COSEWIC
Assessment and Status Report

on the

Dukes' Skipper
Euphyes dukesi

in Canada

SPECIAL CONCERN
2022

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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Dukes' Skipper — Photograph by Blake Mann.

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COSEWIC
Assessment Summary

Assessment Summary – May 2022

Common name
Dukes' Skipper

Scientific name
Euphyes dukesi

Status
Special Concern

Reason for designation
This wetland specialist butterfly is found in open hardwood swamps and clearings of extreme southwestern Ontario. The species has a restricted range within the counties of Essex, Chatham-Kent, and Lambton, with only 12 known extant subpopulations. Its historical habitat has changed since European settlement, which has led to geographical isolation of suitable wetland patches. Larvae feed on native sedges that are displaced when the invasive European Reed encroaches into the butterfly's wetland habitat. This invasive plant is present at seven of the 12 extant subpopulations and has increased its range in southern Ontario by almost 30% between 2010 and 2017. The spread of invasive plants could lead to extirpation at some sites in the future.

Occurrence
Ontario

Status history
Designated Special Concern in May 2022.

COSEWIC
Executive Summary

Dukes' Skipper
Euphyes dukesi

Wildlife Species Description and Significance

Dukes' Skipper (*Euphyes dukesi*) is a large (wingspan 31-37mm) dark skipper with rounded wing edges. The species is sexually dimorphic. Males have sooty-black wings, occasionally showing orange along the forewing costa (forewing front edge) and the centre of the hindwing. Females are dark brown, sometimes showing one or two orange spots in the centre of the forewing. The underside in both sexes is orange-brown with a pale orange-yellow streak running through the centre of the hindwing. The species is uncommon throughout its range. Globally, there are two subspecies of Dukes' Skipper (*E. dukesi dukesi* and *E.d.calhouni*); only the *E.e.dukesi* is assessed in this status report.

Distribution

Globally, Duke's Skipper ranges from southern Ontario, south through Michigan and the Mississippi River drainage to eastern Texas and Louisiana; eastward to the Atlantic and Gulf coasts in Florida. The ranges of the two subspecies (*E.d.dukesi* and *E.d.calhouni*) intersect in northern Florida; only *E.e.dukesi* ranges in Canada.

In Canada, the Dukes' Skipper is restricted to extreme southwestern Ontario in Essex, Chatham-Kent, and Lambton counties. There are 28 documented subpopulations: 12 extant and 16 historical. The Canadian range extent, including extant and historical subpopulations, is 2,486 km^2.

Habitat

Dukes' Skipper is a wetland specialist and found in hardwood swamps and natural clearings or edges with large sedge patches. In Ontario, the larval host plants are Lake Sedge (*Carex lacustris*) and Shoreline Sedge (*Carex hyalinolepis*), both common and widespread throughout skipper's range. A shaded aspect appears important for Dukes' Skipper; adults are observed under a forest canopy with dappled sunlight. Adults nectar on a variety of wildflowers including Swamp Milkweed (*Asclepias incarnata*), Common Milkweed (*Asclepias syriaca*) and thistles (Family Cardueae).

Biology

Dukes' Skipper has one generation per year, a flight period from early July through mid-August and an adult lifespan of approximately three weeks. Females oviposit on the underside of leaves of their host plant. Eggs hatch and larvae feed until they reach their fourth instar, at which stage they enter diapause (i.e., overwintering life stage). Post-diapause larvae emerge in the spring, continue to feed on host plants, and pupate after the fifth instar.

Dukes' Skipper males do not appear territorial but will actively patrol sedge patches in pursuit of females. Females rest and bask on sedges.

The dispersal ability of Duke's Skipper is unstudied and unknown. They are noted to have a slower flight speed, when compared with other members of the genus *Euphyes*. Based on information from related *Euphyes* species, the dispersal distance is estimated to be a maximum of two kilometres.

Population Sizes and Trends

Dukes' Skipper surveys have focused on recording the skipper's presence, habitat preferences and other natural history information. All observations in Canada have been adults, and no information on population trends or fluctuations are available.

The widespread historical loss of wetland and swamp habitats in southern Ontario over the past 200 years has led to geographical isolation of suitable Dukes' Skipper habitat patches. Quantified data that show habitat trends in southwestern Ontario within the last 10 years are not well documented; however, ecosystem changes are trending from non-native/invasive European Reed (*Phragmites australis australis*), which is rapidly spreading into many wetland habitats.

Threats and Limiting Factors

Threats to Dukes' Skipper are inferred from declines in extent and quality of habitat at known sites in southwestern Ontario. The primary threats are ecosystem modifications that result from the spread of invasive plants, primarily European Reed, which is abundant within the habitats of at least seven extant Dukes' Skipper subpopulations. Other threats include habitat conversion to annual and perennial non-timber crops, residential development, and changes to their wetland habitat from climate change. Limiting factors that may contribute to the skipper's decline include its presence as small, localized subpopulations and a limited dispersal ability. Subpopulations in Canada come close to being severely fragmented[1] based on the ecosystem modifications from the spread of European Reed. A single European Reed plant can spread 1-2m/year. This invasive plant grows up to 2 metres, can shade and out-compete native larval host and adult nectar

[1] A taxon can be severely fragmented if most (>50%) of its total area of occupancy is in habitat patches that are (1) smaller than would be required to support a viable population, and (2) separated from other habitat patches by a large distance. Fragmentation must be assessed at a scale that is appropriate to biological isolation in the taxon under consideration (IUCN 2019).

plants, and is contributing to a decline in quality and the gradual loss of available Dukes' Skipper habitat.

Protection, Status and Ranks

Neither Dukes' Skipper or its host plants are listed under the federal *Species at Risk Act* or the Ontario *Endangered Species Act*. Dense-blazing Star (nectar plant) is Threatened under both acts (NHIC 2020b). The skipper's global rank is Vulnerable (G3G4), national rank Imperiled (N2) and Ontario rank imperiled (S2).

TECHNICAL SUMMARY

Euphyes dukesi

Dukes' Skipper

Hespérie de Dukes

Range of occurrence in Canada: Ontario

Demographic Information

Generation time (average age of parents in the population)	1 year
Is there an [observed, inferred, or projected] continuing decline in number of mature individuals?	Inferred and projected decline in number of mature individuals based on ecosystem modifications from the spread of European Reed at subpopulation #1, 14, 16, 19, 23, 24, 26.
Estimated percent of continuing decline in total number of mature individuals within [5 years or 2 generations]	Unknown
[Observed, estimated, inferred, or suspected] percent [reduction or increase] in total number of mature individuals over the last [10 years, or 3 generations].	Unknown
[Projected or suspected] percent [reduction or increase] in total number of mature individuals over the next [10 years, or 3 generations].	Unknown
[Observed, estimated, inferred, or suspected] percent [reduction or increase] in total number of mature individuals over any [10 years, or 3 generations] period, over a time period including both the past and the future.	Unknown
Are the causes of the decline a. clearly reversible and b. understood, and c. ceased?	a. No (spread of European Reed is not clearly reversible) b. Partially (the scope and severity of the threats needs further clarification) c. No (spread of European Reed and other threats continue)
Are there extreme fluctuations in number of mature individuals?	No

Extent and Occupancy Information

Estimated extent of occurrence (EOO)	2,122 km^2 (extant and historical sites with viable habitat)
Index of area of occupancy (IAO)(2x2 grid value).	52 km^2
Is the population "severely fragmented" i.e., is >50% of its total area of occupancy 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. Unknown b. Yes

Number of “locations”*	12-20 (see **Number of Locations**)
Is there an [observed, inferred, or projected] decline in extent of occurrence?	Yes, inferred, and projected decline in habitat quality based on ecosystem modifications from the spread of European Reed at peripheral subpopulations #1,19, 23, 24.
Is there an [observed, inferred, or projected] decline in index of area of occupancy?	Yes, inferred, and projected based on ecosystem modifications from the spread of European Reed at subpopulation #1, 14, 16, 19, 23, 24, 26.
Is there an [observed, inferred, or projected] decline in number of subpopulations?	Yes, inferred, and projected based on ecosystem modifications from the spread of European Reed at subpopulation #1, 14, 16, 19, 23, 24, 26.
Is there an [observed, inferred, or projected] decline in number of “locations”*?	No; the number of locations will likely increase based on variable rate of spread of European Reed both within and among habitats at the 12 known extant subpopulations
Is there an [observed, inferred, or projected] decline in [area, extent and/or quality] of habitat?	Yes, observed, inferred, and projected based on ecosystem modifications from the spread of European Reed at subpopulation #1, 14, 16, 19, 23, 24, 26.
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)**
1. Windsor 2. Upper Big Creek Woods 14. Saint Joachim 16. Belle River 19. Wheatley Provincial Park 20. Kopegaron Woods Conservation Area 21. Mersea Road 6 23. Hillman Marsh Conservation Area 24. Point Pelee National Park 26. Walpole Island 27. Reid Conservation Area 28. Brigden	Unknown
Total	Unknown

* See Definitions and Abbreviations on COSEWIC website and IUCN for more information on this term.

Quantitative Analysis

Is the probability of extinction in the wild at least [20% within 20 years or 5 generations, or 10% within 100 years]?	Unknown; insufficient data

Threats (direct, from highest impact to least, as per IUCN Threats Calculator)

A threats calculator was completed on March 3, 2021; threat impact High.

7. Natural systems modifications (High-Medium impact)
1. Residential & commercial development (Low impact)
    2. Agriculture & aquaculture (Low impact)
    11. Climate change & severe weather (Low impact)
5. Biological resource use (Unknown impact)
6. Human intrusions & disturbance (Unknown impact)
9. Pollution (Unknown impact)

Rescue Effect (from outside Canada)

Status of outside population(s) most likely to provide immigrants to Canada.	S2 Imperiled (Michigan) S3 Vulnerable (Ohio)
Is immigration known or possible?	Unknown
Would immigrants be adapted to survive in Canada?	Yes
Is there sufficient habitat for immigrants in Canada?	Yes
Are conditions deteriorating in Canada?[+]	Yes
Are conditions for the source population deteriorating?[+]	Yes
Is the Canadian population considered to be a sink?[+]	No
Is rescue from outside populations likely?	Unknown

Data Sensitive Species

Is this a data sensitive species? No

Status History

COSEWIC: Designated Special Concern in May 2022.

Status and Reasons for Designation

Status: Special Concern	Alpha-numeric codes: Not applicable.

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

Reasons for designation: This wetland specialist butterfly is found in open hardwood swamps and clearings of extreme southwestern Ontario. The species has a restricted range within the counties of Essex, Chatham-Kent, and Lambton, with only 12 known extant subpopulations. Its historical habitat has changed since European settlement, which has led to geographical isolation of suitable wetland patches. Larvae feed on native sedges that are displaced when the invasive European Reed encroaches into the butterfly's wetland habitat. This invasive plant is present at seven of the 12 extant subpopulations and has increased its range in southern Ontario by almost 30% between 2010 and 2017. The spread of invasive plants could lead to extirpation at some sites in the future.

