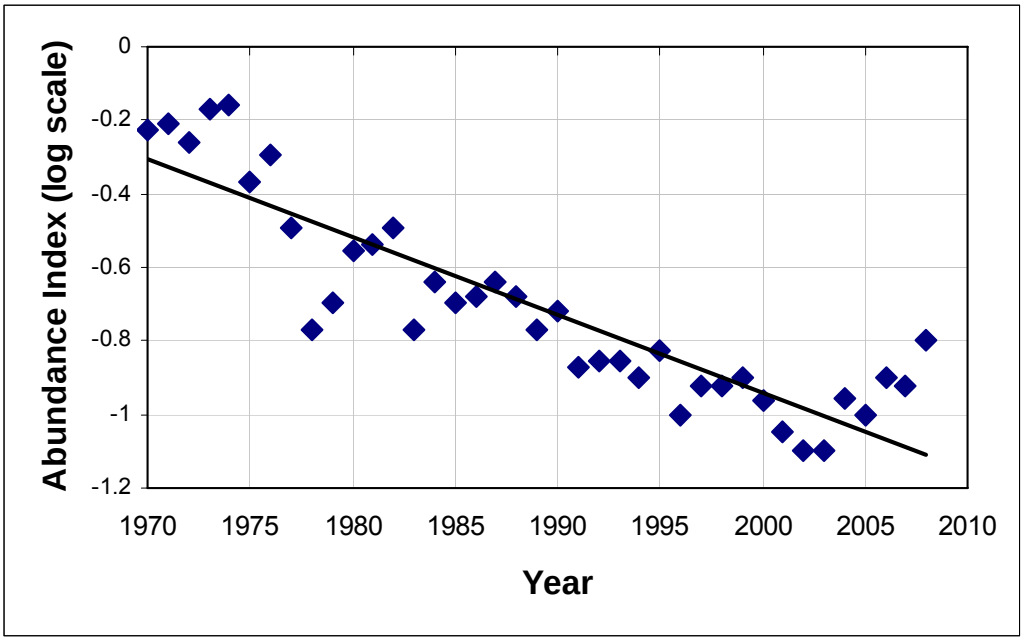

Figure 6. Annual indices of population change for the Eastern Meadowlark in Quebec between 1970 and 2008 plotted on a log scale, based on ÉPOQ/SQBP data (Larivée 2009).

Population trend summary

All available sources lead to the conclusion that the Eastern Meadowlark in Canada has experienced both national and regional population declines since at least the 1960s. The decline has been happening both over the long- (over 40 years) and short-term (over the last 10 years). Similar declines are also apparent for the Eastern Meadowlark population wintering in the U.S. While it is acknowledged that this species was less common and likely had a less extensive breeding range prior to European settlement, it is not possible to determine the degree to which the current population size resembles the prehistoric condition.

Rescue effect

In the event of the extirpation of the Canadian population, immigration of individuals from U.S. jurisdictions is likely. However, nearly every state, including all northern states bordering Canada, shows a statistically significant population decline (Sauer *et al.* 2011). This tempers the likelihood of rescue. Across the Eastern Meadowlark's range in the U.S., BBS results for the period 1966-2009 show a long-term, statistically significant average annual decline of 3.1% (95% CI = -30.7% to -2.9%; n = 2257 routes) or a 74% decline over 43 years (Sauer *et al.* 2011). The U.S. trend for the most recent 10-year period (1999-2009) is -2.2% per year (95% CI = -2.7 to -1.6) or 20% overall.

THREATS AND LIMITING FACTORS

Habitat loss on the breeding grounds

Historically, Eastern Meadowlarks suffered from large-scale habitat loss that occurred across North America, where it is estimated that more than 80% of all native grassland ecosystems (including 99% of tallgrass prairie) have disappeared since the mid-1800s (Knopf 1994; Samson and Knopf 1994; Noss *et al.* 1995; With *et al.* 2008). Tallgrass prairie and savannah habitats in southern Ontario are reduced to just a few thousand hectares (only 3% of their historic extent; Rodger 1998). Native grasslands continue to be adversely affected by encroachment of woody vegetation in the absence of wildfires, grazing or active management; tree planting; and expansion of rock quarries in alvar habitats.

