COSEWIC
Assessment and Status Report

on the

Red-tailed Leafhopper
Aflexia rubranura

Prairie Population
Great Lakes Plains Population

in Canada

SPECIAL CONCERN
2018

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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Red-tailed Leafhopper — Photo provided by authors.

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COSEWIC
Assessment Summary

Assessment Summary – April 2018

Common name
Red-tailed Leafhopper - Prairie Population

Scientific name
Aflexia rubranura

Status
Special Concern

Reason for designation
This flightless leafhopper has limited dispersal ability. It is restricted to remnant oak savanna grassland habitat in southern Manitoba, a habitat that has largely been lost from the province. It relies on the presence of the host plant Prairie Dropseed. The species is known from 8 sites at present, but there are likely to be additional sites found. Current and cumulative threats include agricultural habitat conversion and native and non-native plan succession from fire suppression and overgrazing.

Occurrence
Manitoba

Status history
Designated Special Concern in April 2018.

Assessment Summary – April 2018

Common name
Red-tailed Leafhopper - Great Lakes Plains Population

Scientific name
Aflexia rubranura

Status
Special Concern

Reason for designation
This is a flightless species with limited dispersal ability, restricted to remnant grassland and savanna alvar habitats on Manitoulin and adjacent islands, Ontario. The species' only known host plant, Prairie Dropseed, has a wider distribution but is also rare. The species is known from a small number of sites threatened from ongoing aggregate extraction, fire and fire suppression, livestock grazing, and recreational use.

Occurrence
Ontario

Status history
Designated Special Concern in November 2017.

COSEWIC
Executive Summary

Red-tailed Leafhopper
Aflexia rubranura

Prairie Population
Great Lakes Plains Population

Wildlife Species Description and Significance

Red-tailed Leafhopper is a small (3 – 4 mm length) member of the leafhopper family, Cicadellidae (Order Hemiptera). They are predominately tan-coloured, with distinctive black transverse bars and spots on the head and thorax. The species is aptly named for the prominent red segment at the tip of the abdomen on adult males. Males and most females have shortened and non-functional wings, although occasionally some females develop longer wings and may (but are not known to) fly. It is unknown how often females may develop longer wings, what proportion of a subpopulation they may represent or what environmental factors may trigger such growth. Nymphs are smaller, wingless and have a similar body form with an unmarked yellow back and a brown underside. The eggs have not been described.

Red-tailed Leafhopper is the only member of its genus *Aflexia* which is globally imperilled. The species is restricted to relict prairie, savanna, and alvar habitats which are also imperilled ecosystems in Canada.

Distribution

In Canada, Red-tailed Leafhopper is known from 27 sites separated into two designatable units (DUs). Designatable units should be discrete and evolutionarily significant units of the taxonomic species, where “significant” means that the unit is important to the evolutionary legacy of the species as a whole and if lost would likely not be replaced through natural dispersion. The two DUs for Red-tailed Leafhopper are the Prairie population (8 known sites) which occurs in southern Manitoba and the Great Lakes Plains population (19 known sites) which occurs in Manitoulin and adjacent islands in southern Ontario. The two DUs are separated by over 1000 km of unsuitable habitat, demographically, and have been genetically disjunct for at least 9000 years. Within the United States, the leafhopper is known from a small number (< 50) of sites in Minnesota, Wisconsin, Illinois, and South Dakota.

Habitat

Red-tailed Leafhopper is found in open grassland and savanna habitats where its host plant, Prairie Dropseed (*Sporobolus heterolepis*) grows. Prairie Dropseed is more widely distributed than Red-tailed Leafhopper; however, the presence of the host plant does not ensure the leafhopper's presence. In southern Manitoba and the United States, Red-tailed Leafhoppers are found in remnant patches of Bur Oak savanna within tallgrass prairie. In Ontario, the species is restricted to alvar grasslands and savannas.

Biology

Red-tailed Leafhoppers are monophagous, with both nymphs and adults feeding only on the fluids of Prairie Dropseed. They also use the large clumps of this bunchgrass as shelter. Adults are active from mid-July to mid-September and are believed to oviposit in the stems of Prairie Dropseed where the eggs overwinter until the following spring. In Canada, they have one generation per year, although farther south (Illinois) they can have two generations a year.

Population Sizes and Trends

Red-tailed Leafhopper appears less abundant now than historically due to the near-complete loss of its tallgrass prairie Bur Oak habitat in Manitoba and less drastic losses of its alvar habitat in Ontario. The number of sites occupied by Red-tailed Leafhopper in Canada appears to be stable since it was first recorded in the country approximately 45 years ago, with an increased number of known sites due to increased search effort. There are too few data available from which to derive population estimates.

Threats and Limiting Factors

Habitat trends within the last ten years are poorly known, particularly for the Manitoba (Prairie population) sites. The primary threats to Manitoba subpopulations are conversion to agriculture, and the cumulative effects of fire/fire suppression and native tree encroachment within the open habitats, thereby out-competing and reducing the abundance of host plants available to the leafhopper. Threats to Ontario subpopulations (Great Lakes Plains population) are habitat conversion to housing (e.g., cottage development), fire and fire suppression and subsequent ingrowth of native and non-native plants, livestock over-grazing and habitat degradation from recreation. The primary limiting factors for Red-tailed Leafhopper are its limited dispersal ability, and the availability of Bur Oak savanna habitat in Manitoba and alvar habitat in Ontario; the abundance of its host plant, Prairie Dropseed; and vulnerability to weather patterns.

Protection, Status and Ranks

Red-tailed Leafhopper has no legal protection at the federal or provincial level in Canada. In Ontario, two sites (Misery Bay East and West) are protected by Misery Bay Provincial Park and one site (East Belanger Bay) is in Queen Mother Mnidoo Mnissing

Provincial Park. The Red-tailed Leafhopper site south of St. Laurent, Manitoba, is within the Lake Francis Wildlife Management Unit (WMA). The St. Charles Rifle Range is owned by the federal Department of National Defence. One Ontario site near South Bay is on Wikwemikong First Nation land. A few Red-tailed Leafhopper sites along road allowances may be Crown or municipal land.

Red-tailed Leafhopper is ranked by NatureServe as globally (G2) and nationally (N1N2) imperilled; unranked (NNR) nationally in the United States; critically imperilled (S1) in Ontario and unranked (SNR) in Manitoba.

TECHNICAL SUMMARY – Prairie Population

Aflexia rubranura

Red-tailed Leafhopper
Prairie Population

Cicadelle à queue rouge
Population des Prairies

Range of occurrence in Canada: Manitoba

Demographic Information

Generation time	1 year
Is there an [observed, inferred, or projected] continuing decline in number of mature individuals?	Insufficient data
Estimated percent of continuing decline in total number of mature individuals within [5 years or 2 generations]	Insufficient data
[Observed, estimated, inferred, or suspected] percent [reduction or increase] in total number of mature individuals over the last [10 years, or 3 generations].	Insufficient data
[Projected or suspected] percent [reduction or increase] in total number of mature individuals over the next [10 years, or 3 generations].	Insufficient data
[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.	Insufficient data
Are the causes of the decline a. clearly reversible b. understood c. ceased?	 a. No b. Partially c. No
Are there extreme fluctuations in number of mature individuals?	No

Extent and Occupancy Information

Estimated extent of occurrence (EOO)	3146 km²
Index of area of occupancy (IAO) (2x2 grid value)	28 km²; maximum estimated at < 500 km^2
Is the population "severely fragmented" i.e., is >50% of its total area of occupancy is in habitat patches that are (a) smaller than would be required to support a viable population, and (b) separated from other habitat patches by a distance larger than the species can be expected to disperse?	a. No; populations seem to be able to persist on small patches of the host plant. b. Yes; known habits show it can cross a highway but not repopulate distant sites.
Number of "locations"* (use plausible range to reflect uncertainty if appropriate)	Minimum 8 locations; upper limit unknown

* See Definitions and Abbreviations on COSEWIC website and IUCN (Feb 2014) for more information on this term

Is there an [observed, inferred, or projected] decline in extent of occurrence?	Yes, inferred based on threats to habitat
Is there an [observed, inferred, or projected] decline in index of area of occupancy?	Yes, inferred based on threats to habitat
Is there an [observed, inferred, or projected] decline in number of subpopulations?	Yes, inferred based on threats to habitat
Is there an [observed, inferred, or projected] decline in number of “locations”*?	Yes, inferred based on threats to habitat
Is there an [observed, inferred, or projected] decline in [area, extent and/or quality] of habitat?	Yes, inferred based on threats to habitat
Are there extreme fluctuations in number of subpopulations?	No
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 subpopulation)

Subpopulations (give plausible ranges)	N Mature Individuals
Total	Unknown

Quantitative Analysis

Probability of extinction in the wild is at least [20% within 20 years or 5 generations, or 10% within 100 years].	Insufficient data

Threats (actual or imminent, to populations or habitats, from highest impact to least)

Was a threats calculator completed for this species?

Yes; calculated at Low Impact.

Threats: 7.3 Other ecosystem modifications – Low (cumulative secondary threats from 7.1 Fire and fire suppression; 8.1 Non-native/invasive species and genes; 8.2 Problematic native species and diseases)

What additional limiting factors are relevant?

- Host plant and habitat specificity
- Small subpopulation size and genetic isolation
- Natural parasitic enemies
- Vulnerability to weather patterns

Dispersal ability

* See Definitions and Abbreviations on COSEWIC website and IUCN (Feb 2014) for more information on this term

Rescue Effect (immigration from outside Canada)

Status of outside population(s) most likely to provide immigrants to Canada.	Globally imperilled (G2); Illinois (Imperilled S2), Wisconsin (possibly imperilled S2?); Minnesota (vulnerable S3); not likely to provide immigrants to Canada
Is immigration known or possible?	No. The nearest population in the United States is 300 km from the nearest Manitoba population. Adults are flightless and there is unsuitable intervening habitat.
Would immigrants be adapted to survive in Canada?	Possibly. Same host plant but climate is colder.
Is there sufficient habitat for immigrants in Canada?	Possibly. Apparently suitable habitat appears to be currently unoccupied in Canada.
Are conditions deteriorating in Canada?[+]	Yes. Habitat is slowly being lost to development, encroachment and natural succession by native and non-native plants.
Are conditions for the source population deteriorating?[+]	Unknown.
Is the Canadian population considered to be a sink?[+]	Not likely, species is not able to disperse long distances. Adults are flightless and there is unsuitable intervening habitat.
Is rescue from outside populations likely?	No. The nearest US population is 300 km from the nearest Manitoba population. The nearest Canadian populations (e.g., Great Lakes Plains subpopulations) are over 1000 km from each other. Adults are flightless and there is unsuitable intervening habitat.

Data Sensitive Species

Is this a data sensitive species? No.

Status History

COSEWIC: Designated Special Concern in April 2018

Status and Reasons for Designation Prairie Population:

Status: Special Concern	**Alpha-numeric codes:** Not applicable
Reasons for designation: This flightless leafhopper has limited dispersal ability. It is restricted to remnant oak savanna grassland habitat in southern Manitoba, a habitat that has largely been lost from the province. It relies on the presence of the host plant Prairie Dropseed. The species is known from 8 sites at present, but there are likely to be additional sites found. Current and cumulative threats include agricultural habitat conversion and native and non-native plan succession from fire suppression and overgrazing.	

[+] See Table 3 (Guidelines for modifying status assessment based on rescue effect)

Applicability of Criteria

Criterion A (Decline in Total Number of Mature Individuals): Not applicable.
Criterion B (Small Distribution Range and Decline or Fluctuation): Not applicable. Meets Threatened as the EOO and IAO are below thresholds, but the suspected number of locations likely exceeds threshold.
Criterion C (Small and Declining Number of Mature Individuals): Not applicable.
Criterion D (Very Small or Restricted Population): Not applicable.
Criterion E (Quantitative Analysis): Not applicable.

TECHNICAL SUMMARY – Great Lakes Plains Population

Aflexia rubranura

Red-tailed Leafhopper
Great Lakes Plains Population

Cicadelle à queue rouge
Population des plaines des Grands Lacs

Range of occurrence in Canada: Ontario

Demographic Information

Generation time	1 year
Is there an [observed, inferred, or projected] continuing decline in number of mature individuals?	Insufficient data
Estimated percent of continuing decline in total number of mature individuals within [5 years or 2 generations].	Insufficient data
[Observed, estimated, inferred, or suspected] percent [reduction or increase] in total number of mature individuals over the last [10 years, or 3 generations].	Insufficient data
[Projected or suspected] percent [reduction or increase] in total number of mature individuals over the next [10 years, or 3 generations].	Insufficient data
[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.	Insufficient data
Are the causes of the decline a. clearly reversible b. understood c. ceased?	 a. No b. Yes c. No
Are there extreme fluctuations in number of mature individuals?	Unknown. One site in the United States with abundant individuals was resampled years later, and none were recorded.

Extent and Occupancy Information

Estimated extent of occurrence (EOO)	2926 km²
Index of area of occupancy (IAO)(2x2 grid).	116 km²
Is the population “severely fragmented” i.e., is >50% of its total area of occupancy is in habitat patches that are (a) smaller than would be required to support a viable population, and (b) separated from other habitat patches by a distance larger than the species can be expected to disperse?	a. No; limited dispersal permits populations to persist on very small patches of its host. b. Yes; known habits show it can cross a highway but not repopulate distant sites.
Number of “locations”	19
Is there an [observed, inferred, or projected] decline in extent of occurrence?	Yes, inferred

Is there an [observed, inferred, or projected] decline in index of area of occupancy?	Yes, inferred
Is there an [observed, inferred, or projected] decline in number of subpopulations?	Yes, inferred
Is there an [observed, inferred, or projected] decline in number of “locations”*?	Yes, inferred
Is there an [observed, inferred, or projected] decline in [area, extent and/or quality] of habitat?	Yes, inferred
Are there extreme fluctuations in number of subpopulations?	No
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 subpopulation)

Subpopulations (give plausible ranges)	N Mature Individuals
Total	Unknown

Quantitative Analysis

Probability of extinction in the wild is at least [20% within 20 years or 5 generations, or 10% within 100 years].	Insufficient data

Threats (actual or imminent, to populations or habitats, from highest impact to least)

Was a threats calculator completed for this species? Yes; calculated at Medium Impact.

1.1 Housing and urban areas – Low
2.3 Livestock farming and ranching – Low
3.2 Mining and quarrying – Low
7.1 Fire and fire suppression – Low
7.3 Other ecosystem modifications – Low

What additional limiting factors are relevant?