Applicability of Criteria

Criterion A (Decline in Total Number of Mature Individuals): Not applicable, no data available.
Criterion B (Small Distribution Range and Decline or Fluctuation): Not applicable. Meets Endangered B1 and B2 (EOO 2,122 km² and IAO 52 km²); there is b) inferred and projected decline in c (i) extent of occurrence, (ii) index of area of occupancy, (iii) quality of habitat (due to invasive European Reed); and (iv) number of subpopulations (due to invasive European Reed out-competing host plants), but the rate of this spread is uncertain, and number of locations exceeds threshold for Threatened and Endangered.
Criterion C (Small and Declining Number of Mature Individuals): Not applicable. Number of mature individuals unknown; likely decline based on habitat decline but no data.
Criterion D (Very Small or Restricted Population): Not applicable. Number of mature individuals unknown; the IAO and number of locations exceed thresholds.
Criterion E (Quantitative Analysis): Not calculated; no data are available for 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 (2022)

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
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Canada

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

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2022

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WILDLIFE SPECIES DESCRIPTION AND SIGNIFICANCE

Name and Classification

Phylum:	Arthropoda
Class:	Insecta – Insects
Subclass:	Pterygota – Winged Insects
Order:	Lepidoptera – Butterflies and Moths
Suborder:	Glossata
Infraorder:	Heteroneura
Superfamily:	Papilionoidea – Butterflies and Skippers
Family:	Hesperiidae – Skippers
Subfamily:	Hesperiinae – Grass-skippers
Tribe:	Hesperiini
Genus:	*Euphyes*
Species:	*E. dukesi* – Dukes' Skipper (Lindsey 1923)
Subspecies:	*E. d. dukesi*

Synonyms: *Atrytone dukesi* (Lindsey 1923)

Type Locality and Specimen: The type specimen from Mobile, Alabama is housed at the Smithsonian National Museum of Natural History, Washington, D.C.

French Common Name: Hespérie de Dukes

English Common Name: Dukes' Skipper
Scarce Swamp Skipper (Pyle 1981)
Brown Sedge Skipper (Scott 1986)

Taxonomic Background and Similarities: Dukes' Skipper was first described as *Atrytone (Euphyes) dukesi* (Lindsey 1923). There are 20 recognized species in the genus *Euphyes,* which are found throughout North America, Central America, South America, and the Caribbean. Two subspecies of Dukes' Skipper are recognized (*E.e.dukesi* and *E.e.calhouni*), both occurring in central and eastern North America (see Global Range)

The Barcode of Life Data System (BOLD) is an online genetic data storage and analysis service that uses short sequences of DNA to aid in species identification (Ratnasingham and Hebert 2007). The primary barcode sequence for members of the animal kingdom is a 648-bp region of the cytochrome c oxidase I (COI) gene (Hebert *et al.* 2003; Savolainen *et al.* 2005). Four of the 11 records in BOLD are from Canada, results do not show evidence of subspecies differentiation (e.g., the barcode sequences are similar) (BOLD Systems 2021).

Morphological Description

Like all Lepidoptera, Dukes' Skipper has four distinct life stages: egg, larva (caterpillar), pupa (chrysalis) and adult.

Egg

The eggs are dome-shaped with a flat base. Eggs are pale pea-green when laid. After 24 hours, the eggs develop two reddish rings, one on the anal portion, the other around the centre (Pliske 1957).

Larvae

Within the genus *Euphyes*, larvae of different species are indistinguishable (Hall *et al.* 2014). In general, the larvae of this genus are bluish-green with many small white spots and a dark-green mid-dorsal line that runs the length of the body (Hall *et al.* 2014). The head is whitish with a small quantity of brown colouration on the top, a small dark oval spot is located at the top rear and a brown stripe runs along either side of the head. Dukes' Skipper larvae have five instars; all instars are morphologically similar (Barton 2005).

Pupae

The pupae are not described.

Adult

Adults have a wingspan of 31-37mm (Hall *et al.* 2014). The most distinctive features are their dark colouration and rounded wing edges (Wormington 2016). Males and females are sexually dimorphic but generally similar in appearance. The dorsal side of the male forewing and hindwing are sooty-black, occasionally with orange along the costal (front) and centre of the hindwing (Hall *et al.* 2014) (Figure 1). The dorsal side of the female's forewing and hindwing is dark brown, and occasionally with one or two orange spots in the centre of the forewing (Hall *et al.* 2014) (Figure 2). The ground colour of the ventral fore- and hindwings of both sexes is orange-brown with a pale orange-yellowish streak running horizontally through the centre of the hindwing (Hall *et al.* 2014) (Figure 3). On occasion, the forewing undersides have a black disc (Glassberg 1999).

Dion Skipper (*Euphyes dion*) closely resembles Dukes' Skipper and overlaps with its Canadian range (Hall *et al.* 2014). The underside of both species is orange-brown in colour. Dion Skipper adults are separated by the two orange-yellow horizontal streaks on its hindwing instead of the single streak on Dukes' Skipper (Hall *et al.* 2014) and lack the black disc on ventral forewing (Glassberg 1999).

Figure 1. Dukes' Skipper (*Euphyes dukesi*) adult male. Observed, July 20, 2020, Reid Conservation Area (#27), Wallaceburg, Lambton County, Ontario. Specimen not collected. Photo by B. Mann.

Figure 2. Dukes' Skipper (*Euphyes dukesi*) adult female. Observed July 16, 2016, Spring Garden Road Prairie, Windsor, County of Essex, Ontario. Specimen not collected. Photo by B. Yukich.

Figure 3. Dukes' Skipper (*Euphyes dukesi*) adult, underside, demonstrating one of the distinguishing ways the species is differentiated from other species, by the orange-brown overall appearance with a pale orange-yellowish streak running horizontally through the centre of the hindwing. Observed July 19, 2013, Reid Conservation Area (#27), Wallaceburg, Lambton County, Ontario. Specimen not collected. Photo by B. Mann.

Population Spatial Structure and Variability

The spatial structure and variability of Dukes' Skipper in Canada has not been studied. Genetic studies have not been completed; subpopulation[2] boundaries are unknown, dispersal ability is unknown; however, it can be inferred from information on other members of the genus *Euphyes*, which do not have high dispersal capabilities (Michigan State University 2007; B.C. ENV 2013; NatureServe 2022).

[2] Subpopulations are defined as geographically or otherwise distinct groups in the population between which there is little demographic or genetic exchange (typically one successful migrant individual or gamete per year or less) (IUCN 2013)

Designatable Units

Dukes' Skipper is being assessed as one designatable unit. There is no information on discreteness or evolutionary significance among subpopulations in Canada. All subpopulations occur within the Great Lakes Plains National Ecological Area (COSEWIC 2018).

Special Significance

Dukes' Skipper is an enigmatic and poorly understood species. It is of interest to entomologists because of its rarity and is described as the most extraordinary of any North American butterfly due to its fragmented distribution across the southeastern United States and Canada (Shapiro 1971; Calhoun 1995). Dukes' Skipper is part of Canadian ecosystems that are important to Indigenous people, who recognize the interconnectedness of all species within the ecosystem.

DISTRIBUTION

Global Range

The global range of Dukes' Skipper is within central and eastern North America (Figure 4). *Euphyes dukesi dukesi* (the subspecies that ranges in Canada) occurs in two geographic areas; the southern Great Lakes area (areas adjacent to Lake Michigan, Lake Huron and Lake Erie) extends from southwestern Ontario to southeastern Michigan, northeastern Indiana, and northern Ohio (Vaughan and Sheperd 2005). This geographic area appears disjunct from the southern portion of the subspecies' range, in the lower Mississippi Valley which ranges from central Missouri and southern Illinois to eastern Texas, through Louisiana east to southeastern Virginia and Georgia (Vaughan and Sheperd 2005). Less than one percent of Dukes' Skipper global range is in Canada.

Euphyes dukesi calhouni is disjunct from *E.d.dukesi* and occurs in Florida (Shuey 1996).

Canadian Range

In Canada, Dukes' Skipper is found in extreme southwestern Ontario in Essex, Lambton, and Chatham-Kent counties (Figure 5). There are 28 documented subpopulations[3] in Canada; 12 are extant[4] (1, 2, 14, 16, 19, 20, 21, 23, 24, 26, 27 and 28) and 16 historical[5] (3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 15, 17, 18, 22 and 25) (Table 1). Only one subpopulation has multiple sites[6] (#1a and 1b).

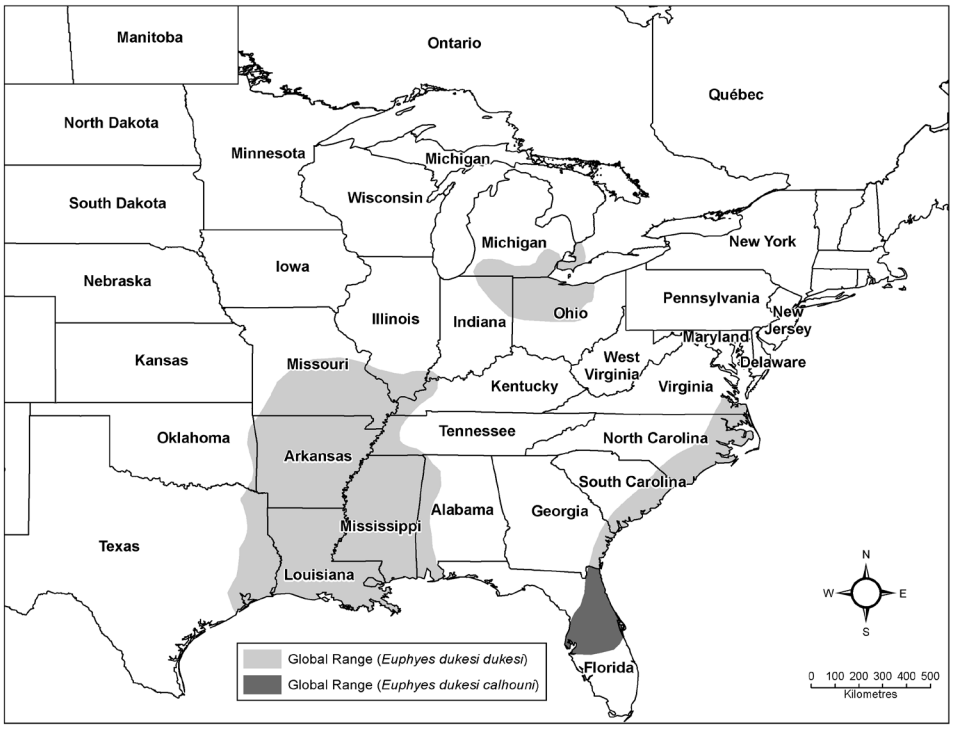

Figure 4. Estimated global range of Dukes' Skipper (*Euphyes dukesi*) based on Calhoun 1995, Lotts and Naberhaus 2017. Only *Euphyes dukesi dukesi* ranges in Canada. Map by G. Schaus.