Despite the large-scale conversion of the eastern forest to forage crops and dairy farms in the 1800s and early 1900s – a time at which Eastern Meadowlarks benefited (Cadman *et al.* 1987; Gauthier and Aubry 1995) – market pressures and modern agricultural practices that involve increased mechanization rapidly converted forage crops (i.e., pastures and hayfields) to intensive cereal and row crops (Jobin *et al.* 1996; Corace *et al.* 2009). This has likely been partly responsible for the recent negative trends in Eastern Meadowlark populations (Jobin *et al.* 1996; Corace *et al.* 2009).

A variety of declining grassland bird species, including Eastern Meadowlark, may also reflect the legacy of past land-use changes (With *et al.* 2008). North American grasslands may have been reduced below some critical habitat threshold corresponding to the individual extinction threshold of many species (Hanski and Ovaskainen 2002). The fact that the largest remaining grassland ecosystems, such as the large extent of tallgrass prairie in Kansas and Oklahoma, cannot apparently support viable populations of Eastern Meadowlarks suggests that habitat degradation is eroding the source potential of these regions (With *et al.* 2008).

Intensification and modernization of agricultural techniques

Since at least the 1950s, increased mechanization and the use of more intensive management practices in agriculture have favoured earlier and more frequent hay cutting (up to three harvests between June 15 and August 15 for Canada), which is known to reduce nest productivity as a consequence of the high rate of mortality in young and adult Eastern Meadowlarks during the breeding season (e.g., Lanyon 1995; Granfors *et al.*1996; Nocera *et al*. 2005, 2007; With *et al.* 2008). In northwestern Arkansas, early mowing activities (mid-May) during the nesting period destroyed 83% of songbird nests (including Eastern Meadowlark), but nest loss was substantially reduced (to only 4%) when harvest was delayed until the third week of June (Luscier and Thompson 2009). Similarly, mowing was the primary disturbance responsible for low productivity of Eastern Meadowlark nests at rural Illinois airports, suggesting that rural airports may act as ecological traps because nesting density was high but nest success was low (Kershner and Bollinger 1996). In Michigan, Eastern Meadowlarks successfully fledged one brood before mowing occurred, but ceased breeding activities after the fields were mowed (Harrison 1974 in Hull 2000). Although Roseberry and Klimstra (1970) reported a relatively low rate of nest loss in Illinois due to hay mowing (18%; 32 of 182 nests), their study occurred at a time when early-season mowing was probably not yet widespread. At the scale of the Upper Great Lakes, Corace *et al.* (2009) could find no significant relationship between hayfield mowing intensity and regional population trends of Eastern Meadowlark. More work on this subject is needed.

Other modern techniques used in agriculture such as spring surface tillage for weed-control also negatively affect Eastern Meadowlark abundance by destroying nests, young, and incubating adults (Castrale 1985; Lanyon 1995).

Predation and Brown-headed Cowbird brood parasitism

Predators of nests and fledglings include foxes, domestic cats and dogs, coyotes, snakes, skunks, raccoons, ground squirrels, and other small mammals (Lanyon 1995; Suedkamp Wells *et al.* 2007). Several studies have suggested that predation is a major source of nest failure of several grassland bird species, including Eastern Meadowlark (Knapton 1988; Granfors *et al.* 1996; Renfrew and Ribic 2003; Renfrew *et al.* 2005; Perkins and Vickery 2007). Predation rate during the egg and nestling stages varies among studies and regions (normally ranging from 15 to 52%; Granfors *et al.* 1996; Renfrew *et al.* 2005), but it can be as high as 80% (Warren and Anderson 2005; Rahmig *et al.* 2008). A study conducted in Missouri reported that predation is also high (70%) during the post-fledgling period (Suedkamp Wells *et al.* 2007).