- Host plant and habitat specificity
- Small subpopulation size and genetic isolation
- Natural parasitic enemies
- Vulnerability to weather patterns
- Dispersal ability

* See Definitions and Abbreviations on COSEWIC website and IUCN (Feb 2014) for more information on this term

Rescue Effect (immigration from outside Canada)

Status of outside population(s) most likely to provide immigrants to Canada.	Globally imperilled (G2); Illinois (Imperilled S2) Wisconsin (possibly imperilled S2?); Minnesota (vulnerable S3); not likely to provide immigrants to Canada
Is immigration known or possible?	No. The nearest population in the United States is 460 km from the nearest Ontario population. Adults are flightless and there is unsuitable intervening habitat.
Would immigrants be adapted to survive in Canada?	Possibly. Same host plant but climate is colder.
Is there sufficient habitat for immigrants in Canada?	Possibly. Apparently suitable habitat appears to be currently unoccupied in Canada.
Are conditions deteriorating in Canada?[+]	Yes. Habitat is slowly being lost to development, encroachment and natural succession by native and non-native plants.
Are conditions for the source population deteriorating?[+]	Unknown.
Is the Canadian population considered to be a sink?[+]	Not likely, species is not able to disperse long distances. Adults are flightless and there is unsuitable intervening habitat.
Is rescue from outside populations likely?	No. The nearest population in the United States is 460 km from the nearest Ontario population. The nearest Canadian populations (e.g., Prairies Designatable Unit) are over 1000 km from each other. Adults are flightless and there is unsuitable intervening habitat.

Data Sensitive Species

Is this a data sensitive species? No.

Status History

COSEWIC: Designated Special Concern in November 2017.

Status and Reasons for Designation:

Recommended Status: Special Concern	**Alpha-numeric codes:** Not applicable
Reasons for designation: This is a flightless species with limited dispersal ability, restricted to remnant grassland and savanna alvar habitats on Manitoulin and adjacent islands, Ontario. The species' only known host plant, Prairie Dropseed, has a wider distribution but is also rare. The species is known from a small number of sites threatened from ongoing aggregate extraction, fire and fire suppression, livestock grazing, and recreational use.	

[+] See Table 3 (Guidelines for modifying status assessment based on rescue effect)

Applicability of Criteria

Criterion A (Decline in Total Number of Mature Individuals): Not applicable. Population trends unknown.
Criterion B (Small Distribution Range and Decline or Fluctuation): Not applicable. Almost meets Threatened, B1ab(iii)+2ab(iii), as the EOO and IAO are below the threshold, there is a continuing decline in the area, extent and quality of habitat, as well as a projected decline in EOO, but there are likely more than 10 locations and the species is not severely fragmented.
Criterion C (Small and Declining Number of Mature Individuals): Not applicable. Insufficient data to estimate decline in total number of mature individuals and subpopulations.
Criterion D (Very Small or Restricted Population): Not applicable.
Criterion E (Quantitative Analysis): Not applicable. Insufficient data to calculate analysis.

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
(2018)

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.

Environment and Climate Change Canada
Canadian Wildlife Service
Environnement et Changement climatique Canada
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Canada

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

COSEWIC Status Report

on the

Red-tailed Leafhopper
Aflexia rubranura

Prairie Population
Great Lakes Plains Population

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2018

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WILDLIFE SPECIES DESCRIPTION AND SIGNIFICANCE

Name and Classification

Phylum: Arthropoda - arthropods

Class: Insecta - insects

Order: Hemiptera – true bugs

Superfamily: Membracoidea

Family: Cicadellidae (leafhoppers)

Subfamily: Deltocephalinae

Genus: *Aflexia*

Species: *Aflexia rubranura* (DeLong 1935)

Red-tailed Leafhopper was first collected on August 13, 1934 at Evergreen Park, Illinois and from this specimen it was described as *Flexamia rubranura* (DeLong 1935). In 1958, the taxonomy was revised (Young and Beirne 1958) and the species became the sole member of the distinctive, monotypic genus *Aflexia* (Oman 1949). There are no named subspecies (Maw *et al*. 2000).

English common names: Although generally referred to as Red-tailed Leafhopper, the species is also known as Red-tailed Prairie Leafhopper (e.g., WI DNR 2016) and Red-veined Prairie Leafhopper (e.g., USFWS 2016; USDA 2003). Leafhoppers and their relatives are sometimes called short-horned bugs based on their tiny, bristle-like antennae.

French common name: cicadelle à queue rouge.

Type specimens: The holotype male, allotype female, and paratypes of both sexes collected at Evergreen, Illinois are housed in the Illinois Natural History Survey Collection Prairie Research Institute, Champaign, Illinois (DeLong 1935). At some point one of these paratype females was transferred and is now housed at the Canadian National Collection of Insects, Arachnids and Nematodes (CNC) (specimen identification number: 480574, collection date 23 Aug. 1934).

Morphological Description

Red-tailed Leafhoppers grow and develop through incomplete metamorphosis. After egg-hatch, the juveniles (nymphs) look similar to adults and grow through a series of moults as they mature (see **Biology**).

Adults:

Red-tailed Leafhopper is a small (3.0 – 3.2 mm length) leafhopper (DeLong 1935). Leafhoppers and their relatives have tiny, bristle-like antennae. Like other Cicadellidae, Red-tailed Leafhoppers have long hind tibia that are highly adapted for jumping and slender beak-like mouthparts that arise at the back of the head. The species exhibits wing polymorphism; most individuals have reduced (brachypterous) front wings with tiny or no hind wings and are therefore flightless. However, some females have long wings (Bouchard 1997; Hamilton and Whitcomb 2010) and may fly (see **Dispersal and Migration**).

Both sexes have a pale yellow to brown body colouration. In males, the posterior half of the pygofers (male genitals) on abdominal segment nine are bright red and conspicuously exposed (see cover photo). Adults and nymphs have diagnostic black markings from the apex of the head (vertex) to the start of the abdomen (clavus) consisting of a series of wide transverse bars, a pair of black spots on the pronotum behind the eyes, and two pairs of spots situated approximately on the middle of the wings (Figure 1). The abdomen has four longitudinal black lines, a proximal pair near the middle that extend almost to the tip of the abdomen and a broader strip near the other margin on either side, converging at the tip of the abdomen. The face and underside are dark brown to black. Adult genitalia are diagnostic (see Young and Beirne 1958).

Figure 1. Adult female Red-tailed Leafhopper from Manitoulin Island, Ontario (BOLDSYSTEMS 2016). Collected 10 km west of Gore Bay (see Table 1) by P. Bouchard, 1996-09-15. See cover photo for male with distinct red genitalia.

Nymphs:

The nymphs are smaller, wingless, but otherwise have a similar body form to the adults.

Eggs:

Red-tailed Leafhopper eggs are not described.

Population Spatial Structure and Variability

The population spatial structure and variability for Red-tailed Leafhopper has not been studied. There are disjunct populations of the species in both Ontario and Manitoba, separated in Canada by over 1000 km of unsuitable habitat and at least 460 km from the nearest known population in Wisconsin, United States.

The Canadian range of Red-tailed Leafhopper was entirely glaciated during the last Wisconsinian glaciation which ended approximately 10,000 years before present (BP) (Matthews 1979). Prairie Dropseed (*Sporobolus heterolepis* (Gray)), the species' host plant (see Life Cycle) is primarily a western species, and may have extended its range into Ontario shortly after deglaciation, thus allowing for the range expansion of Red-tailed Leafhopper (Bouchard *et al*. 2001). Extensive alvar grasslands dominated by Prairie Dropseed, such as the one on Little La Cloche Island (where Red-tailed Leafhoppers are present in Ontario), are considered similar to the continuous periglacial grasslands that existed in the Great Lakes Region until 9000 years ago (Catling and Brownell 1995). Presumably, Prairie Dropseed was more prevalent in Michigan than at present if it enabled dispersal by Red-tailed Leafhoppers from the west (Hamilton pers. comm. 2017). More likely, Red-tailed Leafhopper and Prairie Dropseed inhabited periglacial grasslands in southern Ontario at the time of deglaciation, and moved northward as the ice cap melted (Hamilton and Whitcomb 2010).

Red-tailed Leafhopper is thought to have colonized Manitoulin Island (Ontario) no later than 9000 years before present, when rising lake levels established a barrier from the mainland (Lewis and Anderson 1989; Hamilton 1994). Genetic evidence suggests similar post-glacial dispersal from the west for Prairie Smoke (*Geum triflorum*), another western plant with disjunct populations in Great Lakes alvars, including Manitoulin Island (Hamilton and Eckert 2007).

Both the Ontario and Manitoba Red-tailed Leafhopper subpopulations are morphologically similar and use the same host plant. There is no known evidence of subspecies differentiation. It is unknown if there is significant genetic differentiation among Canadian populations. Red-tailed Leafhopper has been partially barcoded, including one specimen each from Manitoba, Illinois, and Ontario, and genetic records are available in the Barcode of Life Database (Boldsystems 2016). However the barcoding results are inconclusive. Straus (1994) found genetic differentiation among five Illinois populations of Red-tailed Leafhopper using gel electrophoresis.

Designatable Units

The two designatable unit (DU) structure is proposed based on biogeographic distinction and range disjunction. Populations in Manitoba are found in the Prairie National Ecological Area (Prairie DU, hereafter referred to as Prairie population) and the populations in Ontario are found in the Great Lakes Plains National Ecological Area (Great Lakes Plains DU, hereafter referred to as Great Lakes Plains population) (COSEWIC 2017).

The strongest evidence for discreteness for a two DU structure is the natural disjunction of the species' geographic range. The Canadian range of Red-tailed Leafhopper was entirely glaciated during the last Wisconsonian glaciation which ended approximately 10,000 years before present (BP) (Matthews 1979). The two DUs have been demographically and (inferred) genetically disjunct for at least 9000 years due to their separate post-glacial dispersal patterns. Ontario and Manitoba populations are separated by over 1000 km of unsuitable habitat in Canada and at least 460 km from the nearest known population in Wisconsin, United States. The species has limited dispersal ability (see Biology) and appears to be associated with different habitat types: in Manitoba, Red-tailed Leafhoppers are primarily found in prairie-oak savannas and in Ontario, the species is found in prairie-alvar habitats (see Habitat).

To demonstrate significance, there is evidence important to the evolutionary legacy of the species as a whole that, if lost, would likely not be replaced through natural dispersion. There has been persistence of Red-tailed Leafhopper in an ecological setting unique to the species, which in this case is alvar habitats in southern Ontario and oak-savanna habitats in Manitoba, such that it is likely to have given rise to local adaptations. These adaptations are unstudied. If either the Manitoba or Ontario portions of the Red-tailed Leafhopper were lost, it would result in an extensive range disjunction and would not likely be repopulated from the United States or from other parts of Canada. Evidence to support the species inability to repopulate long distances includes their extremely limited dispersal ability. There is reference to a winged female Red-tailed Leafhopper form; however, there have been no observations of actual flight and it is unknown what proportion of the population takes the winged form (i.e., not all females exhibit the winged form). The species has very low dispersal capability, probably fewer than 150m per year. No dispersal would likely take place between these two regions.

Finally, Prairie Dropseed, the host plant, occurs sparsely between the two geographic areas. Thus dispersal from connected host plant patches also limits population connectivity.

There are no subspecies described for Red-tailed Leafhopper and no evidence of genetic distinctiveness: DNA barcoding is inconclusive and other genetic analysis is incomplete. Inherited traits such as morphology, host plant specificity and behaviour appear similar in both the Manitoba (Prairie population) and Ontario (Great Lakes Plains population) populations; however, these specific inherited traits are unstudied.

Special Significance

Red-tailed Leafhopper is a species of special interest to science and the conservation of Canadian fauna; it is unique due to its rarity and habitat associations (see Non-legal Status and Ranks). This species is the only member of its genus, *Aflexia*. Its genus is an anomalous member of the largest tribe Deltocephalini of the largest subfamily of Cicadellidae (Hamilton pers. comm. 2017).

More than a third of the globally known sites of Red-tailed Leafhopper occur in Canada. The habitat types in both DUs are imperilled habitats that also support a large number of other rare taxa (Reschke *et al*. 1999; Brownell and Riley 2000; Manitoba Conservation Data Centre 2017). Like other leafhoppers endemic to Nearctic grasslands, Red-tailed Leafhopper is a good model for studying the post-glacial history and the distribution of Canadian grasslands and their insect fauna (Hamilton 1984, 2005, 2014; Hamilton and Whitcomb 2010).

DISTRIBUTION

Global Range

The global range of Red-tailed Leafhopper extends from southeastern Manitoba south through South Dakota, Minnesota, Wisconsin, and Illinois, with a disjunct population on Manitoulin and adjacent islands in southern Ontario (Figure 2). Its range reflects post-glacial dispersal and the distribution of Red-tailed Leafhopper's host plant, Prairie Dropseed (Bouchard *et al*. 2001; Hamilton 1994, 2014).

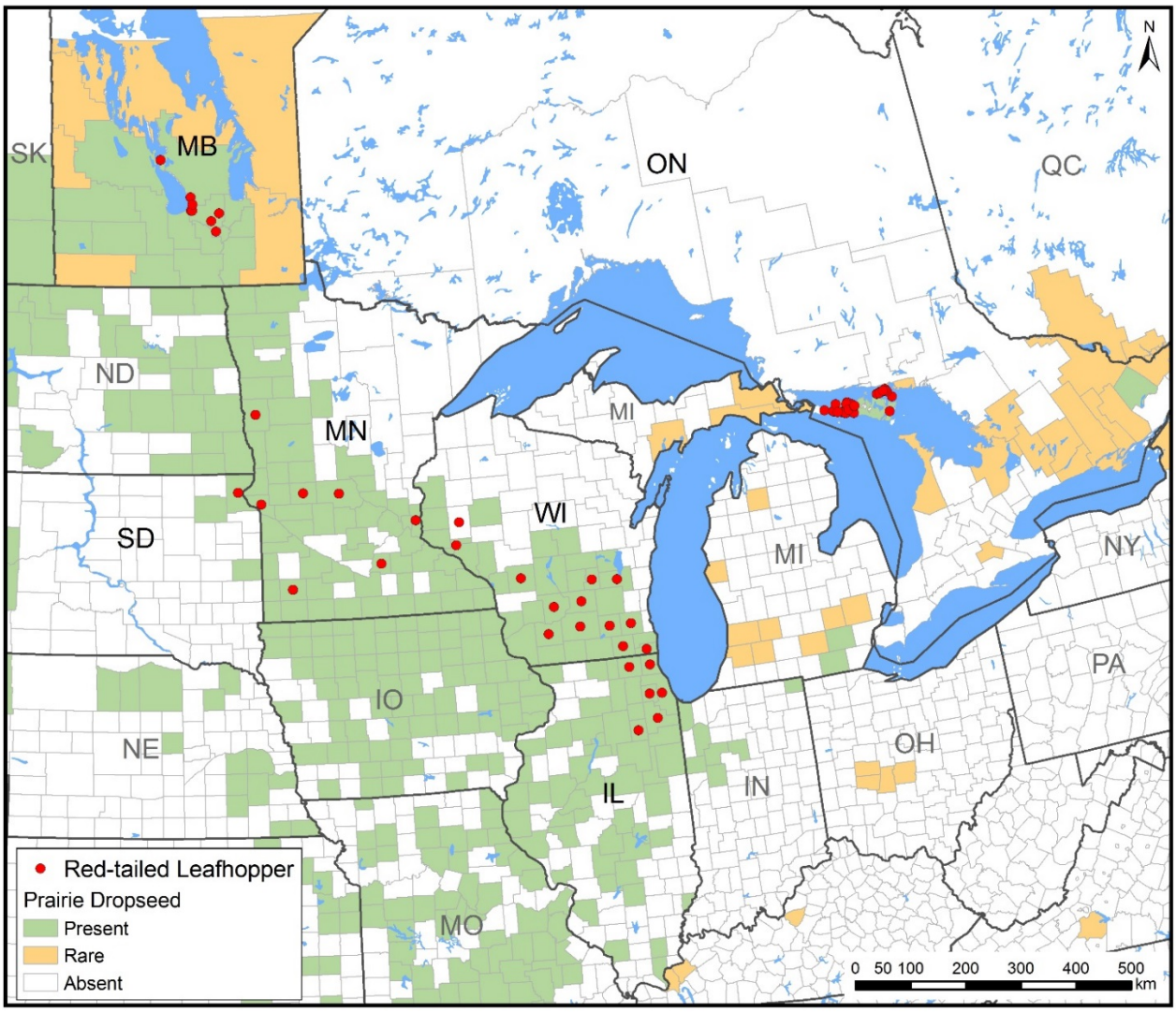

Figure 2. Known global range of Red-tailed Leafhopper (Bouchard *et al*. 2001; Foster pers. comm. 2016; Hamilton 1990, 2004, 2005, 2014; Harris pers. comm. 2016.; INHS 2016; MN DNR 2016; WI DNR 2016) with respect to county/district distribution of Prairie Dropseed (Catling and Brownell 1995; Hamilton 2005; Kartesz 2015; NHIC 2016). Symbols for Red-tailed Leafhopper records in the United States represent the county centroid and may represent multiple sites. Note: Prairie Dropseed also present near Ingolf (see Figure 3) along the Ontario/Manitoba border but may be adventive and is not shown.