[3] Subpopulations are defined as geographically or otherwise distinct groups in the Canadian population between which there is little demographic or genetic exchange (typically one successful migrant individual or gamete per year or less). Subpopulation size is measured as numbers of mature individuals only (IUCN 2001). The separation distance between subpopulations is 2 km when the intervening habitat is unsuitable, and 5 km when there is suitable intervening habitat (NatureServe 2022). A separation distance of 5 kilometres applies due to fragmentation of suitable habitat and the species' poor dispersal ability.

[4] Extant: The species is known or thought very likely to occur currently in the area, which encompasses localities with current or recent (last 20 years) records where suitable habitat at appropriate altitudes remain. Extant ranges should be considered in the calculation of EOO (IUCN 2018).

[5] Historical: Recent field information verifying the continued existence of the subpopulation is lacking, based on historical collection data, but without recent field survey work. The subpopulation may be extirpated due to general habitat loss or degradation of the environment in the area. Historical status is typically applied to an occurrence that has not been reconfirmed for 20 years or more; may also indicate occurrences with imprecise site collection information such that it may be difficult or impossible to determine whether subsequent observations are of the same occurrence (modified from NatureServe 2022).

[6] A site refers to a habitat patch with a confirmed skipper record, where the intervening unsuitable habitat is less than 2 km, or the intervening suitable habitat is less than 5 km. A site can also refer to suitable Dukes' Skipper habitat that has been surveyed, and where the butterfly's presence is either confirmed or the search is with null results.

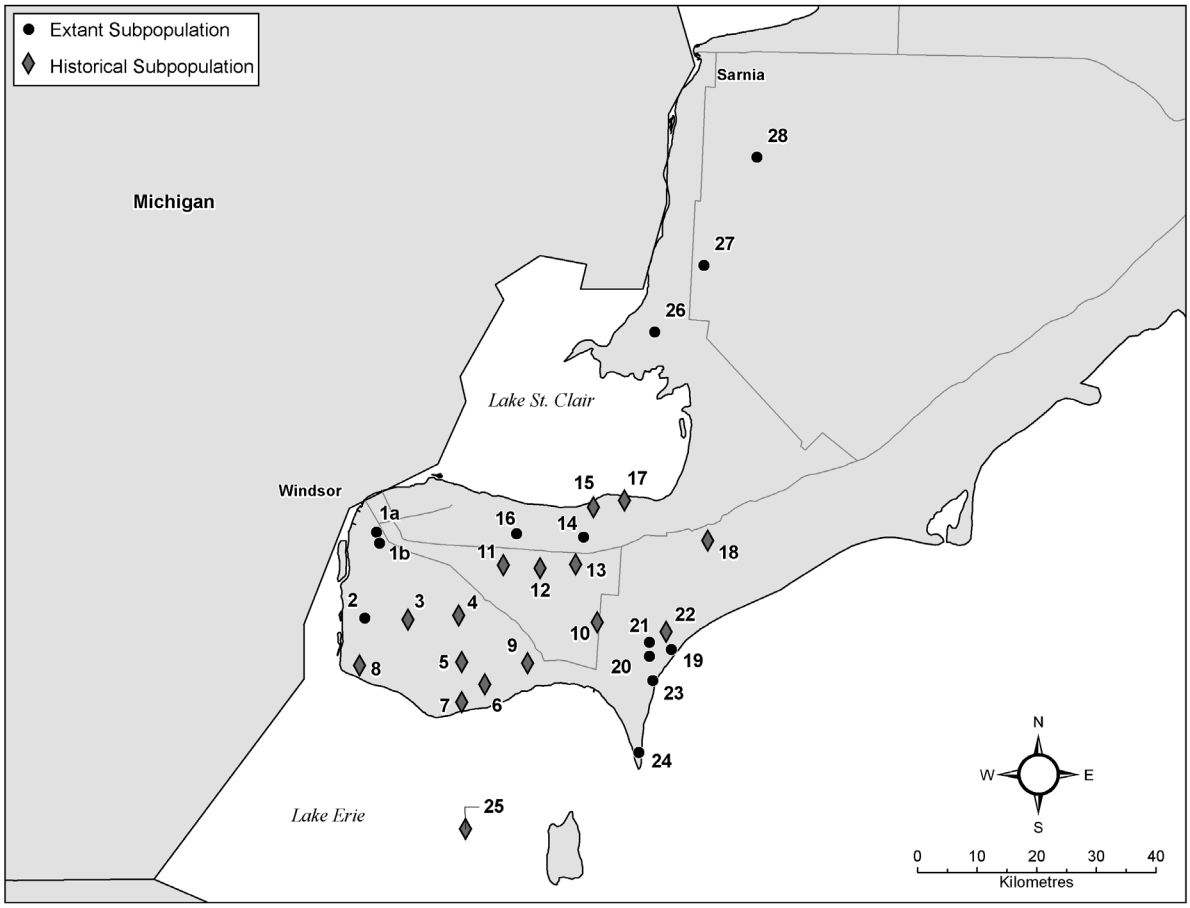

Figure 5. Dukes' Skipper (*Euphyes dukesi*) subpopulations in Canada (see Table 1 for subpopulation names). Map by G. Schaus.

Table 1. Extant and historical Dukes' Skipper (*Euphyes dukesi*) subpopulations (#1-28) in Canada, land ownership and approximate area of the land parcel, and a brief habitat description.

Subpopulation Number (#)	Subpopulation Name	Date of most recent record	Status [7] [8]	Habitat Area (ha)[9]	Land Ownership[10]	Habitat Description
1a	Windsor; Spring Garden Road Prairie	2016-07-16	**Extant**	117	Municipal; City of Windsor	Buttonbush swamp; White Oak (*Quercus alba*) swamp.
1b	Windsor; Brunet Park	2021-07-26	**Extant**	7	Municipal; Township of Lasalle	Woodland with shaded sedge patch.
2	Upper Big Creek Woods	2005-07-19	**Extant**	110	Unknown	Ash (*Fraxinus* spp.) woodland with shaded sedge patch (*Carex hyalinolepis*).
3	Canard Valley Conservation Area/ McGregor	1999-07-29	Historical	99	Provincial; Essex Region Conservation Authority[11]	Woodland with shaded sedge patch.
4	Gesto	1986-07-24	Historical	Unknown	Unknown	Unknown.
5	Pleasant Valley	1987-07-29	Historical	Unknown	Unknown	Unknown.
6	Arner	1986-07-24	Historical	Unknown	Unknown	Unknown.
7	Oxley Poison Sumac Marsh	1996-08-02	Historical	99	Nature Conservancy of Canada (90%); Private (10%)	Poison Sumac (*Toxicodendron vernix*) swamp with shaded sedge patch.
8	Big Creek Marsh	1989-07-13	Historical	900	Provincial; Essex Region Conservation Authority	Unknown.
9	Kingsville	1986-07-23	Historical	Unknown	Unknown	Unknown.
10	Blytheswood	1988-08-05	Historical	Unknown	Private	Agricultural field with sedge patch (*Carex hyalinolepis*).
11	Maidstone Conservation Area	1979-07-31	Historical	20	Provincial; Essex Region Conservation Authority	Oak-Hickory woodland with shaded sedge patch (*Carex lacustris*).
12	South Woodslee	1979-07-31	Historical	Unknown	Unknown	Unknown.
13	Ruscom Station	1983-07-16	Historical	Unknown	Unknown	Unknown.
14	Saint Joachim	2015-08-03	**Extant**	4.7	Private	Agricultural field; woodland with shaded sedge patch.
15	Ruscom Shores Conservation Area	1982	Historical	48.5	Provincial; Essex Region Conservation Authority	Cattail (*Typha* spp.) marsh with shaded sedge patch.
16	Belle River	2018-08-18	**Extant**	0.5	Private	Agricultural field; woodland with sedge patch.
17	Stoney Point	1980-07-06	Historical	Unknown	Unknown	Unknown.

[7] Extant: The species is known or thought very likely to occur currently in the area, which encompasses localities with current or recent (last 20 years) records where suitable habitat at appropriate altitudes remain. Extant ranges should be considered in the calculation of EOO (IUCN 2018).

[8] Historical: Recent field information verifying the continued existence of the occurrence is lacking. Rank is based on historical collection data, but without recent field survey work, the subpopulation may be extirpated due to general habitat loss or degradation of the environment in the area. This rank is typically applied to an occurrence that has not been reconfirmed for 20 years or more. This rank may also indicate occurrences with imprecise locational information such that it may be difficult or impossible to determine whether subsequent observations are of the same occurrence (modified from NatureServe 2022).

[9] This is the spatial area of the park/habitat where Dukes' Skipper has been documented, it is unknown if the species uses the entire polygon and this spatial area is likely an over-estimate.

[10] Land ownership is unknown for several sites due to lack of data on the specific observation.

[11] Unique to Ontario, Conservation Authorities are local watershed management agencies that deliver services and programs to protect and manage impacts on water and other natural resources in partnership with all levels of government, landowners and many other organizations.

There are 31 Conservation Authorities operating in southern Ontario and five Conservation Authorities delivering programs and services in northern Ontario. The network of Conservation Authorities is represented by Conservation Ontario, which is a nonprofit association. Conservation Authorities are either charitable or nonprofit organizations legislated under the Conservation Authorities Act, 1946 (edited from Conservation Ontario 2022).

Subpopulation Number (#)	Subpopulation Name	Date of most recent record	Status [7] [8]	Habitat Area (ha)[9]	Land Ownership[10]	Habitat Description
18	Tilbury East	1981-07-25	Historical	Unknown	Unknown	Unknown.
19	Wheatley Provincial Park	2020-07-25	**Extant**	241	Provincial; Ontario Parks	Unknown.
20	Kopegaron Woods Conservation Area	1998-08-09	**Extant**	19	Provincial; Essex Region Conservation Authority	Unknown.
21	Mersea Road 6	2013-08-03	**Extant**	19	Private	Hickory-Oak woodland with shaded sedge patch.
22	Two Creeks Conservation Area	1988-08-07	Historical	34	Provincial; Essex Region Conservation Authority	Woodland with shaded sedge patches.
23	Hillman Marsh Conservation Area	1997-08-09	**Extant**	344	Provincial; Essex Region Conservation Authority	Unknown.
24	Point Pelee National Park	2012-07-07	**Extant**	1,500	Federal; Parks Canada	Woodlands with shaded sedge patches (*Carex lacustris*).
25	East Sister Island Provincial Park	1988-06-26	Historical	53	Provincial; Ontario Parks	Woodland with shaded sedge patch (*Carex hyalinolepis*); area now overgrown with European Reed.
26	Walpole Island	1990-08-08	**Extant**	4,000	Walpole Island First Nation	Unknown.
27	Reid Conservation Area	2020-08-07	**Extant**	69	Provincial; St. Clair Region Conservation Authority	Oak-Hickory woodland with shaded sedge patches (*Carex hyalinolepis* and *Carex lacustris*). Known from two areas within the site.
28	Brigden	2018-07-16	**Extant**	Unknown	Private	Woodland with shaded sedge patch.