In Wisconsin, agricultural edges did not appear to concentrate mammalian predators (Renfrew *et al.* 2005), which means that grassland birds face predation by species that forage outside of the grassland as well as those that hunt within it (Renfrew and Ribic 2003; Renfrew *et al.* 2005). Reduced vegetation height and density resulting from cattle grazing may facilitate predator travel through pastures, increasing their activity in the pasture interior (Renfrew *et al.* 2005).

Although Eastern Meadowlarks generally show a high rate of cowbird egg rejection (Peer *et al.* 2000), they can be a frequent host for Brown-headed Cowbirds (*Molothrus ater*) in some regions (Lanyon 1995), and cases of nest failure caused by cowbirds have been reported (Lanyon 1957; Roseberry and Klimstra 1970; Elliott 1978). Rates of parasitism vary greatly among studies, being generally low in Ontario (2.4% of 370 nests; Peck and James 1987), Indiana (0%, n = 131 nests; Galligan *et al.* 2006), Illinois (1.8%, n = 221 nests; Peer *et al.* 2000), and Oklahoma (6.1 %, n = 512 nests; Patten *et al.* 2006), but relatively high in Wisconsin (16%, n = 38 nests; Lanyon 1957) and Kansas (7.7- 36.5 %; Rahmig *et al.* 2008). Generally, regional cowbird abundance and parasitism rates are positively related to the amount of cattle grazing (Patten *et al.* 2006; Rahmig *et al.* 2008). At the same time, the abundance of Eastern Meadowlarks itself is also presumably linked to the amount of pastureland.

Habitat fragmentation and edge effect

The effect of habitat fragmentation on Eastern Meadowlarks varies regionally among studies, but most generally imply an effect of area size, edge effects and an increase in predation and cowbird parasitism rates on productivity (Herkert *et al.* 2003). Generally, presence of woody edges negatively affects nest success, which increases with distance from forest edges (Galligan *et al.* 2006). In Oklahoma, Eastern Meadowlarks avoid nesting along wooded roads bordering tallgrass prairies. In southern Wisconsin, they are negatively affected by habitat fragmentation, which promotes closer proximity of nests to nearby woodlots (Ribic and Sample 2001). Rate of cowbird parasitism along wooded roads is significantly higher (19.2%) than in undisturbed prairies (6.1%; Patten *et al.* 2006).

In the mid-continental United States, the daily predation rate of Eastern Meadowlark nests decreases as size of grassland habitat increases (ranging from 5.6 to 7.2% in >100 ha fragments; 5.0 to 13.0% in 100-1000 ha fragments and from 2.2 to 4.6% in very large habitat fragments ≥ 1,000 ha; Herkert *et al.* 2003). The reason for a lower predation rate in larger fragments is unclear, but may be due to the amount of grassland habitat in the surrounding landscape matrix (Herkert *et al.* 2003).

Pesticide use on breeding and wintering grounds

There is evidence that mortality resulting from the use of toxic pesticides has been contributing to farmland bird declines in North America, including Eastern Meadowlark. Mortality from pesticides was first described by Griffin (1959) in Oklahoma, where seven Eastern and Western meadowlark deaths were attributed to exposure to seeds treated with Di-Syston and Thimet. In Maine, territory density of Eastern Meadowlarks decreased, and did not recover during an 8-year study after Lowbush Blueberries (*Vaccinium angustifolium*) were sprayed with the herbicide hexazinone at a rate of 4 kg/ha (Vickery 1993 in Lanyon 1995).