Within its broad geographic range Red-tailed Leafhopper is patchily distributed. The first tally of globally known sites was 28 (Hamilton 1995). Additional sampling since this initial assessment estimates fewer than 100 sites globally (Hamilton pers. comm. 2017).

Outside of Canada, Red-tailed Leafhopper is recorded from scattered prairie remnants across the Midwest United States. It is known from seven counties in western and southern Minnesota (MN DNR 2016) and at least 34 sites in 13 counties in southern Wisconsin (WI DNR 2011), although it may be extirpated from Columbia County (WI DNR 2016; NatureServe 2016). Red-tailed Leafhopper has been reported from six counties in northeastern Illinois, but may be extirpated from McHenry County (INHS 2016; Nyboer *et*

al. 2006; NatureServe 2016). It is known from one county near Sisseton in eastern South Dakota (CNC 2016; NatureServe 2016), but its current status is unknown. Red-tailed Leafhopper has not been found in Michigan (Cuthrell pers. comm. 2016; MNFI 2016), including Drummond Island (e.g., Maxton Plains) despite targeted leafhopper surveys on extensive patches of Prairie Dropseed as recently as 2014 (Bess pers. comm. 2016).

The approximate global range extent (minimum convex polygon) for populations in the United States is 192,593 km^2. Based on separate minimum convex polygons for the Manitoba, Ontario and combined United States populations approximately 3.1% of the global range of Red-tailed Leafhopper is in Canada.

Canadian Range

The Canadian range of Red-tailed Leafhopper includes 27 sites: eight sites in southern Manitoba (Prairie population DU) and 19 sites in central Ontario (Great Lakes Plains population) (Table 1). Sites are defined as patches of habitat with at least 1 km of unsuitable intervening habitat (including no host plants). Globally, approximately 1/3 of the known Red-tailed Leafhopper sites are in Canada.

Table 1. Known Canadian sites of Red-tailed Leafhopper (*Aflexia rubranura*) in Manitoba (Prairie Population) and Ontario (Great Lakes Plains Population). See Figures 3 & 4 for site localities.

Prov.	Site Name	First Record (Year)	Most Recent Record	Notes
Manitoba	Grosse Isle, MB railway wye	Hamilton (1991)	Hamilton (1994)	relict prairie along railway and highway (Figure 7 and Figure 8)
Manitoba	Oak Point	Hamilton (1975)	Hamilton (1981)	relict prairie, 3 miles (4.8 km) south by radio tower
Manitoba	St Ambroise, 7 km east	Hamilton (1991)	Hamilton (1991)	relict prairie, 22 km WNW of Woodlands, MB on N side of Hwy 411
Manitoba	St Ambroise, 9 km east	Hamilton (1991)	Hamilton (1991)	relict prairie
Manitoba	St. Laurent, 8 km south of	Hamilton (1991)	Hamilton (1991)	relict prairie; 2 km south of Twin Lakes Beach Road (Lake Francis Wildlife Management Area); (Figure 6)
Manitoba	Stony Mountain MB, 12 km N	Hamilton (1991)	Hamilton (1991)	relict oak savanna
Manitoba	Wapah MB, 10 km east of	Hamilton (1991)	Hamilton (1991)	relict oak savanna
Manitoba	Winnipeg, St. Charles Rifle Range	Roughley (2000)	Roughley (2003?)	relict prairie on Block B; was monitored over multiple years
Ontario	Barrie Island causeway, 10 km W of Gore Bay	Hamilton (1991)	Foster (2016)	adjacent to Rozels Bay; part of Brownell and Riley (2000) larger "Foxy-Gore Bay Airport - Rozel's Bay" alvar complex

Prov.	Site Name	First Record (Year)	Most Recent Record	Notes
Ontario	Barrie Island, North Line Road	Foster (2016	Foster (2016)	new site along road right-of-way (Figure 9, this report)
Ontario	Barrie Island, west end (20 km west of Gore Bay)	Hamilton (1991)	Foster (2016)	roadside sampled in 2016 approximately 500 m from coordinates of previously sampled alvar site, Bouchard *et al*. (2001) "Site 38, W extremity Barrie Island"
Ontario	East Belanger Bay	Harris (2016)	Harris (2016)	new alvar site approx. 2 km E of previous unsuccessful survey by Bouchard *et al*. (2001) "Site #42 Belanger Bay"
Ontario	Goat Island	Hamilton (1972)	Foster (2016)	encompasses several separate surveys within 1 km of each other including Hamilton (1990) "Site 29, Goat Island, 1 km E Little Current"; and Bouchard *et al*. (2001) "Site 35 Goat Island"
Ontario	Gore Bay Airport	Foster 2016	Foster 2016	new alvar grassland site, part of Brownell and Riley (2000) larger "Foxy-Gore Bay Airport - Rozel's Bay" alvar complex
Ontario	Gore Bay, 10 km SW of	Bouchard (1996)	Bouchard (1996)	Bouchard (1996) "Site 3 Bur Oak grassland savanna alvar" and Bouchard *et al*. (2001) "Site 36, 10 km SW Gore Bay"; Bouchard's coordinates for this site place it on the E side of Hwy 540 and >1 km from where *Aflexia* were collected in the Kip Fleming Tract on the W side of Hwy 540 in 2016
Ontario	Great La Cloche Island	Hamilton (1989)	Hamilton (1989)	Hamilton's (1990) "Site 30, Great La Cloche I Nature Preserve, 5 km E Little Current"; It is actually about **9** km E of bridge into Little Current (Hamilton pers. comm. 2016) and is correctly depicted on Hamilton's (2014) Figure 9; This is same site as Hamilton's (1994) "Site 40, Great La Cloche Island, 5 km E Little Current" and "Site 41, same, 8 km further)" as well as Bouchard *et al*.'s (2001) "Site 33, Great La Cloche Is., 13 km E Little Current" and "Site 34, Great La Cloche Is., 13 km E Little Current", both of which have erroneous coordinates
Ontario	Great La Cloche Island, 2.6 km E of Little Current	Harris (2016	Harris (2016)	new alvar site near roadside approximately 2.6 road km E of bridge into Little Current, near pull-off with turnstile
Ontario	Kip Fleming Tract, 10 km SW Gore Bay	Foster (2016)	Foster (2016)	new oak savanna alvar site, also known as Foxy (or Foxey) Prairie (Brownell and Riley 2000); this is approximately the same location as Hamilton's (1990) "Site 31, 7 km NE Evansville, Ont. Oak savanna along Hwy 540" where he did not find *Aflexia*
Ontario	La Cloche Peninsula at snow plow turnaround	Foster (2016)	Foster (2016)	new site along road allowance on west side of Hwy 6 approximately 850 m N of bridge to Great La Cloche Island, but site likely extends on to adjacent Whitefish River First Nation
Ontario	Little La Cloche Island	Hamilton (1989)	Hamilton (1989)	not included in Hamilton (1990); same as Hamilton's (1994) "Site 42, Little La Cloche Island" and correctly depicted in Hamilton (2014) Figure 9. Some CNCI specimen label data erroneously refer to it as "Great La Cloche Island, 18 km E of Little Current"

Prov.	Site Name	First Record (Year)	Most Recent Record	Notes
Ontario	Misery Bay P.P. (East Block)	Foster (2016)	Foster (2016)	new alvar site on east side of Misery Bay
Ontario	Misery Bay P.P. (West Block)	Bouchard (1996)	Foster (2016)	same site as Bouchard *et al*. (2001) "Site 40, Misery Bay" and within the unsurveyed polygon for Hamilton (1990) "Site 32, Misery Point"
Ontario	North Channel Drive, W of Little Current	Foster (2016)	Foster (2016)	new site along road right-of-way and adjacent grazed alvar
Ontario	Portage Point, 2.5 km west of	Harris (2016)	Harris (2016)	new alvar site west of Portage Bay
Ontario	Sand Bay	Foster (2016)	Foster (2016)	new site along road right-of-way and adjacent alvar more than 1 km from any other known sites
Ontario	Sand Bay, access road	Foster (2016)	Foster (2016)	new site along road allowance and adjacent alvar within the unsurveyed polygon for Hamilton (1990) "Site 32, Misery Point"
Ontario	South Bay, 19 km SW of Wikwemikong	Hamilton (1988)	Hamilton (1988)	roadside limestone ridge surveyed unsuccessfully in 2016 (Harris pers. obs.)

Prairie population:

The Manitoba population of Red-tailed Leafhopper occurs within relict prairie and Bur Oak (*Quercus macrocarpa*) savanna in a narrow band from Winnipeg north to Wapah (Figure 3). The species is not specifically associated with alvar habitats in this portion of its range.

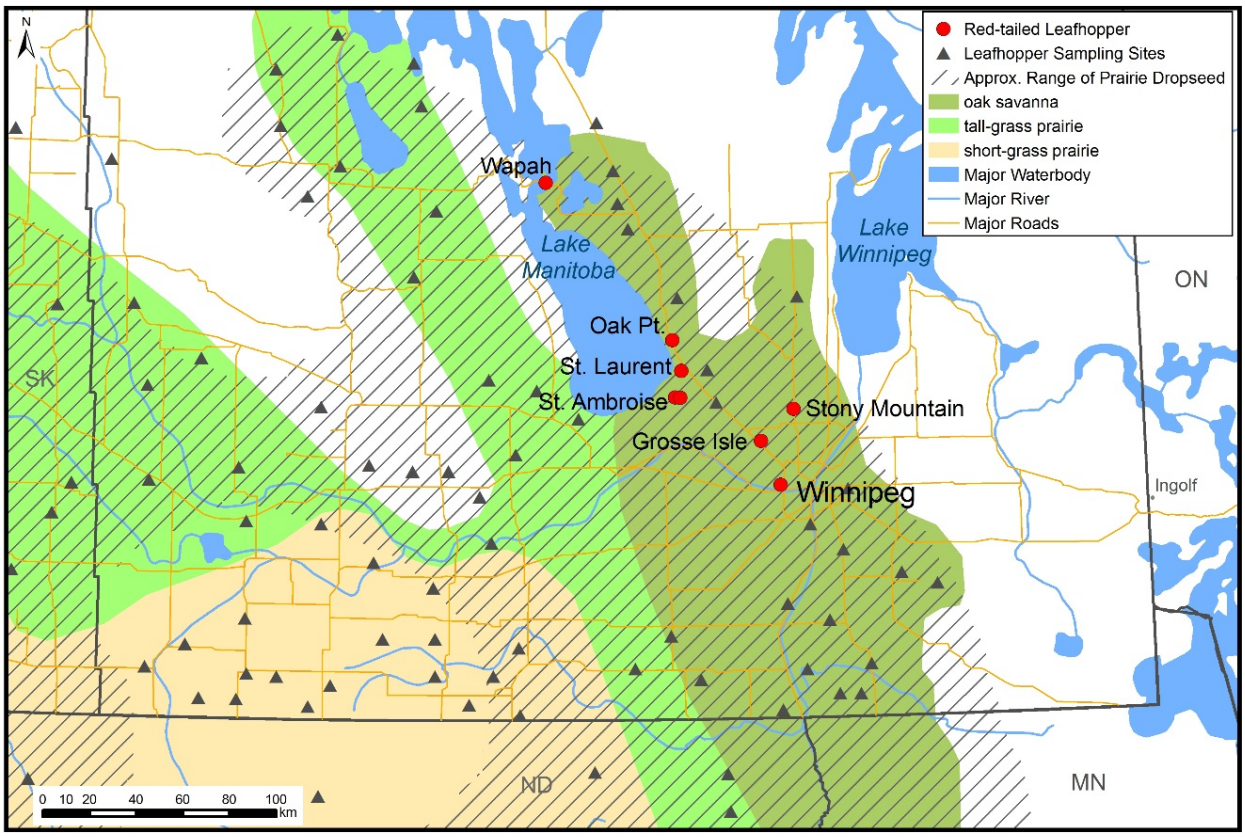

Figure 3. Known Manitoba occurrences of Red-tailed Leafhoppers and other leafhopper sampling sites where it was not found (based on Hamilton 2005; Hamilton pers. comm. 2016), in relation to the distribution of Prairie Dropseed and historical range of prairie-Bur Oak savanna habitats (Barkley 1977; Hamilton 2005).

Great Lakes Plains population:

The Ontario population of Red-tailed Leafhopper occurs within the alvar habitats of Manitoulin Island and adjacent Goat, Great La Cloche, and Little La Cloche islands (Figure 4). Red-tailed Leafhopper is likely present in suitable habitat at additional, unsurveyed sites with Prairie Dropseed on Manitoulin and adjacent islands (Figure 4).