Extent of Occurrence and Area of Occupancy

The extent of occurrence (EOO) of Dukes' Skipper in Canada is 2,122 km^2 using a minimum convex polygon around extant subpopulations only and 2,486 km^2 around both extant and historical subpopulations.

The index of area of occupancy (IAO) of Dukes' Skipper in Canada is 52 km^2 (13 grid squares) based on a fixed 2 x 2 km grid over all extant subpopulations and 68 km^2 (17 grid squares) over both extant and historical subpopulations.

There is an inferred continuing decline in both EOO and IAO based on the presence and potential spread of non-native European Reed within habitats at seven of the 12 extant subpopulations (see **Threats and Limiting Factors**).

Search Effort

Duke's Skipper records in Canada date from 1968-2021. The first record is from the McGregor (#3) neighbourhood in the Town of Essex on July 11, 1968 (Riotte 1973) and the most recent record is from the Reid Conservation Area (#27) on August 16, 2021 (iNaturalist 2021). There are at least 204 museum specimens, photographs, and sight records from 28 subpopulations and 29 sites in Ontario. These records represent a minimum of 637 individuals.

Surveys for Dukes' Skipper are undertaken on foot and surveyors target areas with abundant adult nectar and larval host plants (see Table 2 and 3). When searching for Dukes' Skipper in known sites, it is typically observed with relative ease provided searches are undertaken during the flight period and on warm, sunny days between 0900 and 1600. In the past, Dukes' Skipper subpopulations may be overlooked due to low density, short flight period and small size, and dull adult colours (Iftner *et al.* 1992). No fieldwork associated with the preparation of this 2020 COSEWIC status report was undertaken; surveys below were conducted prior to this COSEWIC assessment.

In 2015 and 2018, butterfly surveys in the County of Essex (NRSI 2015; 2018) targeted appropriate habitat (see **Habitat**) and occurred once each in June, July, and August and coincide with Dukes' Skipper flight period. Search effort at these sites focused on host plants (NRSI 2018). Surveys confirmed Dukes' Skipper from the Hamlet of Saint Joachim (#14) and the Township of Lakeshore (#16).

Table 2. Dukes' Skipper (*Euphyes dukesi*) search effort at extant and historical subpopulations in Canada.

Subpopulation Number	Subpopulation Number and Name	Date of first record	Date of most recent record	Year(s) with known search effort	Number of Dukes' Skipper (all records; from first year observed to most recent year observed)	Reference
1a	Windsor; Spring Garden Road Prairie	1989-07-20	2016-07-16	1989, 1990, 1991, 1992, 1994, 1998, 2005, 2009, 2012, 2016	>70	Macnaughton *et al.* 2020
1b	Windsor; Brunet Park	1988-07-09	2021-07-26	1988, 1989, 2011, 2012, 2013, 2015, 2017, 2018, 2021	>14	Macnaughton *et al.* 2020; NHIC 2020a; iNaturalist 2021
2	Upper Big Creek Woods	2005-07-19	2005-07-19	2005	2	NHIC 2020a
3	Canard Valley Conservation Area/ McGregor	1968-07-11	1999-07-29	1968, 1975, 1976, 1977, 1978, 1979,1999	>36	Macnaughton *et al.* 2020
4	Gesto	1975-07-29	1986-07-26	1975, 1980, 1981, 1982, 1983, 1984, 1985, 1986	>23	Macnaughton *et al.* 2020
5	Pleasant Valley	1987-07-29	1987-07-29	1987	1	Macnaughton *et al.* 2020
6	Arner	1986-07-24	1986-07-24	1986	7	Macnaughton *et al.* 2020

Subpopulation Number	Subpopulation Number and Name	Date of first record	Date of most recent record	Year(s) with known search effort	Number of Dukes' Skipper (all records; from first year observed to most recent year observed)	Reference
7	Oxley Poison Sumac Marsh	1982-07-22	1996-08-02	1982, 1987, 1996	42	Macnaughton *et al.* 2020
8	Big Creek Marsh	1989-07-13	1989-07-13	1989	2	Macnaughton *et al.* 2020
9	Kingsville	1986-07-23	1986-07-23	1986	10	Macnaughton *et al.* 2020
10	Blytheswood	1988-08-05	1988-08-05	1988	1	Macnaughton *et al.* 2020
11	Maidstone Conservation Area	1979-07-31	1979-07-31	1979	1	Macnaughton *et al.* 2020
12	South Woodslee	1979-07-31	1979-07-31	1979	3	Macnaughton *et al.* 2020
13	Ruscom Station	1983-07-16	1983-07-16	1983	1	Macnaughton *et al.* 2020
14	Saint Joachim	2015-08-03	2015-08-03	2015	2	Macnaughton *et al.* 2020; NRSI 2018
15	Ruscom Shores Conservation Area	1982	1982	1982	1	NHIC 2020a
16	Belle River	2015-07-06	2018-08-18	2015, 2018	17	NRSI 2018; Macnaughton *et al.* 2020
17	Stoney Point	1980-07-06	1980-07-06	1980	1	Macnaughton *et al.* 2020
18	Tilbury East	1981-07-25	1981-07-25	1981	1	Macnaughton *et al.* 2020
19	Wheatley Provincial Park	1988-07-10	2020-07-25	1988, 1992, 2004, 2020	11	Macnaughton *et al.* 2020; iNaturalist 2021
20	Kopegaron Woods Conservation Area	1998-08-08	1998-08-09	1998	7	Macnaughton *et al.* 2020
21	Mersea Road 6	2003-07-18	2013-08-03	2003, 2004, 2006, 2007, 2008, 2009, 2013	28	Macnaughton *et al.* 2020
22	Two Creeks Conservation Area	1988-07--25	1988-08-07	1988	2	Macnaughton *et al.* 2020
23	Hillman Marsh Conservation Area	1988-07-10	1997-08-09	1988, 1996, 1997	7	Macnaughton *et al.* 2020
24	Point Pelee National Park	1973-07-01	2012-07-07	1973, 1982, 1983, 1984, 1985, 1986, 1988, 1989, 1990, 1991, 1992, 1993, 1994, 1995, 1996, 1997, 1998, 2000, 2001, 2002, 2003, 2004, 2006, 2008, 2009, 2010, 2012	>200	Macnaughton *et al.* 2020
25	East Sister Island Provincial Park	1988-06-26	1988-06-26	1988	1	Macnaughton *et al.* 2020
26	Walpole Island	1990-08-08	1990-08-08	1990	1	Macnaughton *et al.* 2020

Subpopulation Number	Subpopulation Number and Name	Date of first record	Date of most recent record	Year(s) with known search effort	Number of Dukes' Skipper (all records; from first year observed to most recent year observed)	Reference
27	Reid Conservation Area	2008-07-29	2020-08-07	2008-2021	>134	Macnaughton *et al.* 2020; iNaturalist 2021
28	Brigden	2017-07-18	2018-07-16	2017, 2018	5	Macnaughton *et al.* 2020

Table 3. Search effort at habitats where Dukes' Skipper (*Euphyes dukesi*) has not been documented (i.e., null search effort).

Site Name	Years with search effort	Number Dukes' Skipper Recorded	Search effort (hours within appropriate habitat)	Reference
Pelee Island, Essex County	2010-2019 (each year)	0	Approx. 318 hours	NABA 2020
Pinery Provincial Park, Lambton County	2009-2019 (each year)	0	Approx. 300 hours	NABA 2020

Numerous Dukes' Skipper subpopulations (#1a, #1b, #24 and #27) are visited regularly by butterfly enthusiasts and naturalists. Annual butterfly counts have been held in Windsor (#1a, 1b) since 1994 and completed at Point Pelee National Park (#24) from 1996-2012. Dukes' Skipper was regularly observed at Point Pelee National Park, but has not been observed since 2012, when the last annual butterfly count was held in the park.

An annual summary of Lepidoptera observations is published each year in Ontario Lepidoptera. Available publications from 1969-2017 were also reviewed for Dukes' Skipper observations (TEA 2021).

Online citizen science platforms such as the Ontario Butterfly Atlas and iNaturalist show evidence of null search effort (i.e., none of the target specimen is recorded but the habitat and flight period are appropriate for recording the skipper). For example, between 2009 and 2019, 5,431 *Euphyes* records were submitted to the Ontario Butterfly Atlas: 60 were of Dukes' Skipper within eight of the 28 subpopulations (#1, 14, 16, 19, 21, 24, 27 and 28). In the last 12 years (2010-2021), 532 observers have submitted 2,371 *Euphyes* observations to iNaturalist; however, only 55 are Dukes' Skipper (iNaturalist 2021).

HABITAT

Habitat Requirements

In Canada, Dukes' Skipper habitat includes hardwood forest swamps with natural clearings or edges containing large patches of sedges (*Carex* spp.) (Hall *et al.* 2014) (Figure 6), floodplain forests along riverbanks, forests at the edge of marshes as well as roadside and agricultural ditches with suitable sedge patches (Michigan State University 2007; Hall *et al.* 2014; Macnaughton *et al.* 2020).

Figure 6. Dukes' Skipper (*Euphyes dukesi*) habitat within a treed sedge patch. August 30, 2020, Reid Conservation Area (#27), Wallaceburg, Lambton County, Ontario. Photo by J. Linton.

Dukes' Skipper favours forested wetlands with Red Maple (*Acer rubrum*), Sugar Maple (*Acer sacharrum*), hickories (*Carya* spp.), hackberries (*Celtis* spp.), Black Tupelo (*Nyssa sylvatica*) and oaks (*Quercus* spp.) (Michigan State University 2007; Macnaughton *et al.* 2020). Other plants associated with Dukes' Skipper habitat include Swamp Milkweed (*Asclepias incarnata*), Buttonbush (*Cephalanthus occidentalis*), jewelweeds (*Impatiens* ssp.) and Pickerelweed (*Pontederia cordata*).

Suitable habitats often have heavy clay soils with poor drainage; Dukes' Skipper are rarely observed more than a few metres from standing water (Mather 1963).

In Canada, Dukes' Skipper larval host plants are Lake Sedge (*Carex lacustris*) and Shoreline Sedge (*Carex hyalinolepis*) (Hall *et al.* 2014). In Mississippi, False Hop Sedge (*Carex lupuliformis*) is a larval host plant; however, this plant is rare in Ontario and Dukes' Skipper has not been recorded using this plant (see **Non-legal Status and Ranks**) (Schweitzer *et al.* 2018).

Adults are predominantly observed in broken canopy or woodland-edge habitats with dappled light, and rarely in deeply shaded woodlands (Calhoun 1995; Schweitzer *et al.* 2018). Adults will fly short distances from their woodland habitat and into adjacent open habitats in search of nectar plants (Wormington 2016), particularly to white and purple flowers (Iftner *et al.* 1992; Calhoun 1995). Documented nectar sources in Ontario include Swamp Milkweed, Common Milkweed (*Asclepias syriaca*), thistles (*Cirsium* spp.), Common Dogbane (*Apocynum cannabinum*), Dense Blazingstar (*Liatris spicata*), Virginia Mountain Mint (*Pycnanthemum virginanum*) and Cup Plant (*Silphium perfoliatum*) (Macnaughton *et al.* 2020; Mann pers. comm. 2020). Elsewhere in the species' global range it nectars on Buttonbush and Pickerelweed (Mather 1963; Iftner *et al.* 1992; Michigan State University 2007).