Wintering populations of Eastern Meadowlarks could also be negatively affected by blackbird control programs using various avicides, including 3-chloro-p-toluidine and 3-chloro-4-methylaniline hydrochloride (collectively termed DRC-1339) currently used in the southeastern United States where rice plantations are subject to high depredation rates by blackbirds (Denison 2003; Pipas *et al.* 2003). In Louisiana and Texas, meadowlarks are among the most frequent species using rice fields baited with DRC-1339 (Pipas *et al.* 2003). DRC-1339 dietary feeding tests conducted on nine meadowlarks resulted in 89% mortality when birds were offered 2% DRC-1339-treated rice diluted 1:25 with untreated rice for 5 days (Cummings *et al.* 2003). In North and South Dakota, the Western Meadowlark is also known to be highly sensitive to this avicide (Linz *et al.* 2002). Large-scale studies in rice-producing regions are currently lacking to assess the real impact of the use of this product on winter survival of Eastern Meadowlarks.

A large-scale analysis conducted in the Canadian prairies suggested that the Western Meadowlark was among the top three species being most affected by large-scale use of granular carbofuran pesticides used in row crops (Mineau *et al.* 2005). At the peak of its popularity in the United States, this product was giving rise to an estimated annual loss of 17-91 million birds in cornfields alone. Granular carbofuran formulations are no longer in use in Canada and the United States, but they probably contributed to declines in meadowlark populations prior to their being taken off the market. This product continues to be used in most Latin American countries on a wide variety of crops (Mineau 2005), where it could continue to affect wintering birds from Canada. Elsewhere on the species' wintering grounds, a national analysis of the risk of bird mortality due to pesticide exposure in the U.S. suggested that the greatest number of bird kills likely occurs in the southeastern states, owing to the high proportion of farmlands using pesticides on crops such as cotton, corn, and cranberry (Mineau and Whiteside 2006).

Other threats

Overgrazing and trampling by livestock

Eastern Meadowlarks respond negatively to overgrazing during the breeding season, because it significantly reduces grass cover and plant diversity (Roseberry and Klimstra 1970). Intense grazing that leaves grass height under 10 cm negatively impacts nesting and foraging opportunities (Roseberry and Klimstra 1970). Overgrazing is reported to have the greatest impact on birds nesting in grasslands of short vegetation (Hull 2000). In contrast, Eastern Meadowlarks respond positively to low to moderate grazing in grasslands of taller vegetation (Baker and Guthery 1990; Bock *et al.* 1993; Temple *et al.* 1999; Hull 2000; Powell 2008). Although Eastern Meadowlarks tolerate moderately grazed habitats during the breeding season, relatively high rates of trampling of nests (4.6-7.6%) have been reported in such pastures in Wisconsin (Renfrew *et al.* 2005).

Climate change and extreme weather

In winter and early spring, Eastern Meadowlarks are sensitive to extreme weather patterns such as ice storms and deep snow cover (Krutzsch 1950). Lanyon (1995) suggested that Eastern Meadowlark populations outside the breeding season are regulated by frequent severe weather occurring during migration and on the wintering grounds. Furthermore, With *et al.* (2008) reported a decrease in fecundity and nesting success in Eastern Meadowlarks in Kansas and Oklahoma due to severe drought. In the Great Plains, models of climate change predict higher frequency of droughts and other significant changes in precipitation patterns (Knapp *et al.* 2002) that may negatively impact Eastern Meadowlarks (With *et al.* 2008). The potential impact of climate change on Eastern Meadowlark has not been investigated in Canada.

Effects of human disturbance

Eastern Meadowlarks are sensitive to human presence in their breeding territories and they will often abandon nests if flushed from them; adults will also delay visits to their nest when human activities occur nearby (Lanyon 1995). However, this should be considered a relatively minor threat.

PROTECTION, STATUS, AND RANKS

Legal protection and status

In Canada, the Eastern Meadowlark and its nests and eggs are protected under the *Migratory Birds Convention Act*. In Quebec, it is also protected under the *Loi sur la conservation et la mise en valeur de la faune* (L.R.Q., c. C-61.1), and it is prohibited to hunt, capture, keep in captivity, sell this species or destroy or damage its nest and eggs. In Ontario, the *Fish and Wildlife Conservation Act* (S.O. 1997, c.41, 7. [1]) states that a person shall not destroy, take, or possess the nest or eggs of a bird that belongs to a species that is wild by nature. No other provinces have specific legal protection mechanisms in place for this species.