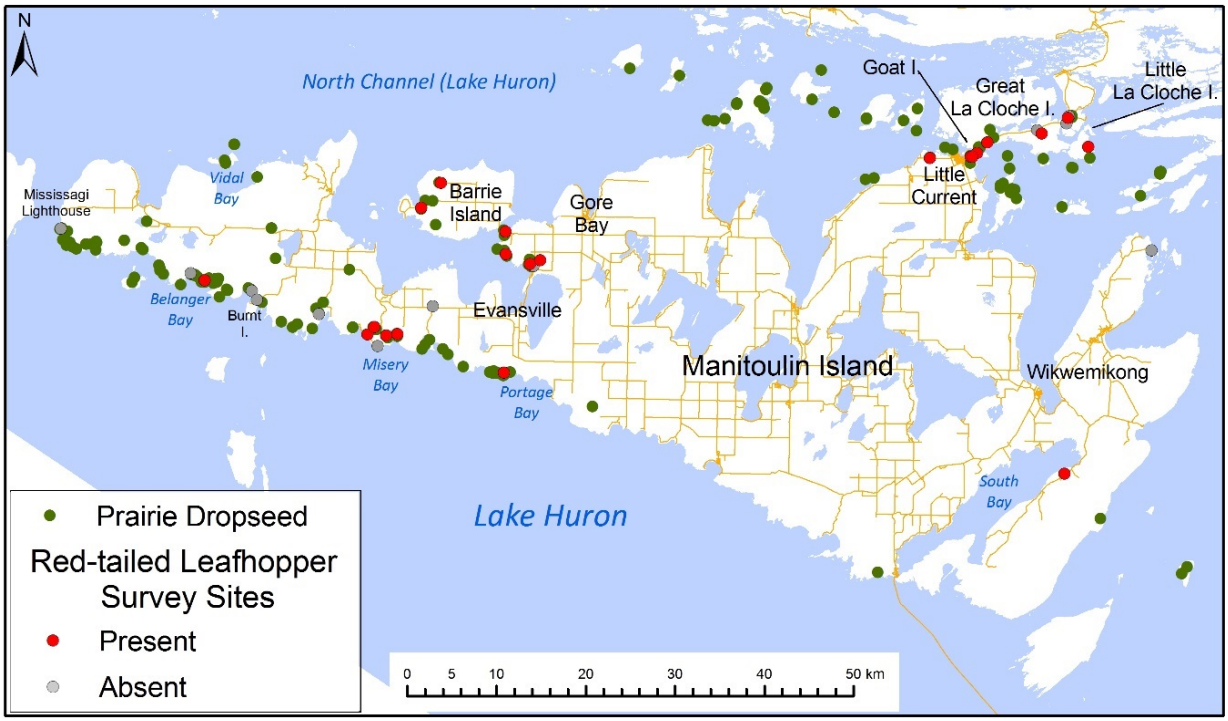

Figure 4. Known Ontario occurrences of Red-tailed Leafhopper and unsuccessful survey sites on and near Manitoulin Island (Bouchard 1997; Bouchard *et al*. 2001; Foster pers. comm. 2016; Harris pers. comm. 2016; Hamilton 1990, 2014) in relation to known host plant (Prairie Dropseed) distribution (Bakowsky pers. comm. 2016; Jones pers. comm. 2016; NHIC 2016; Oldham pers. comm. 2016).

Extent of Occurrence and Area of Occupancy

The Prairie population (Manitoba) has an extent of occurrence (EOO) of 3146 km^2 and an index of area of occupancy (IAO) of 28 km^2 (seven 2 x 2 km grid squares). It is likely the IAO would increase with additional search effort, although given the low number of known sites, limited dispersal ability and fragmented remaining habitat, the number of sites would still likely be less than 500 km^2. The EO could potentially be higher with additional sampling although the extent of Bur Oak savanna in southern Manitoba is limited.

The Great Lakes Plains population (Ontario) has an EO of 2926 km^2 and an IAO of 116 km^2 (29 – 2 x 2 km grid squares). It is likely that the IAO would increase with additional search effort, particularly on Manitoulin and associated islands. Based on known Prairie Dropseed distribution in the Great Lakes Plains population, the IAO could be 2 – 3 times greater than its current calculation. The EO could potentially be higher with additional search effort.

Search Effort

Red-tailed Leafhopper was first recorded in Canada and its host plant determined in 1972 on Goat Island, Ontario (Hamilton 1995; Hamilton pers. comm. 2016). The first Manitoba record was at Oak Point in 1981 (Hamilton 1995; Hamilton pers. comm. 2016).

There has been extensive targeted search effort in Canada (Ontario, the Prairies, and elsewhere) and in the United States for grassland leafhoppers, including Red-tailed Leafhopper (Hamilton 1995, 2014; Figure 5). Canadian grassland leafhopper search effort was summarized by Hamilton (2014), who considered that all Canadian grasslands have been adequately sampled except for the Rainy River District in northwestern Ontario.

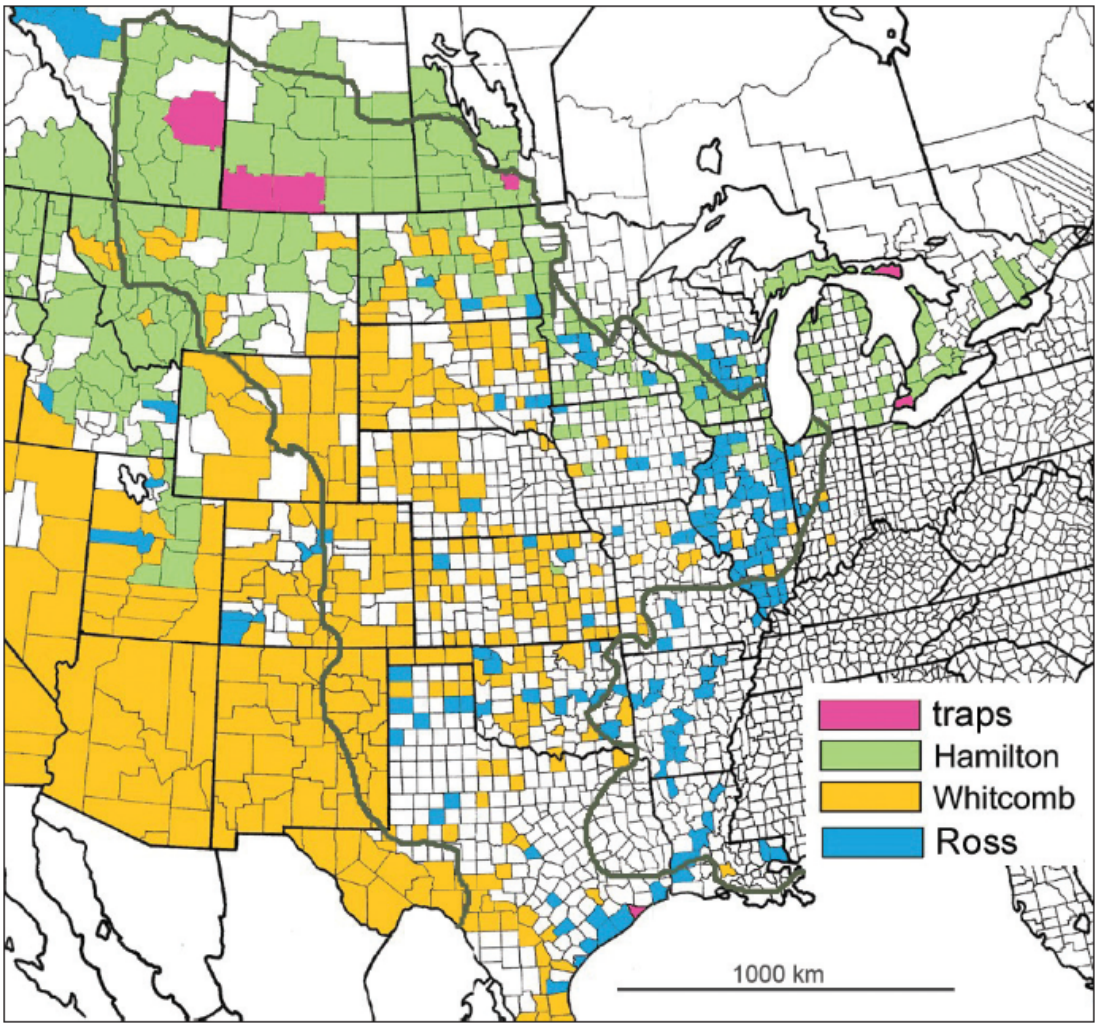

Figure 5. Leafhopper sampling coverage for the prairies and adjacent grasslands 1962–2006 by K.G.A. Hamilton, R.F. Whitcomb, and H.H. Ross. Sampling methods were primarily sweep-netting unless otherwise indicated. Figure reproduced with permission from Hamilton (2014).

A combination of methods has been used to survey for Red-tailed Leafhoppers and other grassland leafhoppers in Canada, although most efforts have focused on determining presence/absence at a site rather than estimating population size. In general, about 100 passes with a sweep net is considered adequate to characterize the leafhopper community of a grassland site (Hamilton 2014). Targeted surveys for Red-tailed Leafhoppers are

facilitated by the distinctive appearance of its host plant (Figure 9). If the host plant is present and the habitat potentially suitable, and presence of Red-tailed Leafhopper can often be confirmed with far fewer than 100 sweep net passes (Foster pers. comm. 2016; Harris pers. comm. 2016).

Prairie population search effort:

In 2017 there was extensive search effort within 23 remnant grassland habitats in Manitoba that included Red-tailed Leafhopper. Leafhoppers were collected during these surveys; however, Red-tailed Leafhopper was not recorded from these sites (Wrigley pers. comm. 2018). At least 23 separate sites were sampled, some numerous times, for a minimum of 15 minutes at each site. Two of these sites are within the general area of known Red-tailed Leafhopper sites (e.g., those sites around Winnipeg and the site near Laurant). These 23 search sites included: West Rennie; Lewis Road off Highway 15; Labarriere Park, South Winnipeg (several times); Julius Road, Highway 44, 3 km East Seddons Corner; Spruce Woods Provincial Park (several times); Stony Mountain Prairie; A Rocha Pembina Valley Interpretive Centre; Birds Hill Park; South Gimli South Willow Creek; Fish Lake Drain, Interlake Nature Conservancy of Canada Property; Camp Morton; Clematis Wildlife Management Area alvar, 8 km Northwest of Inwood; Marble Ridge Alvar, Highway 325, 2 miles south, 10.5 miles west of Hodgson; Agassiz Trail in Tall-grass Prairie Preserve; Kenton Ponds, south Winnipeg; Oak Lake town; Jiggins Nature Conservancy of Canada Property, 17 km south Oak Lake town; Routledge Sandhills, 1 km south, 6km west Oak Lake town; Cherry Point, Oak Lake waterbody; 2.7 km south of St, Laurent; Portage Sandhills, 1.5 km southwest of Southport Airfield; and Zhoda (Wrigley pers. comm. 2018).

Prior to the surveys in 2017, over 70 grassland sites in southern Manitoba and additional sites in southeastern Saskatchewan had been surveyed for grassland leafhoppers including Red-tailed Leafhopper (Hamilton 2005, 2014) (Figure 3). At least 65 of these sites are within the approximate range of Prairie Dropseed, and include those at Stuartburn, Tolstoi, and Gardenton (Hamilton 1995) near the Nature Conservancy of Canada's Tall Grass Prairie Preserve. Prairie sites in Manitoba were sampled using a sweep net for at least 30 minutes, typically for twice that on more difficult sloping sites (Hamilton 1994, 1995).

Red-tailed Leafhopper was not found by Hamilton (2005) on Prairie Dropseed at 13 sites west of the Red River Valley in North Dakota, in western Manitoba, and in eastern Saskatchewan, even though the grass was plentiful at five of those sites. Red-tailed Leafhopper has not been recorded from relict tallgrass prairies south of Winnipeg (Hamilton 2005), even though Prairie Dropseed occurs across the southern prairie portion of Manitoba (Friesen pers. comm. 2016). At least four of these sites appear to be suitable based on the presence of *Memnonia panzer*, another flightless Prairie Dropseed-obligate leafhopper that co-occurs with Red-tailed Leafhoppers at other Manitoba and Ontario sites (Hamilton 1994, 2005).

More general insect collecting has occurred throughout much of the oak savanna, tallgrass prairie grasslands and alvars of Manitoba by entomologists and naturalists. These

areas are targeted for their unique fauna and although these surveys are not quantified, it is likely the leafhopper would have been collected and curated within a museum (e.g., Manitoba Museum, Roughley Entomology Collection at the University of Manitoba, Royal Saskatchewan Museum, Canadian National Collection of Insects, Arachnids and Nematodes [Ottawa]). In 2017 there was a bioblitz that focused on grassland invertebrates at alvar habitats in the Interlake region of Manitoba (near Hodgson) (Canadian Wildlife Federation 2018). Although Red-tailed Leafhopper is not an alvar specialist in Manitoba, search effort within these habitats is still considered applicable. No Red-tailed Leafhoppers were recorded (Canadian Wildlife Federation 2018).

Some of the known Red-tailed Leafhopper sites in Manitoba have not been surveyed for more than two decades (Table 1). However if the habitat remains in high quality, the leafhopper is likely still present at these sites because Red-tailed Leafhopper is not thought to have extreme fluctuations in abundance, nor is it known to disperse or spread quickly throughout a habitat. The geographic positioning system (GPS) coordinates for these areas are general (e.g., the original surveyor did not take GPS coordinates while at the sites) (Figure 3), although the general areas of surveys could be deduced from aerial imagery, correspondence with the original surveyor and there is some recent information on the habitat quality for three of these general areas. It is assumed the Red-tailed Leafhopper is present at these sites, despite the long duration of time since previous surveys.

- The Lake Francis Wildlife Management Area is often hayed and is considered to have high quality tall grass prairie (Morgan pers. comm. 2018).
- The St. Laurent area has some good quality grassland habitat remaining, although most is privately owned and not managed for prairie habitat qualities.
- St. Charles' Ranges habitat is also considered high quality.
- There are some potential remnant prairie patches along that rail line from within Winnipeg to as far as the Lake Manitoba Narrows and beyond. The most notable prairie is just south of Gordon, just past the Perimeter Highway and northwest off highway #6 (Morgan pers. comm. 2018). These habitats have experienced prescribed fire twice since 2012; both times with areas left as unburned refugia (Morgon pers. comm. 2018). Much of the remaining habitat is mostly abandoned rail line prairie and degrading rapidly due to disturbance, non-native weeds and lack of fire (Morgon pers. comm. 2018).

<u>Great Lakes Plains population search effort:</u>

Surveys in 2016 completed in preparation for this status report focused on sites in Ontario and determining presence/absence, with individual sites sampled for 5 to 160 minutes depending on the size of the site, number of Prairie Dropseed, and abundance of Red-tailed Leafhoppers (Foster pers. comm. 2016; Harris pers. comm. 2016). The number of net-passes was not recorded, but at least 100 net-passes were typically completed, unless the presence of Red-tailed Leafhoppers was confirmed with less sampling effort or the sample site was <1 ha. In total, approximately 22 survey-hours were conducted at 24

sites on and near Manitoulin Island from July 24-27, 2016 (Table 1). Red-tailed Leafhoppers were confirmed at 15 sites, including nine new sites. Most of the easily accessible, higher quality habitat on Manitoulin Island has been surveyed at least once, but there remain numerous unsurveyed patches of Prairie Dropseed, particularly on private land and sites only accessible by boat.