In the County of Essex, surveys for Duke's Skipper were completed within White Elm (*Ulmus americana*) mineral deciduous swamp, Bur Oak (*Quercus macrocarpa*) mineral deciduous swamp and fresh-moist Shagbark Hickory (*Carya ovata*) deciduous forest (NRSI 2015). Dukes' Skipper was observed in White Elm mineral deciduous swamps 4.71 ha (#14) and 0.50 ha (#16) in size (NRSI 2015).

Habitats for Dukes' Skipper in the southern United States are similar to those in Canada and include shaded or partially shaded sedge-dominated hardwood and cypress swamps (Schweitzer *et al.* 2018). In Ohio, the skipper has been found along abandoned railway beds with host plants and suitable swamp habitat (Iftner *et al.* 1992; Schweitzer *et al.* 2018). Along the Atlantic Coast the skipper frequents freshwater to brackish tidal marshes where they meet the edge of wet woods (Schweitzer *et al.* 2018).

Habitat Trends

Over the past 200 years, much of the wetland forests, woodlands, prairies, and swamp habitats of southern Ontario have undergone extensive land conversion, which has led to the isolation of habitat patches throughout the range of Duke's Skipper. Prior to European settlement, Indigenous peoples had some influence on land use in the region, but the majority of forests and wetlands remained intact (Butt *et al.* 2005). Prior to European settlement, forests in southern Ontario accounted for ~80% of the landcover, which by the early 2000s had been reduced to 17% of the landcover (Butt *et al.* 2005). In the late 18th and early 19th centuries, there was an estimated 20,266 km^2 of wetland habitat, yet by 2002, approximately 72% had been converted to other uses (Federal, Provincial and Territorial Governments of Canada 2010).

The draining of wetlands for agriculture and development has significantly reduced the suitable swamp habitat available for Dukes' Skipper in southwestern Ontario. The counties of Essex, Lambton, and Chatham-Kent (e.g., Duke's Skipper range) have undergone some of the most severe losses of wetlands and forests in the province (Federal, Provincial and Territorial Governments of Canada 2010; Ducks Unlimited Canada 2010).

Pre-European settlement, Essex County had approximately 155,779 ha of wetlands, or 83.4% of total landcover in the county. By 2002 wetland habitat had been reduced to 3,068 ha or 1.6% of total landcover (Ducks Unlimited Canada 2010). As of 2013, swamp habitat accounts for 743.91 ha or 0.45% of total land area in the County of Essex (ERCA 2013).

- Pre-settlement, Lambton County had approximately 44,237 ha of wetlands, comprising ~50.1% the of landcover; in 2002 wetlands had been reduced to 5,092 ha or 1.8% of total landcover (Ducks Unlimited Canada 2010). Lambton County has also experienced extensive clearing and drainage of forests and swamps, primarily for agricultural uses (Ontario Woodlot Association 2005).

- Prior to European settlement Chatham-Kent County had approximately 140,818 ha of wetlands, or ~56.4% of total land cover and by 2002 it had been reduced to 2,123 ha or 0.8% total landcover (Ducks Unlimited Canada 2010).

Habitat trends in the Canadian range of Dukes' Skipper within the last 10 years are not well documented. From 2011- 2016, in Essex County there was an increase of 80 ha (+2.2 %) in woodland area. In Lambton County there was a decrease of 485 ha (-2.5%); however, data from the southwest part of the county are unavailable. In Chatham-Kent County, there was an increase of 1126 ha (+15%) in woodland area (Statistics Canada 2021). Most of the remaining habitat within Dukes' Skipper's range is in protected areas, floodplains, and other sites unlikely to be cleared for agriculture or development.

European Reed (*Phragmites australis australis*) is an invasive grass that is widespread across southern Ontario. It is a dense growing species, slowly spreading into open wetland areas (OMNR 2011) and gradually changing the plant composition within these wetland areas (see **Threats**).

BIOLOGY

Life Cycle and Reproduction

Dukes' Skipper undergoes complete metamorphosis and develops through four distinct life stages: egg, larva (five instars), pupa, and adult.

In Ontario, Dukes' Skipper typically has only one generation per year, with the earliest records from June 22 and the latest records from September 26 (Macnaughton *et al.* 2020). The average Dukes' Skipper flight period is shorter, and from early July to mid-August (Wormington 2016).

Dukes' Skipper have a polygynandrous[12] mating system (Barton 2005). Males actively search for and pursue females within sedge patches, quickly moving on to other sedge patches if no females are found (Iftner *et al.* 1992; Calhoun 1995; Hall *et al.* 2014). Males are not considered territorial. Females are more sedentary than males and are often observed perching on sedges when not actively foraging or ovipositing (Calhoun 1995). Adults of both sexes are described as slow flying. Adults often remain just above the tops of sedges and rarely fly above 1.5 metres in height (Calhoun 1995).

Following mating, females oviposit eggs singly on the undersides of host plant leaves (Barton 2005; Schweitzer *et al.* 2018). Oviposition is typically concentrated around sedges growing singly or in small clusters along the shaded edge of larger sedge patches. Females are thought to disperse more widely than males while seeking out suitable host plants for oviposition (Calhoun 1995). The adult lifespan is estimated to be three weeks (Barton 2005).

Eggs hatch and larvae feed and moult several times before entering diapause (to overwinter) in the fourth instar (Barton 2005). Larvae construct shelters by cutting and folding leaves, or by tying the edges of one or more leaves together (Schweitzer *et al.* 2018). The following spring, larvae emerge from diapause, and moult once more before entering the pupal life stage (Opler and Krizek 1984). Prior to pupating the larvae enter the shelter and plug the entrance with flakes of wax which they produce (Schweitzer *et al.* 2018). Pupation lasts 1 - 2 weeks (Opler and Krizek 1984).

In Canada, Dukes' Skipper records suggest it typically has one brood per year. However, a second brood was recorded at Point Pelee National Park on September 7, 1991 (Wormington 2016), the only report of a potential second brood in Ontario. In some butterflies, a second brood is only produced occasionally, in unseasonably warm years. Second broods have not been recorded in nearby Ohio or Michigan (Iftner *et al.* 1992; Nielsen 1999). The latest observation of Dukes' Skipper in Ontario is from the Spring Garden Road Prairie (#1a) on September 26, 1992. No additional information is provided with the observation; however, such a late date is indicative of a second brood. The fall of 1992 was noted to be abnormally warm, with worn Dukes' Skipper observed into early September at Point Pelee National Park (Wormington 2016).

The flight period is longer in the southern United States and up to three broods have been reported for the subspecies *calhouni* in Florida (Calhoun 1995).

[12] Polygynandrous is a type of polygamy in which a female will pair with several males, each of which will also pair with several different individual females (Barton 2005).

Physiology and Adaptability

Little is known about the physiology and adaptability of Dukes' Skipper. The species has limited adaptability to reside in habitats where there are fluctuations in hydrology (Calhoun 1995; Michigan State University 2007). Wetland drainage or drought in suitable habitat may cause the species to disappear from the site (Calhoun 1995). For example, during 2020, increased water levels flooded one of the two occupied sedge patches at Reid Conservation Area (#27) and it is suspected this loss of sedge habitat may have caused a decline in the skipper's abundance in that same year (Mann pers. comm. 2020).

Dukes' Skipper requires canopy cover, shade, or partial shade as an essential characteristic of suitable habitat (Schweitzer *et al.* 2018).

Dukes' Skipper is not known to occupy human-created wetlands (Schweitzer *et al.* 2018).

Dukes' Skipper is most active in sunny and warm weather but will remain active in warm overcast weather and even during brief rain showers (Calhoun 1995).

Dispersal and Migration

Dukes' Skipper does not migrate. Little is known about the dispersal ability of Dukes' Skipper in Canada or the United States. Information from other similar species is available, and a maximum dispersal of two kilometres is inferred based on data from these other species. As read in COSEWIC (2013): "Mardon Skipper (*Polites mardon*), has an apparent maximum dispersal distance of about 1.6 km (Runquist 2004), but generally moves less than 0.8 km annually (Potter and Fleckenstein 2001). On average, Dakota Skippers (*Hesperia dacotae*) moved less than 300 m over 3-7 days, and less than 200 m through unsuitable habitat (Dana 1991). Ottoe Skippers (*Hesperia ottoe*), are known to disperse a maximum of 1.78 km through unsuitable habitat, but generally moved less than 200 m (Selby 2005)".

Dukes' Skipper may come close being severely fragmented[13]. Each of the subpopulations was evaluated for its isolation (i.e., distance from other subpopulations) and its viability. It is likely all subpopulations are separated by a distance greater than it can disperse. Subpopulation viability is based on the rapid growth of European Reed, which is confirmed at seven of the 12 extant subpopulations, although the plant is likely present at all subpopulation habitats (Table 5). There was insufficient data to meet the severe fragmentation criteria; it is unlikely >50% of the total area of occupancy is in habitat patches that are smaller than would be required to support a viable subpopulation and will become extirpated within the next three years.

[13] A taxon can be severely fragmented if most (>50%) of its total area of occupancy is in habitat patches that are (1) smaller than would be required to support a viable population, and (2) separated from other habitat patches by a large distance. Fragmentation must be assessed at a scale that is appropriate to biological isolation in the taxon under consideration (IUCN 2019).

Interspecific Interactions

Little is known on the Dukes' Skipper interspecific interactions, such as disease, predation and/or parasitism. Larval and adult skippers are predated by spiders (Araneae), ambush bugs (Phymatinae), wasps (Vespidae; Pompilidae, Sphecidae), ants (Formicidae), dragonflies (Anisoptera), robber flies (Asilidae) and tiger beetles (Cicindelini) (Scott 1986; Hall *et al.* 2014). Vertebrate predators include birds (Aves), frogs and toads (Anura) and rodents (Rodentia) (Scott 1986).

Both Dukes' Skipper and Dion Skipper (a closely related *Euphyes* species) larvae feed on Lake Sedge (Hall *et al.* 2014). These two skippers are often observed in separate microsites within the same wetland habitat patches; Dion Skipper occurs in the open wetland areas of the habitat patch and Dukes' Skipper prefers the more shaded wetland habitats (Shuey 1985). Both skippers use similar nectaring areas, although do not appear in direct competition for food resources (Shuey 1985).

POPULATION SIZES AND TRENDS

Sampling Effort and Methods

There is little information from which to determine the Canadian population size, or the subpopulation sizes and trends for Dukes' Skipper. Most Dukes' Skipper observations are incidental or were made during informal surveys. Sampling effort and methods to date have focused on recording the species' presence (null results do not confirm absence) and most sites have had limited surveys (see **Search Effort**).