Non-legal status and ranks

At the global level, the species is considered secure (G5; Table 1) by NatureServe. It is ranked 'Least concern' according to the IUCN Red List (NatureServe 2009). Although the Eastern Meadowlark did not appear on the 'Watch List' of the North American Landbird Conservation Plan (Rich *et al.* 2004), the National Audubon Society recently ranked it sixth on its North American "List of Top 20 Common Birds in Decline" (see http://stateofthebirds.audubon.org/cbid/browseSpecies.php). Likewise, Berlanga *et al.* (2010) include the Eastern Meadowlark on a featured list of 42 "Common Birds in Steep Decline" in North America.

In the United States, the species is ranked secure (N5; Table 1). At the state level, it is ranked critically imperiled (S1) or imperiled (S2) in two states, and vulnerable (S3) in five (NatureServe 2009).

In Canada, the Eastern Meadowlark is presently considered secure and common (N5). It is considered apparently secure (S4) in Ontario, vulnerable (S3) in Quebec, imperiled (S2) in New Brunswick and critically imperiled (S1) in Nova Scotia (NatureServe 2009; Gouvernement du Québec 2010; Table 1). The species is currently not tracked by biodiversity information centres in Ontario (Ontario Ministry of Natural Resources 2009), Quebec (Gouvernement du Québec 2010) or the Maritimes (S. Blaney pers. comm. 2009).

Table 1. Ranks assigned to the Eastern Meadowlark in North America, based on NatureServe (2009), le Centre de données sur le patrimoine naturel du Québec (2010), and General Status Ranks (CESCC 2006).

Region	Rank*	General Status
Global	G5	---
United States	N5B	---
Canada	N5B	Secure
Ontario	S4B	Secure
Quebec	S3B	Vulnerable
New Brunswick	S1S2B	May be at risk
Nova Scotia	S1B	Sensitive

* G = is a global status rank; S = rank assigned to a province or state; N= is a national status rank; B= breeding status. S1 indicates that a species is critically imperiled because of extreme rarity (often 5 or fewer occurrences) or because of some factor(s) such as steep declines, making it especially vulnerable to extirpation; S2 indicates that a species is imperiled because of rarity or other factors making it vulnerable to extirpation, usually with 6 to 20 occurrences or few individuals remaining (i.e., 1000 to 3000); S3 indicates that a species is vulnerable at the subnational level because it is rare or uncommon, or found only in a restricted range, or because of other factors making it vulnerable to extirpation; S4 indicates a species is apparently secure; S5 indicates that a species is secure because it is common, widespread, and abundant.

Habitat protection and ownership

Private lands

A rough comparison of the dairy farms in central and eastern Canada (Natural Resources Canada 2009) with the Eastern Meadowlark's range suggests that the species' distribution is closely linked to these private agricultural lands. Several non-government conservation groups are involved in the conservation and stewardship of grassland habitats on private lands in Canada, but the amount of habitat currently enrolled in such programs within the Eastern Meadowlark's breeding range is modest at best.

Public lands

Little information is available on the quantity of available habitat and the level of habitat protection on public lands in central and eastern Canada, but it undoubtedly constitutes only a tiny fraction of the area occupied by this species. Small areas of grassland habitat on public lands are protected in national and provincial parks, Migratory Bird Sanctuaries and National Wildlife Areas. According to the Parks Canada's Biotics database, the Eastern Meadowlark is present (including incidental observations) in at least 11 protected areas managed by Parks Canada (Parks Canada 2009). There are few data on occurrence of Eastern Meadowlarks on lands owned by the Department of National Defence, but the species undoubtedly occurs on Ontario properties owned by the military, including Meaford, Petawawa, London, and Trenton (Jennifer Rowland pers. comm. 2010).

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