From 1988 to 1997, a total of 51 alvar sites in Ontario, New York, Wisconsin, Ohio, and northern Michigan were sampled using a combination of methods (Bouchard *et al*. 2001)(see Sampling Effort and Methods). This included sites on the Napanee Plain (n=8), Smith Falls Plain (n=2), Carden Plain (n=2), and Bruce Peninsula (n=15), as well as 13 sites on Manitoulin and adjacent islands. No Red-tailed Leafhoppers were recorded on the Ontario mainland despite repeated sampling of alvars, including some with large patches of Prairie Dropseed (e.g., Burnt Lands/Ramsay Alvar, Point Anne, Cabot Head, Prairie Point, Dorcas Bay) (Bouchard *et al*. 2001; Hamilton 1991; Hamilton pers. comm. 2017). Of the 40 alvar sites surveyed for leafhoppers in Ontario (Bouchard 1998; Bouchard *et al*. 2001), ten were sampled from mid-May to mid-September 1996-1997 using sweeping and traps (pitfall, yellow pan, Malaise, and flight intercept). The remaining 30 Ontario alvar sites were each sampled between 1988 and 1996 using a sweep net for 30-90 minutes per visit, with most sites visited at least once in June and August (Bouchard *et al*. 2001). Prairie sites in Ontario were similarly sampled using a sweep net for at least 30 minutes, typically for twice that on more difficult sloping sites (Hamilton 1994, 1995). Red-tailed Leafhopper (and other alvar and grassland leafhoppers) sampling sites in Ontario in relation to known Prairie Dropseed occurrences are shown in Figure 6.

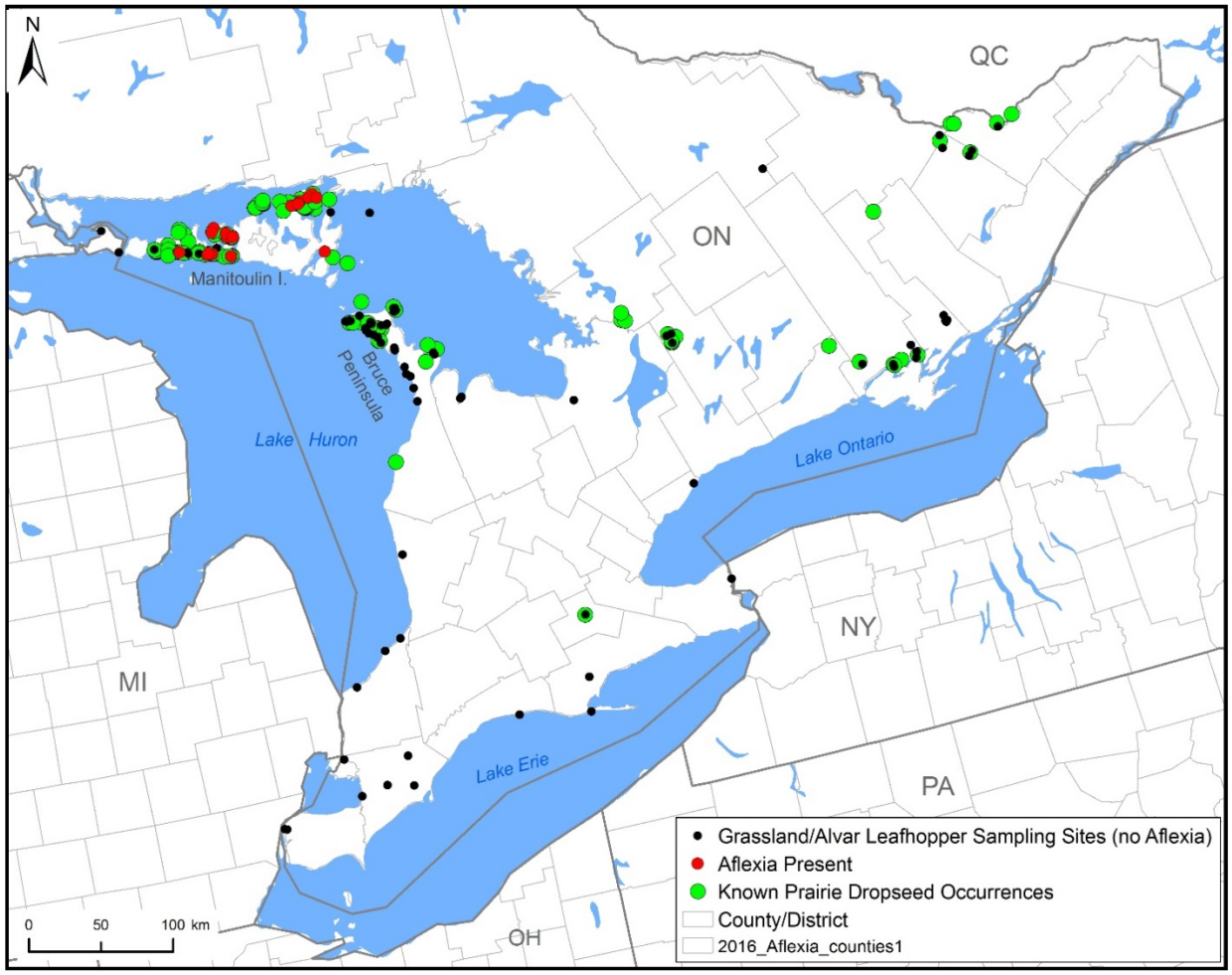

Figure 6. Main Ontario survey sites for Red-tailed Leafhopper and other alvar/grassland leafhoppers in relation to known host plant (Prairie Dropseed) distribution (see Search Effort).

If their habitat remains intact, Red-tailed Leafhoppers can persist in small patches of habitat; for example, they have persisted on Goat Island near Little Current, Ontario for over 40 years since it was first recorded there in 1975 and presumably for 9000 years since it became isolated by rising lake levels.

Ingolf is the only known site for Prairie Dropseed in northwestern Ontario, despite numerous botanical surveys of relict prairies and Bur Oak savanna (Ontario Ministry of Natural Resources search effort data; Northern Bioscience search effort data). The most significant tallgrass prairie remnant in northwestern Ontario is at Kay-Nah-Chi-Wah-Nung National Historic Site (Manitou Mounds) in Rainy River District, but Prairie Dropseed is not known from the site and no Red-tailed Leafhoppers have been found there during sweeping and pan-trapping for leafhoppers (Harris and Foster 2005).

Red-tailed Leafhopper has not been recorded elsewhere in southern Ontario in alvar or relict prairie habitats that have had targeted leafhoppers surveys. The species is unlikely to be present in northwestern Ontario due to the near absence of its host plant. There have been extensive botanical surveys of relict prairies in northwestern Ontario yet the only known site for Prairie Dropseed in the northwestern area of the province is along the railway near Ingolf on the Manitoba border (NHIC 2016; Oldham pers. comm. 2016), where it may be adventive. Prairie Dropseed is not known from Ojibway Prairie and Walpole Island which are both located in extreme southwestern Ontario (Hamilton 1991; NHIC 2016) (Figure 2).

Prairie Dropseed is more widely distributed than Red-tailed Leafhopper (Figure 2), and the presence of the host plant does not ensure the leafhopper's presence. Prairie Dropseed is present (and abundant in at least some sites) in western Manitoba, eastern Saskatchewan, and west of the Red River Valley in North Dakota, but Red-tailed Leafhoppers have not been recorded in these areas (Hamilton 2005). Similarly, Red-tailed Leafhopper has not been recorded south of the oak savanna in the United States even though Prairie Dropseed is present (Figure 2). Targeted surveys have failed to find Red-tailed Leafhopper on the Bruce Peninsula or elsewhere in mainland southern Ontario, despite the occasional presence of its host plant and *Memnonia panzeri* (Hamilton 2000, 2014). Red-tailed Leafhopper has not been reported from Quebec. Prairie Dropseed is found in Quebec although it is considered rare (S3; NatureServe 2016) and restricted to the extreme southern portion of the province along the border with Ontario (University of Saskatchewan 2017).

A study of the *Sporobolus heterolepis* voucher specimens at the Canadian Museum of Nature (Ottawa) was done to determine if the detection of monophagous leafhoppers or oviposition scars of Red-tailed Leafhopper was possible (Light 2018). No evidence was visible and in conclusion until the oviposition location on the plant is known, it is difficult to know where to look for evidence of the leafhopper (Light 2018).

HABITAT

Habitat Requirements

Red-tailed Leafhoppers are obligate feeders on Prairie Dropseed (Poaceae) and are therefore dependent on open habitats that support this plant. The species is not recorded from all host plants at occupied sites, nor are they present at all Prairie Dropseed within the plants Canadian range. Post-glacial dispersal patterns, habitat loss or impairment, metapopulation dynamics, and/or undocumented microhabitat preferences undoubtedly influence the abundance and distribution of Red-tailed Leafhoppers (see Limiting Factors).

Prairie population:

In Manitoba, Red-tailed Leafhoppers are typically recorded from Prairie Dropseed growing in patches of relict Bur Oak savanna grassland, rather than true tallgrass prairie (Hamilton 2005). Savanna is an open (< 50% tree cover) vegetation type with scattered trees along with grasses and other prairie plant species (Figure 7 and Figure 8). Bur Oak savanna is fairly widespread in southern Manitoba and extends from Lake Manitoba south to the United States border in both shallow and deep soils. However, Red-tailed Leafhopper has not been recorded south of Winnipeg and the Bur Oak savanna habitat is no longer contiguous due to historical agricultural land conversion. Red-tailed Leafhopper is similarly absent south of oak savanna in the United States, despite the presence of Prairie Dropseed, which also suggests Red-tailed Leafhopper is more characteristic of Bur Oak savanna rather than true tallgrass prairie (Hamilton 2005).

Figure 7. Typical native prairie at Lake Francis Wildlife Management Area, Manitoba circa 1991 where Red-tailed Leafhopper has been collected. Photo Andy Hamilton.

Figure 8. Small patch of degraded prairie at Grosse Isle Manitoba rail right-of-way with abundant Red-tailed Leafhopper and Prairie Dropseed circa 1994. Photo courtesy Andy Hamilton.

Figure 9. Typical alvar habitat at Misery Bay Provincial Park, Ontario with clumps of Prairie Dropseed and Red-tailed Leafhopper. Photo taken July 25, 2016 by Robert Foster.

Alvar in Manitoba is a subset of savanna habitat and is restricted to a few small patches between Lake Manitoba and Lake Winnipeg and was probably never any more widespread. Alvar is always associated with shallow soils over limestone bedrock and can include a range of vegetation types. Savanna vegetation can occur in an alvar, and alvar and savanna can overlap but are not always the same habitats. Unlike in Ontario, Red-tailed Leafhopper has not been found in alvars in Manitoba and is not thought to be associated with these habitats (Hamilton pers. comm. 2016) although the host plant does occur in these habitats. There is no systematic authoritative map of native prairie and Bur Oak savanna for Manitoba.

Great Lakes Plains population:

In Ontario, Red-tailed Leafhoppers are recorded from Prairie Dropseed growing in alvars (Hamilton 1994). Alvars are naturally open habitats with thin or no soil over limestone bedrock that are adapted to seasonal cycles of flooding and drought (Brownell and Riley 2000). Suitable habitat includes patches of grassland alvar as well as Bur Oak alvar savanna, such as that found at the Kip Fleming Tract - Foxy Prairie (Reschke *et al*. 1999). Red-tailed Leafhoppers are also found on limestone ridges, which are similar to alvars, but do not experience seasonal flooding (Hamilton 1995). In Ontario, diverse assemblages of prairie leafhoppers are predominately found on alvars and sandy areas rather than deep-soil prairie, and no prairie leafhopper species have been found in deep-soil prairie sites in southern Ontario east of Long Point (Hamilton 1994).

During standardized sampling on Manitoulin Island, Bouchard (1997) recorded Red-tailed Leafhoppers in “dominant” numbers (n=597) on a grassland alvar near the Barrie Island causeway at Rozel’s Bay (10 km W of Gore Bay, Table 1). In comparison, he recorded three Red-tailed Leafhoppers on grassland savanna alvar 10 km southwest of Gore Bay at or near the Kip Fleming Tract (Table 1) that was characterized by about 65% grass and sedge cover, with the rest of the habitat covered by Bur Oak and a few bare rock openings. Using equivalent techniques and search effort, Bouchard (1997) recorded ten Red-tailed Leafhoppers on Jack Pine (*Pinus banksiana*) pavement alvar at Misery Bay and none on deep-crack alvar 10 km west of Evansville (Figure 4) that had 65% cover of Common Juniper (*Juniperus communis*) and other shrubs.

On Manitoulin Island, Prairie Dropseed appears to be most abundant in grassland and savanna alvars, where there may be hundreds or thousands of clumps of the host plant (Oldham unpublished data). Prairie Dropseed is less abundant on pavement alvars being largely restricted to cracks in the bedrock, but can be locally common.

Habitat outside of Canada:

Within the United States, Red-tailed Leafhoppers appear to be restricted to prairie remnants. In Illinois, Red-tailed Leafhoppers are highly dependent on medium- to high-quality remnants of open, xeric to mesic native prairie, including hillside pastures and short grass meadows (Panzer *et al*. 1995). The species was originally described (DeLong 1935) from a large series of male and female specimens collected in “prairie habitat from short

grasses" at Evergreen, Illinois, and Delong (1948) described it as occurring "on the moist prairies" in at least two localities in northern Illinois. These habitats may have been similar to the *Eleocharis-Juncus-Sporobolus* association found on wet black-soil prairie at Goose Lake Prairie State Park near Morris, Illinois where Hamilton collected Red-tailed Leafhopper in 1993 (Hamilton 1995). In Minnesota and Wisconsin, its habitat is described as areas of original wet-mesic to dry prairie sod with the host plant present (MN DNR 2016; WI DNR 2011). One United States site with abundant individuals was resampled years later, and none were recorded during this survey (Hamilton pers. comm. 2017).

Habitat Trends

Prairie population:

Since the 1850s, over 99% of the native prairie across North America has been converted to agriculture or severely degraded by domestic livestock overgrazing (Samson and Knopf 1994), with Red-tailed Leafhopper habitat undoubtedly declining as well. The pace of habitat loss accelerated in Manitoba with of the arrival of the railway circa 1870 (Hamilton 2005) and now less than 0.5% of the original 600,000 ha of tall-grass prairie (including Bur Oak savanna) remains (Robertson *et al*. 1997; Samson and Knopf 1994). Mixed-grass prairie, which also supports Prairie Dropseed, has experienced an even greater loss in Manitoba (Samson and Knopf 1994). Much of what prairie remains is highly fragmented and restricted to protected areas and along railroad right-of-way (Whiles and Charlton 2006). Red-tailed Leafhopper habitat in Manitoba is now extremely fragmented in small relict grassland and oak savanna remnants. However most of the remnant oak savanna sites are at risk of natural succession of native vegetation from lack of grazing and/or fire suppression and invasive non-native plants (Friesen pers. comm. 2018).

Great Lakes Plains population:

In Ontario, alvar habitat has declined less dramatically despite the long human occupation of Manitoulin Island (e.g., Brownell and Riley 2000; Riley 2013). There have been localized losses and wider impairment due to conversion to pasture, logging, quarrying, and other development (Jones 2015), but quantitative data on Red-tailed Leafhopper habitat are not currently available. The dry, shallow soils over limestone bedrock appear to have limited widespread agricultural conversion. No known Red-tailed Leafhopper sites appear to have been lost since the species was recorded within Canada. However, in the last ten years there has been continuing degradation at some sites due to limestone quarrying, overgrazing, and other land use practices (see Threats and Limiting Factors).