Abundance

Dukes' Skipper abundance at known sites is not well documented (see **Search Effort**). If the species is present in a habitat, a surveyor will typically observe five or more individuals (Wormington 2016). The Ontario Butterfly Atlas reports up to 20 individuals on a single day at the Spring Garden Road Prairie (#1a; July 20, 1989, and August 11, 1990) and at McGregor (#3; July 30, 1977). The highest count at Point Pelee National Park (#24) was 14 adults on July 23, 1995 (Wormington 2016). In the last ten years (2010-2019), the highest abundance reported on a single day is 10 individuals (August 3, 2016) at Reid Conservation Area (#27) (Macnaughton *et al.* 2020). Table 2 tallies the number of individuals observed within each subpopulation in Canada.

Fluctuations and Trends

No information on population fluctuations or trends is available for Dukes' Skipper in Canada. The species does not appear to have extreme fluctuations, based on annual records from subpopulations in Ontario (Macnaughton *et al.* 2020).

Rescue Effect

Dukes' Skipper subpopulations at Upper Big Creek Woods (#2) and Big Creek Marsh (#5) are adjacent to the Canada-United States border and separated by 6 km. This distance includes the open waters of the Detroit River and suitable habitat on river islands. The closest iNaturalist record is approximately 12 km from #2 and #5 in Lake Erie Metropark, just south of Gibraltar, Michigan (Harrison pers. comm. 2020).

Dukes' Skipper is considered to remain local, rarely venturing far from suitable habitat. Based on the dispersal capabilities of similar species (see COSEWIC 2013; **Dispersal and Migration**), it is expected that Dukes' Skipper could disperse up to two kilometres. Subpopulations on islands, such as East Sister Island (#25), suggest the species may at times disperse over water, although it is unknown if this dispersal is aided by extreme weather events. These factors indicate that rescue from populations in the neighbouring states of Michigan and Ohio is possible.

THREATS AND LIMITING FACTORS

Threats

The Dukes' Skipper threat assessment (Table 4) is based on the IUCN-CMP (International Union for Conservation of Nature–Conservation Measures Partnership) unified threats classification system. The IUCN-CMP Threats Classification system is consistent with methods used by COSEWIC across taxa, as well as the federal, provincial, and territorial governments, and it adopts an international standard. For a detailed description, see the Open Standards website (Conservation Measures Partnership 2016a). For information on how the values are assigned, see Salafsky *et al.* (2008), Master *et al.* (2012), and Table 4 footnotes for details.

Table 4. Results for the Dukes' Skipper (*Euphyes dukesi*) threats assessment in Canada. The classification below is based on the IUCN-CMP (International Union for the Conservation of Nature–Conservation Measures Partnership) unified threats classification system. For a detailed description of the threat classification system, see the CMP web site (CMP 2010). 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 information on how the values are assigned, see Master *et al.* (2009) and footnotes to this table.

Scientific Name	Dukes' Skipper (*Euphyes dukesi*)
Date:	March 3, 2021
Assessor(s):	Kristiina Ovaska (Moderator), Jennifer Heron (Arthropods SSC Co-chair), Daniel Riley (report writer), Charlotte Teat (report writer), David McCorquodale (Arthropods SSC Co-chair), Jeremy deWaard (SSC member), Alan Harris (SSC member), Colin Jones (SSC member), Jessica Linton (SSC member), Ken Tuninga (Canadian Wildlife Service), Leah Ramsay (SSC member), Robert Buckowski (SSC member), Jamie Lewthwaite (SSC member), Erin Carroll (SC Reed Conservation Area), Tammy Dobbie (Parks Canada), John Klymko (SSC member), Sarah Semmler (SSC member), Rosie Soares (COSEWIC Secretariat), Rachael Windsor (Parks Canada), Alan Fretz (Parks Canada).

Overall Threat Impact:		**Level 1 Threat Impact Counts**	
Threat Impact		**high range**	**low range**
A	Very High	0	0
B	High	1	0
C	Medium	0	1
D	Low	3	3
Calculated Overall Threat Impact:		High	High
Assigned Overall Threat Impact:	**B = High**		
Impact Adjustment Reasons:	No adjustment		
Overall Threat Comments	European Reed is a significant threat at all subpopulations. In some areas, restoration and removal of the plant is ongoing, and the threat from these plants may be declining.		

Threat		**Impact[1] (calculated)**		**Scope[2] (Next 10 Yrs)**	**Severity[3] (10 Yrs or 3 Gen.)**	**Timing[4]**	**Comments**
1	Residential & commercial development	D	Low	Restricted (11-30%)	Slight (1-10%)	Moderate (Possibly in the short term, < 10 yrs/3 gen)	
1.1	Housing & urban areas	D	Low	Restricted (11-30%)	Slight (1-10%)	Moderate (Possibly in the short term, < 10 yrs/3 gen)	See **Threats and Limiting Factors.**
1.2	Commercial & industrial areas						Not applicable.
1.3	Tourism & recreation areas						Not Applicable
2	Agriculture & aquaculture	D	Low	Small (1-10%)	Slight (1-10%)	Moderate (Possibly in the short term, < 10 yrs/3 gen)	
2.1	Annual & perennial non-timber crops		Low	Small (1-10%)	Slight (1-10%)	Moderate (Possibly in the short term, < 10 yrs/3 gen)	See **Threats and Limiting Factors.**
2.2	Wood & pulp plantations						Not Applicable
2.3	Livestock farming & ranching						Not Applicable
2.4	Marine & freshwater aquaculture						Not Applicable

Threat		Impact[1] (calculated)		Scope[2] (Next 10 Yrs)	Severity[3] (10 Yrs or 3 Gen.)	Timing[4]	Comments
3	Energy production & mining						
3.1	Oil & gas drilling						Not Applicable
3.2	Mining & quarrying						Not Applicable
3.3	Renewable energy						Not Applicable
4	Transportation & service corridors						
4.1	Roads & railroads						Not Applicable
4.2	Utility & service lines						Not Applicable
4.3	Shipping lanes						Not Applicable
4.4	Flight paths						Not Applicable
5	Biological resource use		Unknown	Restricted - Small (1-30%)	Unknown	Moderate (Possibly in the short term, < 10 yrs/3 gen)	
5.1	Hunting & collecting terrestrial animals		Negligible	Negligible (<1%)	Negligible (<1%)	Moderate (Possibly in the short term, < 10 yrs/3 gen)	Dukes' Skipper has been collected in Canada for scientific purposes. It may be targeted by collectors due to its rarity.
5.2	Gathering terrestrial plants						Not applicable. Dukes' Skipper host plants are not edible or targeted for collection.
5.3	Logging & wood harvesting		Unknown	Restricted - Small (1-30%)	Unknown	Moderate (Possibly in the short term, < 10 yrs/3 gen)	See **Threats and Limiting Factors.**
5.4	Fishing & harvesting aquatic resources						Not Applicable
6	Human intrusions & disturbance		Unknown	Large (31-70%)	Unknown	High (Continuing)	
6.1	Recreational activities		Unknown	Large (31-70%)	Unknown	High (Continuing)	See **Threats and Limiting Factors.**
6.2	War, civil unrest & military exercises						Not Applicable
6.3	Work & other activities						Not Applicable.
7	Natural system modifications	BC	High - Medium	Pervasive (71-100%)	Serious - Moderate (11-70%)	High (Continuing)	
7.1	Fire & fire suppression						Not Applicable
7.2	Dams & water management/use		Unknown	Restricted (11-30%)	Unknown	Moderate (Possibly in the short term, < 10 yrs/3 gen)	See **Threats and Limiting Factors.**
7.3	Other ecosystem modifications	BC	High - Medium	Pervasive (71-100%)	Serious - Moderate (11-70%)	High (Continuing)	See **Threats and Limiting Factors.**
8	Invasive & other problematic species & genes		Unknown	Large - Small (1-70%)	Unknown	High (Continuing)	
8.1	Invasive non-native/ alien species/diseases		Unknown	Large - Small (1-70%)	Unknown	High (Continuing)	See **Threats and Limiting Factors.**
8.2	Problematic native species/diseases						Not Applicable
8.3	Introduced genetic material						Not Applicable

Threat		Impact[1] (calculated)		Scope[2] (Next 10 Yrs)	Severity[3] (10 Yrs or 3 Gen.)	Timing[4]	Comments
8.4	Problematic species/ diseases of unknown origin						Not Applicable
8.5	Viral/prion-induced diseases						Not Applicable
8.6	Diseases of unknown cause						Not Applicable
9	Pollution		Unknown	Pervasive - Large (31-100%)	Unknown	High (Continuing)	
9.1	Domestic & urban waste water						Not Applicable
9.2	Industrial & military effluents						Not Applicable
9.3	Agricultural & forestry effluents		Unknown	Pervasive -Large (31-100%)	Unknown	High (Continuing)	See **Threats and Limiting Factors.**
9.4	Garbage & solid waste						Not Applicable
9.5	Air-borne pollutants						Not Applicable
9.6	Excess energy						Not Applicable
10	Geological events						
10.1	Volcanoes						Not Applicable
10.2	Earthquakes/ tsunamis						Not Applicable
10.3	Avalanches/ landslides						Not Applicable
11	Climate change & severe weather	D	Low	Pervasive (71-100%)	Slight (1-10%)	High (Continuing)	
11.1	Habitat shifting & alteration		Unknown	Pervasive (71-100%)	Unknown	Moderate (Possibly in the short term, < 10 yrs/3 gen)	See **Threats and Limiting Factors.**
11.2	Droughts		Unknown	Pervasive (71-100%)	Unknown	High - Moderate	See **Threats and Limiting Factors.**
11.3	Temperature extremes		Unknown	Pervasive (71-100%)	Unknown	High - Moderate	See **Threats and Limiting Factors.**
11.4	Storms & flooding		Low	Pervasive (71-100%)	Slight (1-10%)	High (Continuing)	See **Threats and Limiting Factors.**
11.5	Other impacts						Not Applicable

[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 5. Summary of applicable threats to Dukes' Skipper (*Euphyes dukesi*) subpopulations. An 'x' in the table indicates the threat is inferred or suspected, to be ongoing; however, the subpopulation-specific scope, severity and timing may not be fully understood. Applicability of the threat is based on information from regional specialists and general knowledge about the subpopulation habitats.

Sub-pop #	Subpopulation Name	Status Total Sites	IUCN-CMP Threat Number (See Threats and Limiting Factors and Table 5)											
			1.1	2.1	5.3	6.1	7.2	7.3	8.1	9.3	11.1	11.2	11.3	11.4
			6	6	14?	16	6	7/12 of the extant subpopulations have documented evidence of rapid spread of European Reed: 20 (minimum) including historical subpopulations, are suspected to be declining,	Likely all	19 + 8?	29	29	29	29
1a	Windsor; Spring Garden Road Prairie	**Extant**				x		x; European Reed present (Kamstra pers. comm. 2020; Yukich pers. comm. 2020)	x	x	x	x	x	x
1b	Windsor; Brunet Park					x		x	x	x	x	x	x	x
2	Upper Big Creek Woods	**Extant**				x		x	x	x	x	x	x	x
3	Canard Valley Conservation Area/ McGregor	Historical			?	x		x	x	x	x	x	x	x
4	Gesto	Historical			?			unknown	x		x	x	x	x
5	Pleasant Valley	Historical			?			unknown	x		x	x	x	x
6	Arner	Historical			?			unknown	x		x	x	x	x
7	Oxley Poison Sumac Marsh	Historical				x		x	x	x	x	x	x	x
8	Big Creek Marsh	Historical				x		x	x	x	x	x	x	x
9	Kingsville	Historical			?				x		x	x	x	x
10	Blytheswood	Historical	x	x		x	x	x	x	x	x	x	x	x
11	Maidstone Conservation Area	Historical				x		x	x	x	x	x	x	x
12	South Woodslee	Historical			?			unknown			x	x	x	x
13	Ruscom Station	Historical			?			unknown			x	x	x	x
14	Saint Joachim	**Extant**	x	x	?		x	x; European Reed present (NRSI 2015)		x	x	x	x	x
15	Ruscom Shores Conservation Area	Historical				x		x	?	x	x	x	x	x
16	Belle River	**Extant**	x	x	?		x	x; European Reed present (NRSI 2015)	?	x	x	x	x	x
17	Stoney Point	Historical	?	?	?		?	unknown	?	?	x	x	x	x
18	Tilbury East	Historical	?	?	?		?	unknown			x	x	x	x
19	Wheatley Provincial Park	**Extant**				x		x; European Reed present (iNaturalist 2021)		x	x	x	x	x
20	Kopegaron Woods Conservation Area	**Extant**				x		x		x	x	x	x	x
21	Mersea Road 6	**Extant**	x	x	?		x	x		x	x	x	x	x

Sub-pop #	Subpopulation Name	Status Total Sites	IUCN-CMP Threat Number (See Threats and Limiting Factors and Table 5)											
			1.1	2.1	5.3	6.1	7.2	7.3	8.1	9.3	11.1	11.2	11.3	11.4
22	Two Creeks Conservation Area	Historical				x		x		x	x	x	x	x
23	Hillman Marsh Conservation Area	**Extant**				x		x; European Reed present (ERCA 2016)		x	x	x	x	x
24	Point Pelee National Park	**Extant**				x		x; European Reed present (O'Neill pers. comm. 2020).			x	x	x	x
25	East Sister Island Provincial Park	Historical						x; European Reed present (Kamstra pers. comm. 2020; Yukich pers. comm. 2020)	?		x	x	x	x
26	Walpole Island	**Extant**	x	x	?	x	x	X; European Reed present (University of Windsor Daily News 2021)	?	x	x	x	x	x
27	Reid Conservation Area	**Extant**				x		x	?	x	x	x	x	x
28	Brigden	**Extant**	x	x	?		x	x	?	x	x	x	x	x

Threats are defined as the proximate activities or processes that have caused, are causing, or may cause in the future the destruction, degradation, and/or impairment of Dukes' Skipper in Canada. Limiting factors are not considered during this assessment process. For purposes of threat assessment, only present and future threats are considered. Historical threats, indirect or cumulative effects of the threats, or any other relevant information that would help understand the nature of the threats are presented under the subheadings below.

Threats for Dukes' Skipper were assessed for the entire Canadian Range. Most threats are inferred from generally known threats to Lepidoptera in southwestern Ontario and the extent and quality of the habitat present at known sites. The overall assigned threat impact is High based on input from various regional experts and butterfly specialists (see Table 4 for full list of participants). Threats below are written highest to least impact and only those scored or unknown are discussed; negligible/non-applicable threats are listed in Table 4.

<u>IUCN Threat 7. Natural System Modifications (High-medium impact)</u>

7.2 Dams and water management/use (Unknown impact).

Changes to the water table through flooding and/or drought can adversely impact wetland habitats, host plant abundance and likely Dukes' Skipper abundance (Calhoun 1995). Habitats adjacent to agricultural areas are influenced by maintenance and upgrades to agricultural drainage and tiling systems, which may then impact Dukes' Skipper subpopulations. This threat may be of higher impact to small subpopulations located on privately owned lands, although the severity is unknown.

7.3 Other ecosystem modifications (High-medium impact).

The growth and spread of invasive non-native plants modify an ecosystem and adversely impact arthropod and plant diversity and abundance (Ballard *et al.* 2013; Litt *et al.* 2014). Invasive plants (both native and non-native) have a greater impact on butterflies, like Duke's Skipper, which are host plant specialists (Burghardt *et al.* 2010).

The rapid growth and spread of non-native and invasive European Reed throughout Duke's Skipper habitats are the highest threat to the species. The plant can quickly spread, with annual cane shoots that reach 2-4m (OMNR 2011). The plant can takeover small wetlands or wet areas, growing in dense monocultural stands (Schweitzer *et al.* 2018), mainly because it can effectively disperse through rhizome fragments or seeds (OMNR 2011). European Reed spreads quickly and out-competes native species by releasing a toxin from its roots which can kill neighbouring plants (OMNR 2011). When the shoots die, the dead canes can remain standing for 3 to 4 years, preventing any shade-intolerant plants from growing under the dead European Reed (OMNR 2011). Most notably, a single European Reed plant can spread at a rate of 1-2m per year (OMNR 2011). These characteristics make European Reed a significant threat that can cause ecosystem modifications, thereby reducing the area, extent and quality of Dukes' Skipper host plants and habitat.

It is widely speculated that European Reed is the leading ecosystem modification contributing to the loss of Dukes' Skipper habitat in southwestern Ontario (Schweitzer *et al.* 2018; Kamstra pers. comm. 2020; O'Neill pers. comm. 2020; Pratt pers. comm. 2020; Yukich pers. comm. 2020). There is documented evidence of rapid spread of European Reed at seven of the 12 Duke's Skipper subpopulations (#1, 14, 16, 19, 23, 24, 26; Table 5).

- European Reed is present at Point Pelee National Park (#24) and may be expanding its presence into areas where Dukes' Skipper has been observed (e.g., Schuster Trail [O'Neill pers. comm. 2020]). However, in 2020, a European Reed removal and marsh restoration project began in the park, including Schuster Trail (Windsor pers. comm. 2021).
- European Reed has grown rapidly into a sedge meadow at Spring Garden Road Prairie (#1a) and on East Sister Island (#25; although this subpopulation is considered historical) (Kamstra pers. comm. 2020; Yukich pers. comm. 2020).
- European Reed was noted in two of the four locations that contained suitable habitat for Dukes' Skipper in the County of Essex (#14 and #16) (NRSI 2015). There was no notable increase in European Reed at these sites between 2015 and 2018 (Teat pers. comm. 2021).

Other invasive and non-native wetland plant species, such as Purple Loosestrife (*Lythrum salicaria*), Flowering Rush (*Butomus umbellatus*) and Narrow-leaved Cattail (*Typha angustifolia*) may also be threatening Dukes' Skipper habitat by out-competing native host plants and restricting waterflow through wetlands. Purple Loosestrife has

spread rapidly throughout eastern North America since its introduction in the 1800s (Warne 2016). In Ontario, Flowering Rush is still most concentrated in the two areas of initial introduction (eastern Lake Ontario/St. Lawrence River, and in western Lake Erie and Lake St. Clair), and more thinly scattered throughout the Great Lakes region. But it has a very wide range of hardiness (zones 3-10) which makes it capable of being widely invasive in the United States and Canada (Simkovic 2020). Narrow-leaved Cattail is able to quickly colonize habitats and create monodominant vegetation stands due to its robust size, rapid growth rate, and rhizomatic expansion (Bansal *et al.*, 2019). These three invasive plants are capable of further ecosystem modifications, thereby reducing available habitat for Dukes' Skipper in Canada.

Emerald Ash Borer (*Agrilus planipennis*) is an invasive beetle and the larvae feed on Green Ash (*Fraxinus pennsylvanica*), White Ash (*Fraxinus americana*), Black Ash (*Fraxinus nigra*), Pumpkin Ash (*Fraxinus profunda*), and Blue Ash (*Fraxinus quadrangulate*). Emerald Ash Borer larvae will girdle a tree, which leads to tree mortality within two to three years of infestation (Government of Canada 2020). These trees have a wide distribution in southern Ontario; many within Dukes' Skipper habitats. The decline and eventual mortality of these trees has the potential to open up gaps in the woodland canopy. Since shade or partial shade is an essential characteristic of suitable habitat for Dukes' Skipper, the loss of too many ash trees in any wetland occupied by Dukes' Skipper may render the habitat unsuitable for the species.

IUCN Threat 1. Residential and Commercial Development (Low impact)

1.1 Housing and urban areas (Low impact).

Housing and other urban development results in direct loss of habitat, and also can negatively impact habitats adjacent to the development. Potential development is suspected at all private land sites (See Table 5). Other areas include the Oxley Poison Sumac Swamp, which is 10 % privately owned. It is likely that developments proposed on wetland habitats (i.e., Dukes' Skipper habitats) would trigger a requirement for an Environmental Impact Assessment (Lambton County 1998; County of Essex 2014; Chatham-Kent 2018). In Ontario, residential developments are not typically permitted in wetlands without extensive environmental study prior to development (OMNRF 2013).

IUCN Threat 2. Agriculture and Aquaculture (Low impact)

2.1 Annual and perennial non-timber crops (Low impact).

Agricultural fields are located adjacent to numerous Dukes' Skipper subpopulations. Dukes' Skipper and its host plants are vulnerable to water table fluctuations that result from agricultural drainage or irrigation (Calhoun 1995; Schweitzer *et al.* 2018).

On private lands, particularly where Dukes' Skipper occurs in small woodlands, there is the potential for habitat conversion of these woodlots to agricultural fields. Extensive wetland drainage would be required for conversion to appropriate agricultural lands

(Oldham 1983). The extent that agricultural expansion threatens Dukes' Skipper on Walpole Island (#26) is not known.

IUCN Threat 11. Climate Change and Severe Weather (Low impact)

11.1 Habitat Shifting & Alteration (Unknown impact).

Dukes' Skipper overwinters as a fourth instar larva, emerging in the spring to feed. Unseasonably warm weather or late-season frost may stimulate larvae to have longer than normal activity periods. High host plant growth and abundance may not be synchronous with larval activity, thereby leading to larval mortality, should there be insufficient host plant availability. Changes to local weather and temperatures remain unstudied for Dukes' Skipper. Studies on asynchronous butterfly emergence in Britain found that for each 1°C rise in temperature in the spring, 92% of butterfly species emerge between one to nine days earlier (Brooks *et al.* 2016).

11.2 Droughts (Unknown impact).

Drought can have adverse impacts on butterfly species, as extreme hot and dry periods are linked to reduced subpopulation sizes (directly caused by heat stress to larvae) and declines in host plant quality and quantity (Oliver *et al.* 2015). The impact of drought is greater for species in fragmented habitat, like Dukes' Skipper (Oliver *et al.* 2015). The stress of heat waves and drought increases mortality rates of Lepidoptera during early development (Klockmann and Fischer 2017).

11.3 Temperature Extremes (Unknown impact).

Late season or early frost has the potential to cause mortality of early emergence Dukes' Skipper larvae and its host plants.