Canadian leafhopper faunas can persist over long periods in isolated grasslands much too small to preserve relict populations of larger animals (Hamilton and Whitcomb 2010). Specialist leafhoppers, such as Red-tailed Leafhopper, can sometimes persist on very small patches (Hamilton and Whitcomb 2010) and many of the Canadian sites for this species are in very small patches of suitable habitat. For example, Red-tailed Leafhopper were found in a small (<1 ha) patch of Prairie Dropseed along a road right-of-way on Barrie Island in 2016 (Table 1; Figure 10) and have apparently persisted for thousands of years on

small Goat Island (< 100 ha) east of Little Current, Ontario.

Figure 10. Prairie Dropseed with Red-tailed Leafhoppers along North Line Road on Barrie Island, Ontario, adjacent to grazed cattle pasture. Photo taken July 26, 2016 by Robert Foster.

BIOLOGY

Life Cycle and Reproduction

Red-tailed Leafhoppers have a hemi-metabolous life cycle and grow by incomplete metamorphosis. In Canada, adult Red-tailed Leafhoppers have been collected from July 20 to September 15, with most specimens taken in late July and early August (CNCI unpublished specimen label data). The eggs overwinter (WI DNR 2016) and hatch into nymphs sometime the following spring. When adults mature and mate, females oviposit eggs on the stems of its host plant, Prairie Dropseed, and newly hatched nymphs resemble adults and mature through several stages, changing in size and growing in proportion (WI DNR 2016). Both adults and nymphs suck fluids from Prairie Dropseed using beak-like mouthparts, and individuals could therefore potentially compete for food. Both nymphs and adults also take shelter within clumps of the host plant.

In Canada, Red-tailed Leafhopper has one generation per year (Bouchard 1997), although farther south (Illinois) they can have two generations a year (Panzer 1998). There is normally just one generation per year in Wisconsin, but two broods per year consistently occur at Chiwaukee Prairie and possibly other sites in the extreme southernmost part of the

state (WI DNR 2011). At double-brood sites, adults are active from mid-June through late July and then again in September (WI DNR 2011), and nymphs are active from mid-May or June and again in August (WI DNR 2015). At sites in the United States with a single brood, nymphs are likely active from early June or July (WI DNR 2016).

Physiology and Adaptability

Red-tailed Leafhopper is monophagous and dependent on Prairie Dropseed as its host plant. This is not unique to leafhoppers; approximately 60% of the 223 Canadian grassland-endemic leafhopper species are monophagous, of which 85 species feed on grasses (Hamilton and Whitcomb 2010).

Red-tailed Leafhopper shows some flexibility in life history and morphology. For example, in southern portions of its range in the United States. populations have two broods per year (bivoltine), whereas in the northern portions of its range including Canada, it is univoltine (Bouchard 1997). Presumably the egg state, at least when it overwinters, is cold-hardy.

Dispersal and Migration

Most leafhopper species do not readily disperse over great distances (Hamilton and Langor 1987). For example, postglacial recolonization rates in the Yukon (YT) were estimated at less than 1 km/year for half of the 24 leafhopper species recorded from the Arctic (Hamilton 1999, 2005). Dispersal rates for flightless leafhoppers are much less (Hamilton and Zack 1999; Hamilton 2005). Red-tailed Leafhoppers are thought to be weak dispersers, and are absent or rare on prairie sites on high hills (Hamilton 1995). The distance that Red-tailed Leafhoppers are able to disperse in a single season is estimated at least 150 metres (WI DNR 2011).

Most females and all male Red-tailed Leafhoppers have shortened, non-functioning wings, but occasionally a female individual is fully winged. These long-winged females are most common in the first generation in bivoltine populations (e.g., Illinois) where they account for approximately 10% of individuals (Hamilton and Whitcomb 2010), but have also been observed in a couple of univoltine populations on Manitoulin Island (Bouchard 1997). Elsewhere, these long-winged forms are rare (< 0.3%) (Hamilton and Whitcomb 2010). Whether fully winged females are capable of flight is unknown but considered unlikely (Hamilton 1995). If the long-winged form can fly, it could help maintain subpopulation connectivity (Panzer 2003), especially if dispersal is aided by wind. Red-tailed Leafhoppers are slow to re-colonize after burns, suggesting that fully-winged females (if present) do not fly (Hamilton 1995).

Interspecific Interactions

There is no information regarding interspecific interactions specific to Red-tailed Leafhoppers. However, most species of leafhoppers are subject to competition, predation and parasitism by a variety of insects, birds, and other animals during all life stages.

Other phytophagous insects that feed upon Prairie Dropseed could compete with Red-tailed Leafhopper. These could include generalist species such as grasshoppers (Orthoptera) or co-occurring Prairie Dropseed specialists such as the native leafhopper *Memnonia panzer* (Hamilton 2000). Competition between sap-sucking insects is uncommon, but may occur in cases of superabundance on isolated patches of their host plant (Hamilton and Zack 1999). Red-tailed Leafhoppers are sensitive to vibrations and movement, and when disturbed quickly let go of their grip on the host plant and drop down into the duff (WI DNR 2011). This behaviour may help reduce direct mortality from grazers (although not for eggs). A range of generalist predators such as spiders, ants, beetles, shrews, and birds may prey upon Red-tailed Leafhoppers.

Large populations of leafhoppers in extensive patches of habitat often have high (approaching 100%) parasitism rates (Hamilton and Whitcomb 2010). Leafhoppers and their relatives (Auchenorrhyncha) are the main hosts of dryinid parasitoid wasps (Dryinidae) (Guglielmino 2002; Guglielmino *et al*. 2013). Although parasites of Red-tailed Leafhopper are not documented in the literature, closely related *Flexamia prairiana* are parasitized by *Gonatopus ashmeadi* (Guglielmino *et al*. 2013), and it is possible dryinid wasps also attack Red-tailed Leafhoppers. Other important parasites of Auchenorrhyncha include Strepsiptera (twisted wing parasitic insects) and big-headed flies (Pipunculidae) (Waloff and Jervis 1987). Isolated grass patches such as those in alvars or small prairie reserves may have higher populations of leafhoppers because their enemies may be more sporadic.

POPULATION SIZES AND TRENDS

Sampling Effort and Methods

A combination of methods has been used to survey for Red-tailed Leafhoppers and other grassland leafhoppers in Canada, although most efforts focused on determining presence/not detected rather than estimating site subpopulation size (see Search Effort). In general, about 100 passes with a sweep net is considered adequate to characterize the leafhopper community of a grassland site (Hamilton 2014). There is not sufficient information from which to derive subpopulation sizes and trends.

Abundance

No abundance estimates are available for individual sites, DUs or the total Canadian population. Red-tailed Leafhoppers are often found in prodigious numbers on Prairie Dropseed (Hamilton 1994, 2005), and this high reproductive effort may compensate for losses due to spring flooding or fire, common disturbance in alvars and Bur Oak savanna respectively (Hamilton and Whitcomb 2010). Most of the remaining Red-tailed Leafhopper sites with large populations are at the periphery of its range (Hamilton 1997) likely due to habitat loss and degradation at sites in the United States.

Fluctuations and Trends

There are few data from which to calculate subpopulation fluctuations or trends for Red-tailed Leafhopper for both DUs. Prairie Dropseed is a perennial grass (Snyder 1992), which likely contributes to stability in Red-tailed Leafhopper subpopulations compared to annual grass species. Furthermore, Red-tailed Leafhoppers are not dependent on the flowers or seeds of Prairie Dropseed, so flowering success in any given year probably does not have significant effect on short-term leafhopper numbers.

The progressive loss of natural prairie, oak savanna, and alvar habitat over the last 150 years has likely resulted in a corresponding reduction in the size and number of undocumented Red-tailed Leafhopper subpopulations; however, most of this loss occurred before any leafhopper surveys were conducted. No documented Canadian Red-tailed Leafhopper subpopulation is known to have been extirpated since the first was discovered in the 1970s. However, the loss and fragmentation of habitat has led to a decrease in the ability to recolonize isolated remnant habitat patches.

Rescue Effect

Rescue from United States populations is unlikely. Ontario populations of Red-tailed Leafhoppers are at least 460 km from the nearest populations in Wisconsin and Manitoba populations are more than 300 km from the nearest populations in northern Minnesota. These distances are beyond dispersal abilities, given that females are likely flightless and there are large intervening areas of unsuitable habitat. Attempts to re-establish leafhoppers on prairie sites in the United States have failed (Hamilton pers. comm. 2017).

THREATS AND LIMITING FACTORS

Populations of endemic leafhoppers of Canadian grasslands appear to be remarkably resilient to most stressors, allowing relict populations to persist in grasslands isolated in agricultural and forested landscapes (Hamilton and Whitcomb 2010). However, these subpopulations cannot readily disperse across altered landscapes and are therefore vulnerable to habitat loss in the short-term; in particular, Red-tailed-Leafhopper may be sensitive to repeated disturbance from fire.

Threats to Red-tailed Prairie Leafhopper are categorized and described using the International Union for the Conservation of Nature - Conservation Measures Partnership (IUCN-CMP) threats calculator (see Salafsky *et al*. 2008; Master *et al*. 2009; Open Standards 2017). The overall calculated threat impact is Medium for the Great Lakes Plains Population (Table 2) and Low for the Prairie Population.

Table 2. Threats Calculator for Great Lakes Plains Designatable Unit. Threats assessment results for Red-tailed Leafhopper (*Aflexia rubranura*) Great Lakes Plains population. The threat classification below is based on the International Union of Conservation Networks (IUCN) and Conservation Measures Partnership (CMP) unified threats classification system. For a detailed description of the threat classification system, see the Open Standards website (Open Standards 2017). Threats may be observed, inferred, or projected to occur in the near term. Threats are characterized here in terms of scope, severity, and timing. Threat "impact" is calculated from scope and severity. For details, see Salafsky *et al.* (2008) and Master *et al.* (2009).

Species Scientific Name:	Red-tailed Leafhopper, *Aflexia rubranura*, Great Lakes Plains Population
Date:	December 14, 2016
Assessor(s):	Rob Foster (report co-writer), Al Harris (report co-writer), Paul Grant (Arthropods SSC Co-chair); Brian Starzomski (Arthropods SSC member); Colin Jones (Ontario rep and Arthropods SSC member); Angèle Cyr (COSEWIC Secretariat); and Jennifer Heron (Arthropods SSC Co-chair and moderator of call).

		Level 1 Threat Impact Counts	
Threat Impact		**high range**	**low range**
A	Very High	0	0
B	High	0	0
C	Medium	0	0
D	Low	4	4
	Calculated Overall Threat Impact:	Medium	Medium

Threat		**Impact (calculated)**		**Scope (next 10 Yrs)**	**Severity (10 Yrs or 3 Gen.)**	**Timing**
1	Residential & commercial development	D	Low	Small (1-10%)	Moderate (11-30%)	High (Continuing)
1.1	Housing & urban areas	D	Low	Small (1-10%)	Moderate (11-30%)	High (Continuing)
1.2	Commercial & industrial areas		Negligible	Negligible (<1%)	Moderate (11-30%)	High (Continuing)
1.3	Tourism & recreation areas		Negligible	Negligible (<1%)	Moderate (11-30%)	High (Continuing)
2	Agriculture & aquaculture	D	Low	Small (1-10%)	Serious - Moderate (11-70%)	High (Continuing)
2.3	Livestock farming & ranching	D	Low	Small (1-10%)	Serious - Moderate (11-70%)	High (Continuing)
3	Energy production & mining	D	Low	Small (1-10%)	Extreme (71-100%)	High (Continuing)
3.2	Mining & quarrying	D	Low	Small (1-10%)	Extreme (71-100%)	High (Continuing)
3.3	Renewable energy		Negligible	Unknown	Negligible (<1%)	Low (Possibly in the long term, >10 yrs/3 gen)
4	Transportation & service corridors		Negligible	Negligible (<1%)	Negligible (<1%)	High (Continuing)
4.1	Roads & railroads		Negligible	Negligible (<1%)	Negligible (<1%)	High (Continuing)
4.2	Utility & service lines		Negligible	Negligible (<1%)	Negligible (<1%)	High (Continuing)

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing
5	Biological resource use		Negligible	Negligible (<1%)	Negligible (<1%)	High (Continuing)
5.1	Hunting & collecting terrestrial animals		Negligible	Negligible (<1%)	Negligible (<1%)	Moderate (Possibly in the short term, < 10 yrs/3 gen)
5.3	Logging & wood harvesting		Negligible	Negligible (<1%)	Negligible (<1%)	High (Continuing)
6	Human intrusions & disturbance		Negligible	Negligible (<1%)	Negligible (<1%)	High (Continuing)
6.1	Recreational activities		Negligible	Negligible (<1%)	Negligible (<1%)	High (Continuing)
7	Natural system modifications	D	Low	Small (1-10%)	Extreme - Moderate (11-100%)	High (Continuing)
7.1	Fire & fire suppression	D	Low	Small (1-10%)	Extreme - Moderate (11-100%)	High (Continuing)
7.3	Other ecosystem modifications	D	Low	Restricted (11-30%)	Moderate (11-30%)	Moderate (Possibly in the short term, < 10 yrs/3 gen)
8	Invasive & other problematic species & genes		Negligible	Negligible (<1%)	Negligible (<1%)	High (Continuing)
8.1	Invasive non-native/alien species/diseases		Negligible	Negligible (<1%)	Negligible (<1%)	High (Continuing)
9	Pollution		Unknown	Small (1-10%)	Unknown	High (Continuing)
9.3	Agricultural & forestry effluents		Unknown	Small (1-10%)	Unknown	High (Continuing)
11	Climate change & severe weather		Unknown	Unknown	Unknown	Moderate (Possibly in the short term, < 10 yrs/3 gen)
11.1	Habitat shifting & alteration		Unknown	Unknown	Unknown	Moderate (Possibly in the short term, < 10 yrs/3 gen)
11.2	Droughts		Unknown	Unknown	Unknown	Moderate (Possibly in the short term, < 10 yrs/3 gen)
11.3	Temperature extremes		Unknown	Unknown	Unknown	Moderate (Possibly in the short term, < 10 yrs/3 gen)
11.4	Storms & flooding		Unknown	Unknown	Unknown	Moderate (Possibly in the short term, < 10 yrs/3 gen)

[1]**Impact** – The degree to which a species is observed, inferred, or suspected to be directly or indirectly threatened in the area of interest. The impact of each stress is based on Severity and Scope rating and considers only present and future threats. Threat impact reflects a reduction of a species population or decline/degradation of the area of an ecosystem. The median rate of population reduction or area decline for each combination of scope and severity corresponds to the following classes of threat impact: very high (75% declines), high (40%), medium (15%), and low (3%). Unknown: used when impact cannot be determined (e.g., if values for either scope or severity is unknown).

[2]**Scope** – Proportion of the species that can reasonably be expected to be affected by the threat within 10 years. Usually measured as a proportion of the species' population in the area of interest. (Pervasive = 71–100%; Large = 31–70%; Restricted = 11–30%; Small = 1–10%)

[3]**Severity** – Within the scope, the level of damage to the species from the threat that can reasonably be expected to be affected by the threat within a 10-year or three-generation timeframe. Usually measured as the degree of reduction of the species' population (Extreme = 71–100%; Serious = 31–70%; Moderate = 11–30%; Slight = 1–10%).

[4]**Timing** – High = continuing; Moderate = only in the future (could happen in the short term [< 10 years or 3 generations]) or now suspended (could come back in the short term); Low = only in the future (could happen in the long term) or now suspended (could come back in the long term); Insignificant/Negligible = only in the past and unlikely to return, or no direct effect but limiting

Table 3. Threats Calculator for Prairie population. Threats assessment results for Red-tailed Leafhopper (*Aflexia rubranura*) Prairie population. The threat classification below is based on the International Union of Conservation Networks (IUCN) and Conservation Measures Partnership (CMP) unified threats classification system. For a detailed description of the threat classification system, see the Open Standards website (Open Standards 2017). Threats may be observed, inferred, or projected to occur in the near term. Threats are characterized here in terms of scope, severity, and timing. Threat "impact" is calculated from scope and severity. For details, see Salafsky *et al.* (2008) and Master *et al.* (2009).

Species Scientific Name:	Red-tailed Leafhopper, *Aflexia rubranura*, Prairie Population
Date:	First call that included the species in its entire Canadian range December 14, 2016 Threats updated February 8, 2018 on a call that focused only on the Prairie Designatable Unit.
Assessor(s):	Canadian range of the species, December 14, 2016: Rob Foster (report co-writer), Al Harris (report co-writer), Paul Grant (Arthropods SSC Co-chair); Brian Starzomski (Arthropods SSC member); Colin Jones (Ontario rep and Arthropods SSC member); Angèle Cyr (COSEWIC Secretariat); and Jennifer Heron (Arthropods SSC Co-chair and moderator of call). Updated for Prairies population only, February 8, 2018: Paul Grant (Arthropods SSC Co-chair); Angèle Cyr (COSEWIC Secretariat); Ruben Boles (CWS); John Klymko (Arthropods SSC); Sarah Semmler (Arthropods SSC); Leah Craig-Moore (CWS); Jennifer Heron (Arthropods SSC Co-chair and moderator of call).

		Level 1 Threat Impact Counts	
Threat Impact		**high range**	**low range**
A	Very High	0	0
B	High	0	0
C	Medium	0	0
D	Low	1	1
	Calculated Overall Threat Impact:	Low	Low

	Threat	Impact (calculated)	Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
1	Residential & commercial development					
1.1	Housing & urban areas					Not applicable. Most sites are not within close proximity to areas with high potential for urban development; only site with potential applicability is Stony Mountain, but not likely in the next ten years.
2	Agriculture & aquaculture	Unknown	Large - Restricted (11-70%)	Unknown	High (Continuing)	

Threat		Impact (calculated)	Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
2.1	Annual & perennial non-timber crops					Not applicable. Agricultural activities such as haying are not a threat – Prairie Dropseed does not grow within these crops, nor is it found in other crops.
2.3	Livestock farming & ranching	Unknown	Large - Restricted (11-70%)	Unknown	High (Continuing)	Unknown. Grazing occur within many remnant grassland and/or Bur Oak habitats. Overgrazing is the threat though, because the prairies and the leafhopper evolved with bovid grazers. Livestock do consume Prairie Dropseed and could potentially consume eggs, nymphs or adults. It is likely most sites where the leafhopper occurs would have grazing, although the density of livestock and duration of grazing is unknown.
3	Energy production & mining					
3.2	Mining & quarrying					Not Applicable. Sites in Manitoba are not likely to have quarrying or gravel extraction.
4	Transportation & service corridors	Unknown	Small (1-10%)	Unknown	High (Continuing)	
4.1	Roads & railroads					Not applicable. A small portion of the St Charles site may be developed for centre port highway, although the highway is planned through a section of non-natural (e.g., manicured) habitat and not likely to impact the natural ecosystems in this area.
4.2	Utility & service lines	Unknown	Small (1-10%)	Unknown	High (Continuing)	Unknown. Likely some utility expansion, but Prairie Dropseed prefers open habitats, so the utility service lines would likely temporarily disturb site although plant would grow back.
5	Biological resource use	Negligible	Negligible (<1%)	Negligible (<1%)	High (Continuing)	
5.1	Hunting & collecting terrestrial animals	Negligible	Negligible (<1%)	Negligible (<1%)	Moderate (Possibly in the short term, < 10 yrs/3 gen)	See text in body of report.
5.2	Gathering terrestrial plants					Not applicable. Prairie Dropseed plants or seeds are not harvested for commercial and/or traditional purposes.
6	Human intrusions & disturbance	Unknown	Small (1-10%)	Unknown	High (Continuing)	

Threat		Impact (calculated)	Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
6.1	Recreational activities	Unknown	Small (1-10%)	Unknown	Moderate (Possibly in the short term, < 10 yrs/3 gen)	Hiking/ATV use (direct mortality from trampling of host plants, eggs, nymphs or adults) or dog walking (defecation, digging and urination on host plants) is potential threat at some sites. There is some recreational use at the St. Charles site, and there is an interpretive centre planned at another site, but the planning stages and/or footprint are unknown at this time.
6.2	War, civil unrest & military exercises	Unknown	Small (1-10%)	Unknown	High (Continuing)	Applicable at one site, St. Charles has military use. Access to the site is restricted and impacts are unknown.
7	Natural system modifications	Low	Pervasive (71-100%)	Slight (1-10%)	High (Continuing)	
7.1	Fire & fire suppression	Unknown	Large (31-70%)	Unknown	High (Continuing)	Both managed and wild fire is scored under this threat. Different sites where the leafhopper occurs are managed differently with site-specific wild fire plans. Grasslands are not typically managed on an annual cycle.
7.2	Dams & water management/use					Not Applicable. The areas are not within flood zones and/or are now managed for flooding. Major flood zones in Manitoba are farther south of the leafhopper's range.
7.3	Other ecosystem modifications	Low	Pervasive (71-100%)	Slight (1-10%)	High (Continuing)	Natural succession from native woody vegetation (8.2), fire suppression (7.1), and the spread of invasive non-native plants (8.1) are cumulative threats that adversely affect the growth and abundance of Prairie Dropseed. These threats are secondary to the leafhopper. Each is discussed separately under the threat heading in the body of the report.
8	Invasive & other problematic species & genes					
8.1	Invasive non-native/alien species/diseases					Not applicable. Competition from the growth of non-native plants with Prairie Dropseed is considered a secondary threat and scored under 7.3. Non-native animals that may consume the leafhopper are not considered a threat.
8.2	Problematic native species/diseases					Not applicable. Browsing by native White-tailed Deer is not considered a threat to Prairie Dropseed; the deer are not in over-abundant numbers. Natural succession of native woody plans (e.g., Aspen) is scored under 7.3 Other ecosystem modifications.
9	Pollution	Unknown	Small (1-10%)	Unknown	High (Continuing)	
9.3	Agricultural & forestry effluents	Unknown	Small (1-10%)	Unknown	High (Continuing)	Unknown. Impacts from agricultural pesticide drift are unknown; this requires site-specific information.

Threat		Impact (calculated)	Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
11	Climate change & severe weather	Unknown	Unknown	Unknown	Moderate (Possibly in the short term, < 10 yrs/3 gen)	
11.1	Habitat shifting & alteration	Unknown	Unknown	Unknown	Moderate (Possibly in the short term, < 10 yrs/3 gen)	Unknown. The distribution of Prairie Dropseed may change with climate change, but this is outside the timeframe of the threats assessment.
11.2	Droughts	Unknown	Unknown	Unknown	Moderate (Possibly in the short term, < 10 yrs/3 gen)	Unknown. Although Prairie Dropseed and the leafhopper have evolved with drought as a factor.
11.3	Temperature extremes	Unknown	Unknown	Unknown	Moderate (Possibly in the short term, < 10 yrs/3 gen)	Unknown. Early and/or late season frost may kill the leafhopper, but the scope, severity and timing are unknown.

Threat 1. Residential or Commercial Development

1.1 Housing & urban areas, 1.2 Commercial & industrial areas and 1.3 Tourism & recreation areas

Great Lakes Plains population (Low impact):

Residential or commercial development is a threat on Manitoulin Island; most of the island is privately owned. Most alvar habitats are near the Lake Huron shoreline and potentially at risk of residential or cottage development. Construction of buildings, yards, driveways, or access roads could potentially destroy habitat for Prairie Dropseed and associated Red-tailed Leafhoppers. Road in-fill, foundations, or septic fields, could potentially introduce invasive non-native plant species (see 8. Invasive and other problematic species and genes) as well as making the habitat less suitable for Prairie Dropseed.

Prairie population:

Not applicable at known sites. The prairies closest to Winnipeg and close to Highway 6 are threatened by urban development and associated threats like road building (Hamel pers. comm. 2018). However, these sites are not known to have Red-tailed Leafhopper subpopulations.

Threat 2. Agriculture and Aquaculture

2.1 Annual & perennial non-timber crops

Great Lakes Plains population:

Not applicable.

Prairie population (Negligible impact):

At present, agricultural development is not a significant threat to most known Manitoba Red-tailed Leafhopper sites (Friesen pers. comm. 2017). Haying occurs at least two Manitoba sites (Oak Point and Lake Francis) (Friesen pers. comm. 2017), but its effect on Red-tailed Leafhoppers is unknown.

2.3 Livestock farming and ranching

Great Lakes Plains population (Low impact):

Livestock over-grazing on alvars is a potential threat at some Red-tailed Leafhopper sites in Ontario. Light grazing may maintain some alvars in an open state, but overgrazing may cause changes in the vegetation and damage soils (Reschke *et al*. 1999).

Historically, most alvars on Manitoulin Island were grazed by domestic livestock, and the resulting non-native weeds and degraded habitat are still visible in many areas (Jones 2015). Prairie Dropseed has good forage value for livestock (Snyder 1992) and at present cattle are grazed on at least one Red-tailed Leafhopper site (Gore Bay Airport). Low grazing does not appear to be detrimental, but overgrazing can significantly reduce Prairie Dropseed cover (Foster pers. comm. 2016; Jones pers. comm. 2016) likely with corresponding decreases in Red-tailed Leafhopper. For example, no Prairie Dropseed was observed in an overgrazed pasture on North Line Road (Figure 10), but Prairie Dropseed was abundant (and Red-tailed Leafhopper present) on the other side of the fence along the road allowance.

Prairie population:

Not applicable. Unsurveyed oak savanna habitats probably benefit from light grazing due to the natural succession of native vegetation from fire suppression (see Threat 8.2). However, overgrazing may lead to excessive urination, defecation, trampling of habitat and host plants and overall habitat degradation.

IUCN Threat 3. Energy Production and Mining

3.2 Mining and quarrying

Great Lakes Plains population (Low impact):

Aggregate removal is a threat at alvar sites. At least two known sites are found on private property on Great La Cloche and Little La Cloche Island where there is an active limestone quarry operation. Direct or indirect impacts from quarry operations on Red-tailed Leafhopper or its habitat is unknown due to access restrictions, but satellite imagery (GoogleEarth™) indicates that the previous collection site on Little La Cloche Island is immediately adjacent to active removal areas. Manitoulin Island is predominately limestone, and alvars are attractive for limestone quarries because there is very little overburden and often few trees to remove.

Threat 4. Transportation and Service Corridors

4.1 Roads & railroads and 4.2 Utility & service lines

Historically, the construction of transportation and service corridors likely resulted in loss of Red-tailed Leafhopper habitat, as they bisect a number of alvar sites in Ontario and are adjacent to some prairie sites in Manitoba. Pipelines and hydroelectric transmission lines are less of a threat, because the habitat in the rights-of-way is less disrupted than roads.

Great Lakes Plains population (Negligible impact):

New road construction, such as private access roads on Manitoulin Island, could result in a small loss of habitat at other sites.

Mowing of roadside verges likely has no negative impacts on Red-tailed Leafhoppers; Prairie Dropseed and Red-tailed Leafhoppers were abundant in a road allowance on Manitoulin Island (Figure 10). Mowing seems to have little, if any, effect on prairie insects (Hamilton 1995). Although little is known about the effects of mowing on Red-tailed Leafhoppers (USDA 2003), a number of sites have been managed primarily by mowing with no apparent negative impacts on Red-tailed Leafhoppers (e.g., 7 km E of St. Ambroise).

Prairie population (Unknown impact):

The Province of Manitoba is planning to extend the CentrePort Canada Way (Morgan 2015), although this is not likely to impact Red-tailed Leafhopper habitat at the St. Charles Rifle Range; this expressway expansion is in the design stage and the province is apparently working on a route that will preserve as much of the existing natural prairie habitat as possible (Gibson 2014). The prairies closest to Winnipeg and close to Highway 6 are threatened by urban development and associated threats like road building (Hamel

pers. comm. 2018). However, these sites are not known to have Red-tailed Leafhopper.

Threat 5. Biological Resource Use

5.1 Hunting and collecting (Negligible impact)

The occasional collecting of Red-tailed Leafhopper for scientific voucher specimens does not represent a threat to Canadian populations (both Prairie population and Great Lakes Plains population). Prairie Dropseed does not appear to be harvested for human use, except as an ornamental plant; it would likely be purchased from nurseries rather than collected from nature.

5.3 Logging and wood harvesting

Great Lakes Plains population (Negligible impact):

Alvar habitats on Manitoulin Island are often used as staging areas for logging operations in adjacent forests, including near some Red-tailed Leafhopper sites (OMNR 2013). During logging operations, heavy machinery can potentially trample Red-tailed Leafhopper individuals and damage Prairie Dropseed habitat.

Prairie population:

Not applicable.

Threat 6. Human Intrusions and Disturbance

6.1 Recreational activities (Negligible impact)

Great Lakes Plains population and Prairie population:

There is a small risk of Red-tailed Leafhoppers or their host plants being crushed by all-terrain vehicle (ATV) users. ATV and off-road vehicles are common on many alvars on Manitoulin and adjacent islands, including some where Red-tailed Leafhoppers are present (OMNR 2013). Prairie Dropseed clumps could potentially be crushed, although this was not observed during 2016 field surveys (Foster pers. comm. 2016).

Small relict prairie and alvar sites, particularly along roadsides are vulnerable to disturbance from work-related activities. For example, at the small (approx. 6 ha) Grosse Isle railway junction site, much of Red-tailed Leafhopper habitat next to the highway was reduced to a mud bath when heavy construction equipment was parked on it in 1991 (Hamilton 1995).

6.2 War, civil unrest & military exercises

Prairie population (Negligible impact):

Military exercises could potentially affect Red-tailed Leafhoppers or their habitat at the St. Charles Rifle Range in Winnipeg. However, there is negligible risk of trampling by vehicles or personnel.

Threat 7. Natural System Modifications

7.1 Fire & fire suppression

Great Lakes Plains population and Prairie population (Low impact):

Fire can have mixed effects on Red-tailed Leafhoppers. It can kill eggs, nymphs, and adults and cause short-term loss of habitat, but can also help maintain the open habitats that support its host plant, Prairie Dropseed, over the long-term. Red-tailed Leafhopper might be adversely affected by fire management regimes across much its range (Hamilton 1995), although populations are more resilient to frequent fires in Illinois where there are two generations per year (Hamilton 1997).