11.4 Storms & flooding (Low impact).

Increased rainfall may result in water level fluctuations which can contribute to erosion and direct loss of Dukes' Skipper habitat. In 2020, there was extensive flooding at Reid Conservation Area (#27) which may have contributed to the low abundance (and no detection) of Dukes' Skipper in that year (Mann pers. comm. 2020). Subpopulations located along Lake Erie are particularly susceptible to storms and flooding, including Point Pelee National Park (#24) and East Sister Island (#25). Storm severity and associated wave action have resulted in substantial erosion along the northern shore of Lake Erie. Erosion at Point Pelee National Park has led to extensive loss of wetlands along the shoreline and may eventually result in a complete loss of these habitats (Parks Canada 2020). This loss of wetland habitat has the potential to directly eliminate suitable habitat for Dukes' Skipper.

There is potential that a warming climate could also improve conditions for a species at the northern limit of its range. A study of Sachem Skipper (*Atalopedes campestris*), found that warmer winter temperatures were required to increase the northern range of this species (Crozier 2004).

IUCN Threat 5. Biological Resource Use (Unknown impact)

5.3 Logging and wood harvesting (Unknown impact).

Dukes' Skipper inhabits shaded woodlands. Logging increases sun exposure and, depending on the number of trees harvested at a site, may render the habitat unsuitable for the species (Calhoun 1995). Alternatively, selective logging could improve habitat by creating canopy gaps. Large-scale logging in southern Ontario is uncommon at the present, although selective logging is ongoing in many woodlots. Generally, only woodlands that meet a minimum size (>4 ha) and demonstrate an important ecological function are considered for protection from development; these areas receive protection by local municipal Official Plans.

Six of the 12 extant Dukes' Skipper subpopulations occur on private properties with potential for logging. The severity of the logging is unknown at these subpopulations, although would likely occur within the next ten years.

IUCN Threat 6. Human Intrusions and Disturbance (Unknown impact)

6.1 Recreational activities.

At least 16 Dukes' Skipper subpopulations occur on habitats with recreational use (Table 5). These areas are used for hiking, cycling, camping, and possible unauthorized motorized vehicle off-roading. Dukes' Skipper (all life stages) occupy habitat near to the ground and are potentially threatened from pedestrian or vehicular trampling, or vegetation maintenance activities to support trail use and camping. Small, localized subpopulations with few individuals are at the highest risk, although across the whole Canadian population, the severity is considered low.

IUCN Threat 8. Invasive & Other Problematic Species & Genes (Unknown impact)

8.1 Invasive non-native/alien species/diseases (Unknown impact).

Non-native arthropods may predate on Dukes' Skipper adults and larvae. German Yellow Jackets (*Vespula germanica*) and European Paper Wasp (*Polistes dominula*) both predate on caterpillars. Non-native Asian Lady Beetle (*Harmonia axyridis*) and Seven-spotted Lady Beetle (*Coccinella septempunctata*) have been observed eating small caterpillars (Schweitzer *et al.* 2018). Invasive non-native plants are scored under 7.3 (other ecosystem modifications.

Threats from non-native Spongy Moth (*Lymantria dispar dispar*) are assessed under threat 9.3. The spread of non-native invasive plants is assessed under threat 7.3.

IUCN Threat 9. Pollution (Unknown impact)

9.3 Agricultural and forestry effluents (Unknown impact).

Pollution, pesticides, and herbicides have adverse impact on insect populations. Many of the extant subpopulations of Dukes' Skipper, including those in protected areas, are located adjacent to agricultural fields and have the potential to receive agricultural runoff (containing fertilizers, herbicides, and pesticides) or pesticide drift. These toxins may threaten Dukes' Skipper and/or their host plants (Dover *et al.* 1990).

Spongy Moth (*Lymantria dispar dispar*)[14] is a non-native moth that was detected in southern Ontario in 1969. The larvae are defoliators and cause extensive damage to a wide range of host trees and shrubs. *Bacillus thuringiensis* var. *kurstaki (Btk)* is a broad-spectrum insecticide used to control Spongy Moth in Ontario and is lethal to lepidopteran larvae (Rastall *et al.* 2003). In Ontario, application of *Btk* began shortly after Spongy Moth was detected in 1969. *Btk* is typically applied by aerial spraying and is the most common control method utilized by southern Ontario municipalities and conservation authorities. If used at sites with extant populations of Dukes' Skipper, it may pose a threat to their survival. It has been noted that the preferred habitat of Dukes' Skipper is not particularly vulnerable to defoliation by Spongy Moth larvae, as such the likelihood of aerial spraying in Dukes' Skipper habitat is somewhat reduced (Schweitzer *et al.* 2018). *Btk* is applied in late April through to May (Surgeoner and Farkas 1990). It is not known how *Btk* impacts Dukes' Skipper, particularly with regards to larvae emerging from diapause in their fourth instar (Schweitzer *et al.* 2018).

Limiting Factors

Limiting factors are generally not human-induced and include characteristics that make Dukes' Skipper less likely to respond to conservation efforts. The primary limiting factors for Dukes' Skipper relate to it being a wetland specialist with key requirements for suitable habitat and its dependence on Lake Sedge and Shoreline Sedge as larval host plants (see Habitat Requirements). Other limiting factors include the small population size in Canada, the isolation of subpopulations and poor dispersal ability.

Small subpopulation size

Dukes' Skipper subpopulations are likely small, and the habitats in which they occur are small, localized areas. It appears the skipper can persist at a site less than a hectare in size (iNaturalist 2021; Macnaughton *et al.* 2020). A small number of individuals limits the ability of subpopulations to recover from any increase in mortality of adults or larvae.

[14] Former English names are European Gypsy Moth and LDD Moth. The name has recently changed (Entomological Society of Canada 2022).

Isolated subpopulations

With the exception of a few larger areas of habitat, the majority of the sites are small and isolated within the landscape. Small, localized subpopulations can result in increased resource competition, inbreeding, loss of genetic diversity, decreased resilience to threats, and with limited habitat, there is concern for the long-term viability of the skipper.

Poor dispersal ability

The dispersal ability of female Dukes' Skipper is not well understood; however, based on other skippers (see **Dispersal and Migration**) dispersal is limited to a maximum of two kilometres. Limited dispersal reduces the skipper's ability to populate new or historical sites, particularly when the intervening habitat is highly fragmented and unsuitable, which includes much of its range in southern Ontario.

Number of Locations

There are 12 extant Dukes' Skipper subpopulations in Canada (Table 1). The ecosystem modifications within Dukes' Skipper wetland habitats, that result from the ingrowth and spread of non-native European Reed, is the primary threat to the skipper. European Reed is confirmed at seven (#1, 14, 16, 19, 23, 24, 26) of the 12 extant subpopulations, although it is suspected to be present in low abundance at some habitats and projected to invade all subpopulation habitats within the next ten years. The rate of spread of the plant likely differs within and among habitats, and there are European Reed control and removal programs at some subpopulation habitats and none at others. Because the growth and spread of the plant is different at each of the seven subpopulation habitats, the number of locations is estimated to be a minimum of 12 locations: a minimum of seven locations based on the variable rate of the growth and spread and the management approaches to control European Reed, at the seven subpopulation habitats with documented presence of the invasive plant; plus those subpopulation habitats with no European Reed represent another 5 locations; plus the potential to record new subpopulations (and the presence of European Reed at those sites) up to an estimated maximum of 20 locations. See **Threats and Limiting Factors** (7.3 other ecosystem modifications) for further information on European Reed.

PROTECTION, STATUS AND RANKS

Legal Protection and Status

Dukes' Skipper is not protected under the Canadian *Species at Risk Act* or the Ontario *Endangered Species Act*. The confirmed host plants in Ontario (Lake Sedge and Shoreline Sedge) are also not protected under these acts; however, False Hop Sedge (host plant confirmed in Mississippi [Schweitzer *et al.* 2018] although unconfirmed in Canada) is Endangered under both acts (NHIC 2020b). Dense-blazing Star (nectar plant) is Threatened under both acts (NHIC 2020b).

Non-Legal Status and Ranks

Dukes' Skipper conservation status ranks (NatureServe 2022):

Global	G3G4 (Vulnerable to Apparently Secure)
Canada	N2 (Imperiled)
United States	N3 (Vulnerable)
Ontario	S2 (Imperiled)
Michigan	S2 (Imperiled)
Ohio	S3 (Vulnerable)

Larval host plant conservation status ranks (NHIC 2020b):

Shoreline Sedge	S4 (Apparently Secure) (last assessed December 31, 2015)
Lake Sedge	S5 (Secure) (last assessed December 31, 2015)
False Hop Sedge	S1 (Critically Imperiled) (last assessed December 31, 2015)

Nectar plants (NHIC 2020b):

Dense-blazing Star S2 (Imperiled) (NatureServe 2022)

Habitat Protection and Ownership

Habitat ownership is summarized in Table 1. The ownership of nine subpopulations is unknown although likely private land (Table 1).

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Front Cover photograph by Blake Mann taken July 19, 2013, at Reid Conservation Area, Wallaceburg, Lambton County, Ontario.

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Daniel Riley is a Terrestrial and Wetland Biologist with Natural Resource Solutions Incorporated (NRSI), an environmental consulting firm located in Waterloo, Ontario. At NRSI, Daniel is a bird specialist and leads natural resource inventories and evaluations, environmental impact studies and research. Daniel is active in the Ontario birding and butterflying community and is currently serving as secretary of the Ontario Bird Records Committee. Since graduating with a Bachelor of Landscape Architecture from the University of Guelph, Daniel has worked on a number of projects focused on species at risk. Daniel regularly completes field surveys and detailed impact assessments for a wide range of insect species in Ontario. He is also experienced in the preparation of COSEWIC Status reports and is the primary author on the updated Barn Swallow (*Hirundo rustica*) Status Report (unpublished).

Charlotte Teat is a Terrestrial and Wetland Biologist with NRSI, an environmental consulting firm located in Waterloo, Ontario. Charlotte's main areas of expertise are butterfly and bird ecology, and she is also experienced and has a strong general knowledge

of many other taxonomic groups in Canada. Charlotte has over 10 years of experience conducting field surveys for insects, including targeted surveys specifically for Dukes' Skipper, which she has encountered in the field on several occasions. She is familiar with survey techniques, identification of the species, and its habitat requirements. Charlotte has extensive report writing experience through preparation of various types of reports and documents, including an undergraduate thesis, M.E.S. thesis, technical reports, impact assessments, and providing peer-review of documents prepared by others. Charlotte has considerable editorial experience, as evident from her involvement as editor of Ontario Insects for the last four years, which is the newsletter of the Toronto Entomologists' Association. She has also prepared several poster and oral presentations at conferences in Canada and the United States.

COLLECTIONS EXAMINED

OAC Insect Collection, Biodiversity Institute of Ontario, University of Guelph, Guelph, Ontario (Paiero pers. comm. 2020)

Canadian National Collection of Insects, Arachnids and Nematodes, Ottawa, Ontario (Anderson pers. comm. 2020)

Royal Ontario Museum, Toronto, Ontario (Hubley pers. comm. 2020)