The absence of Red-tailed Leafhoppers on many frequently burned prairies and most railway rights-of-way where Prairie Dropseed is abundant and more fire-tolerant leafhoppers, *Memnonia panzeri,* are present suggests that it is susceptible to fire impacts (Hamilton 1995). Red-tailed Leafhoppers overwinter as eggs in exposed stems, which are highly vulnerable to fall and spring burns when the grass is dry and highly flammable (Hamilton 1994). Red-tailed Leafhopper populations require four or more generations (i.e., four years) for full recovery post-fire compared to only one generation for co-occurring *M. panzeri* (Panzer 1998). Red-tailed Leafhopper recovery post-fire likely depends on in situ survival (Panzer 2002), as well as overland migration of flightless individuals from unburned areas, perhaps with some assistance from wind (Hamilton 1995). The high fecundity of Red-tailed Leafhoppers may also help compensate for a high proportion of fire-kill (Panzer 2002), especially if fires increase Prairie Dropseed growth due to post-fire mineral recycling, or decimation of predators and parasites (Hamilton and Whitcomb 2010).

7.3 Other ecosystem modifications

Great Lakes Plains population (Low impact):

The impacts of fire on Red-tailed Leafhopper populations in alvar habitats are unknown. As in prairies, fire may prevent succession woody plants such as Creeping Juniper (*Juniperus horizontalis*), Common Juniper (*J. communis*), Aromatic Sumac (*Rhus aromatica*) and maintain the more open habitats that Prairie Dropseed requires. Conversely, there is little or no evidence that some alvar habitats on Manitoulin originated from fire or are maintained by it (Jones and Reschke 2005; Jones 2015). Seasonal and periodic drought, shallow soils, cold onshore winds, and grazing are other factors

contributing to maintaining alvars in an open state (Brownell and Riley 2000). The relative lack of natural or prescribed fires on Manitoulin and adjacent islands may be a contributing factor to the persistence of a high number of Red-tailed Leafhopper sites compared to more frequently burned prairie sites in the US Midwest. In contrast, Prairie Dropseed is considered to be resilient to fire, often increasing in flower production, height, and cover post-fire (Snyder 1992).

Prairie population (Low impact):

Fire is an intrinsic natural force that maintains prairies and other grasslands by discouraging woody succession, but wildfire is now relatively uncommon within the Canadian range of Red-tailed Leafhopper. Natural fires in extensive grasslands usually had numerous skips that served as refugia for Red-tailed Leafhoppers and other prairie insects (Hamilton and Whitcomb 2010). However, annual burning by prairie managers to discourage woody succession can have negative impacts on invertebrates if no section of the managed prairie is left unburned (Hamilton and Whitcomb 2010). Large leafhopper faunas are often found at small prairie sites where there is little or no fire management; the infrequency of fire is believed to contribute to the sites unusually high species richness (Hamilton and Whitcomb 2010). Prescribed fire has been applied to Grosse Isle (Hamilton 1995), sometimes on an annual basis (Morgan pers. comm. 2018), St. Charles Rifle Range (Morgan 2015), and possibly Lake Francis WMA (Friesen pers. comm. 2017), although how this has affected Red-tailed Leafhoppers is unknown, due in part to lack of recent leafhopper surveys. Red-tailed Leafhoppers persisted at the Grosse Isle site despite twice annual burning of the railway wye, perhaps surviving in wetter areas or along the verges (Hamilton 1995).

Threat 8. Invasive and Other Problematic Species and Genes

8.1 Invasive non-native/alien species/diseases

Great Lakes Plains population (Negligible impact):

Invasive non-native plants such White Sweet Clover (*Melilotus albus*) and Smooth Brome (*Bromus inermis*) can degrade alvar habitat by competing with Prairie Dropseed for space and nutrients (Reschke *et al*. 1999; Jones 2015). However, no direct negative impacts of invasive plant species at Ontario sites was observed during 2016 fieldwork (Foster and Harris pers. comm. 2016).

Prairie population (Negligible impact):

White Sweet Clover, Smooth Brome and Leafy Spurge (*Euphorbia esula*), Canary Grass (*Phalaris canariensis*) and Canada Thistle (*Cirsium arvense*) are widespread throughout many Bur-oak savanna and prairie grassland habitats and could impact Red-tailed Leafhopper habitat, particularly along rights-of-way. Impacts of invasive species on Prairie Dropseed at Manitoba sites are undocumented.

8.2 Problematic native species/diseases (scored under 7.3 Other ecosystem modifications).

Prairie population (Not scored):

The main threat to the oak savanna portions of Interlake prairies and oak savanna habitats is the natural succession and encroachment of woody plants (e.g., aspens) and the slow change of the ecosystem into forest and shrub vegetation, due mainly from nature wildfire suppression (Friesen pers. comm. 2018; Hamel pers. comm. 2018).

Threat 9. Pollution

9.3 Agricultural & forestry effluents

Great Lakes Plains population and Prairie population (Unknown impact):

It is unknown if pesticides or herbicides are sprayed at or near Red-tailed Leafhopper prairie/savanna habitat in Manitoba or (less-likely) alvars in Ontario. Red-tailed Leafhoppers or Prairie Dropseed could be impacted by the drift of agrochemicals used to control pest insects or weeds on adjacent fields, and there is an unknown but likely negligible risk.

Threat 11. Climate Change and Severe Weather (Unknown impact)

11.1 Habitat shifting & alteration, 11.2 Droughts, 11.3 Temperature extremes and 11.4 Storms & flooding

Great Lakes Plains population and Prairie population (Unknown impact):

The potential impact of climate change on Red-tailed Leafhoppers, their host plant, and their alvar and savanna habitats is unknown. Periodic droughts are likely beneficial to Red-tailed Leafhoppers, at least in Ontario, killing back woody vegetation (Catling 2014), and maintaining more open alvar habitats upon which Prairie Dropseed and the leafhoppers depend (Hamilton and Whitcomb 2010). In the short-term, small, isolated populations of Red-tailed Leafhopper or Prairie Dropseed are likely vulnerable to stochastic events and could be threatened by hailstorms or severe early or late frosts, particularly if the frequency and intensity of severe weather events increases due to climate change. Prairie Dropseed is a perennial grass and likely more resilient than Red-tailed Leafhopper.

Decreased precipitation and increased mean annual temperatures and aridity associated with climate change (Colombo 2008) could slow succession of open alvars and savannas to more treed conditions, particularly if there are prolonged and/or severe droughts. There is also the potential for more frequent and/or intense fires, although wildfires are actively suppressed in the areas where Red-tailed Leafhoppers occur because of the risk to human safety and infrastructure. The impacts are difficult to predict, however, and the long-term impact of climate change on future Red-tailed Leafhopper habitat may depend on the unknown interplay between temperatures, aridity, and vegetation dynamics.

Limiting Factors

Limiting factors are generally not human-induced and include characteristics that make the species more vulnerable to ongoing threats. The main limiting factors for Red-tailed Leafhoppers are likely a combination of the following and are applicable to both DUs.

Host plant and habitat specificity.

Red-tailed Leafhoppers are dependent on Prairie Dropseed to complete their life cycle. Given Red-tailed Leafhopper's habitat and host plant specificity and the scarcity of alvars and remaining native tallgrass prairie, availability of suitable habitat is the primary biological factor limiting this species' recovery.

Small subpopulation size and genetic isolation.

Red-tailed Leafhopper subpopulations are within small, isolated, and limited habitat patches. Not all apparently suitable habitats are occupied in Canada, perhaps due to post-glacial history, limited dispersal ability, and/or undocumented microhabitat preferences.

Natural parasitic enemies.

Parasites are known to attack leafhoppers during all life stages; however, no species-specific information is available for Red-tailed Leafhopper.

Vulnerability to weather patterns.

Temperature and rainfall impact the species' growth and adult movement. Humidity and extreme winter temperatures affect Red-tailed Leafhopper survival, abundance and distribution. The previous years' weather affects the next year's subpopulation and contributes to the degree days and subsequent emergence of the next year's generation.

Dispersal ability.

Red-tailed Leafhopper is flightless and not able to disperse long distances through unsuitable habitat.

Natural herbivory could result in the mortality of associated Red-tailed Leafhoppers. Prairie Dropseed is palatable to native White-tailed Deer (*Odocoileus virginianus*), which are found in Red-tailed Leafhopper habitats in both Manitoba and Ontario.

Number of Locations

Great Lakes Plains population

Most sites in Ontario are within alvar complexes. For example, several known Red-tailed Leafhopper sites (i.e., Barrie Island Causeway, Gore Bay Airport, Kip Fleming Tract, and Bouchard's "10 km SW of Gore Bay") are all part of the Foxy Prairie - Gore Bay Airport - Rozel's Bay Complex (Brownell and Riley 2000). However, the distribution of Prairie Dropseed and Red-tailed Leafhopper at such sites is not fully known and there may not be dispersal among known locations. Threats (e.g., quarrying, cattle over-grazing and residential development) vary in severity among sites.

Based on these factors, Canadian Red-tailed Leafhoppers may be considered to represent 27 locations, one for each of the known sites (separated by at least 1 km of unsuitable habitat).

Prairie population

There are a minimum of eight sites of Red-tailed Leafhopper in the Prairie population, although there are likely additional subpopulations within remnant patches of savanna habitat. Each of these sites represents at least one location for the species, based on the cumulative threats from ecosystem modifications at each site. The upper number of locations is unknown; there are likely additional subpopulations with separate threats and thus additional locations.

PROTECTION, STATUS AND RANKS

Legal Protection and Status

Red-tailed Leafhopper, its host plant and associated habitat have no legal protection at the provincial (Manitoba or Ontario) or federal level in Canada and the species is not covered by the *Convention on International Trade in Endangered Species of Wild Fauna and Flora* (CITES).

Non-Legal Status and Ranks

The conservation status ranks for Red-tailed Leafhopper are (NatureServe 2016):

Global:	imperilled (G2)
National (Canada):	critically imperilled to imperilled (N1N2)
United States:	nationally not ranked (NNR)
Ontario:	critically imperilled (S1)
Manitoba:	not ranked (SNR)
Illinois	Imperilled (S2)
Wisconsin	possibly imperilled (S2?)

Minnesota	vulnerable (S3)
South Dakota:	not ranked

Red-tailed Leafhopper has not been listed under the United States *Endangered Species Act* (US FWS 2016). At the state level, the species is listed as Endangered in Wisconsin (WI DNR 2016), Threatened in Illinois (IESPB 2015), and Special Concern in Minnesota. The species has no legal protection in South Dakota.

Red-tailed Leafhopper's host plant, Prairie Dropseed, is ranked as S3 in Ontario, S3S5 in Manitoba, and G5 globally (NatureServe 2016). Elsewhere within the range of Red-tailed Leafhopper, Prairie Dropseed is ranked as S2S3 in Illinois and SNR in Minnesota, South Dakota, and Wisconsin.

Habitat Protection and Ownership

Great Lakes Plains population:

Two sites (Misery Bay East and West) are protected by Misery Bay Provincial Park and one site (East Belanger Bay) is in the recently established Queen Mother Mnidoo Mnissing Provincial Park. One Ontario site near South Bay is on Wikwemikong First Nation land. A few Red-tailed Leafhopper sites along road allowances may be Crown or municipal land. Although the Ontario Provincial Policy Statement (PPS) can provide some protection from development, only 21% of alvars in Ontario have some form of legal protection in Ontario (ECO 2013). No provincially significant Areas of Natural or Scientific Interest (ANSI) that would benefit from protection under the PPS have been designated on Manitoulin Island, however.

Prairie population:

One site south of St. Laurent, Manitoba, is within the Lake Francis Wildlife Management Unit (WMA). The St. Charles Rifle Range is owned by the federal Department of National Defence; there is the possibility that a portion could be sold to the province of Manitoba for expressway expansion (Government of Manitoba 2014).

The remaining Red-tailed Leafhopper sites in both the Prairie and Great Lakes Plains subpopulations are on private land.

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BIOGRAPHICAL SUMMARY OF REPORT WRITERS

Robert Foster is co-founder and principal of Northern Bioscience, an ecological consulting firm offering professional consulting services supporting ecosystem management, planning, and research. Dr. Foster has a B.Sc. in Biology from Lakehead University and a D. Phil in Zoology from the University of Oxford. Rob has worked as an ecologist in Canada for over 25 years and has conducted numerous insect surveys for protected areas planning and environmental assessments in Ontario, as well as Manitoba, Minnesota, Quebec, Alberta, and British Columbia. Rob has written or co-written over twenty COSEWIC status reports including 15 insects, 5 vascular plants, a spider, a land snail, and a bird.

Allan Harris is a biologist with over 25 years' experience in northern Ontario. He has a B.Sc. in Wildlife Biology from the University of Guelph and an M.Sc. in Biology from Lakehead University. After spending seven years as a biologist with Ontario Ministry of Natural Resources, he co-founded Northern Bioscience, an ecological consulting company based in Thunder Bay, Ontario. Al has written or co-written dozens of scientific papers, technical reports, and popular articles, including COSEWIC status reports for the Monarch, Gold-edged Gem, Nuttall's Sheep Moth, Lake Huron Grasshopper, Riverine Clubtail, Laura's Clubtail, Rapids Clubtail, Gibson's Big Sand Tiger Beetle, Northern Barrens Tiger Beetle, Powesheik Skipperling, Mormon Metalmark, Weidemeyer's Admiral, Bogbean Buckmoth, Hop-tree Borer, Georgia Basin Bog Spider, Broad-banded Forestsnail, Nahanni Aster, Crooked-stem Aster, Bluehearts, Drooping Trillium and Small-flowered Lipocarpha. Al also authored the Ontario provincial status report for woodland caribou, and has authored or coauthored national and provincial recovery strategies for vascular plants and birds.

COLLECTIONS EXAMINED

The following collections were contacted for Canadian specimens of Red-tailed Leafhopper:

Canadian National Collection of Insects, Arachnids and Nematodes (CNC), Ottawa, ON (Owen Lonsdale)

Chicago Field Museum, Chicago, IL. (on-line search)

E.H. Strickland Entomological Museum, University of Alberta, Edmonton, AB (online search).

Illinois Natural History Survey Collection Prairie Research Institute, Champaign, IL (online search).

J.B. Wallis / R.E. Roughley Museum of Entomology, University of Manitoba, Winnipeg, MB (T. Galloway).

Lyman Entomological Museum, McGill University, Ste,-Anne-de-Bellevue, QC (T. Wheeler).

Royal Alberta Museum, Edmonton, AB (Tyler Cobb).

Royal Ontario Museum, Toronto, ON. (Brad Hubley).

Royal Saskatchewan Museum, Regina, SK (Cory Sheffield).

Spencer Entomological Collection, Beaty Biodiversity Museum, University of British Columbia, Vancouver, BC (Karen Needham)

Yale Peabody Museum of Natural History, New Haven, CT (on-line search)

Other collections with significant leafhopper holdings have been examined by Hamilton (1972, 2004).