



Davis's Shieldback

(*Atlantiscus davisii*) in Ontario

Ontario Recovery Strategy Series

2024

About the Ontario Recovery Strategy Series

This series presents the collection of recovery strategies that are prepared or adopted as advice to the Province of Ontario on the recommended approach to recover species at risk. The Province ensures the preparation of recovery strategies to meet its commitments to recover species at risk under the *Endangered Species Act 2007* (ESA) and the Accord for the Protection of Species at Risk in Canada.

What is recovery?

Recovery of species at risk is the process by which the decline of an endangered, threatened, or extirpated species is arrested or reversed, and threats are removed or reduced to improve the likelihood of a species' persistence in the wild.

What is a recovery strategy?

Under the ESA a recovery strategy provides the best available scientific knowledge on what is required to achieve recovery of a species. A recovery strategy outlines the habitat needs and the threats to the survival and recovery of the species. It also makes recommendations on the objectives for protection and recovery, the approaches to achieve those objectives, and the area that should be considered in the development of a habitat regulation. Sections 11 to 15 of the ESA outline the required content and timelines for developing recovery strategies published in this series.

Recovery strategies are required to be prepared for endangered and threatened species within one or two years respectively of the species being added to the Species at Risk in Ontario list. Recovery strategies are required to be prepared for extirpated species only if reintroduction is considered feasible.

What's next?

Nine months after the completion of a recovery strategy a government response statement will be published which summarizes the actions that the Government of Ontario intends to take in response to the strategy. The implementation of recovery strategies depends on the continued cooperation and actions of government agencies, individuals, communities, land users, and conservationists.

For more information

To learn more about species at risk recovery in Ontario, please visit the Ministry of Environment, Conservation and Parks Species at Risk webpage at: www.ontario.ca/speciesatrisk

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Authors

Jessica Linton – Natural Resource Solutions Inc.

Andie Siemens – Natural Resource Solutions Inc.

Audrey Heagy – Independent Consultant, Norfolk County, Ontario

Mary Gartshore – Independent Consultant, Norfolk County, Ontario

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Declaration

The recovery strategy for Davis's Shieldback (*Atlanticus davisii*) was developed in accordance with the requirements of the Endangered Species Act, 2007 (ESA). This recovery strategy has been prepared as advice to the Government of Ontario, other responsible jurisdictions and the many different constituencies that may be involved in recovering the species.

The recovery strategy does not necessarily represent the views of all individuals who provided advice or contributed to its preparation, or the official positions of the organizations with which the individuals are associated.

The recommended goals, objectives and recovery approaches identified in the strategy are based on the best available knowledge and are subject to revision as new information becomes available. Implementation of this strategy is subject to appropriations, priorities and budgetary constraints of the participating jurisdictions and organizations.

Success in the recovery of this species depends on the commitment and cooperation of many different constituencies that will be involved in implementing the directions set out in this strategy.

Responsible jurisdictions

Ministry of the Environment, Conservation and Parks
Environment and Climate Change Canada – Canadian Wildlife Service, Ontario

Executive summary

The Davis's Shieldback is a flightless, non-migratory katydid in the family Tettigoniidae (Order Orthoptera). Adults are brown and grey in colour and approximately 20 to 25 mm in length. They have a sculpted shield-like plate (pronotum) on the top and sides of their thorax. Females have a long sword-like ovipositor while males have two short projections (cerci) at the end of the abdomen. Nymphs are similar in appearance to the adults but are smaller.

No specific studies have been conducted on the biology and natural history of the Davis's Shieldback, although it is known that they grow through incomplete metamorphosis, producing one generation per year. Based on the biology of closely related species, eggs most likely overwinter, hatching as nymphs in the spring before maturing as adults in early summer which die later in the year and do not overwinter. In Ontario, nymphs have been observed between mid-May through early July and adults are active from July through September.

Both adults and nymphs are omnivores, feeding on other insects, scavenging dead insects, and consuming plant material. The species is most active from dusk until shortly after midnight. During this activity period, adult males advertise their presence to nearby females by producing a quiet but distinct song (stridulation) by rubbing their wings together.

The global range of Davis's Shieldback occurs in eastern North America, with their primary range being south of the Great Lakes and extending from Iowa east to Vermont, southwards to North Carolina and west to Arkansas. In Canada, Davis's Shieldback occurs only in a small area north of Lake Erie in southern Ontario, comprised of six extant subpopulations.

In Canada, the Davis's Shieldback is associated with remnant oak woodland, oak savanna and sand barrens, occupying their habitat throughout their annual cycle. Key habitat features that are thought to be important to the species include well-drained sandy soils, dry leaf litter, low shrubs or saplings, and availability of sunlight at ground level. The dispersal capabilities of Davis's Shieldback are unknown, however, the recent (2021) discovery of new locations in restored habitats suggest that colonization of new areas is possible where habitat connectivity is present.

The Davis's Shieldback is currently listed as threatened on the Species at Risk in Ontario (SARO) List. The most widespread and continuing threat to Davis's Shieldback (and their rare habitats generally) is ecosystem modifications associated with fire suppression and oak regeneration failures, resulting in canopy closure and/or changes in vegetation structure. Other threats identified include invasive species, recreational activities (e.g., ATVing), industrial and commercial development, and afforestation.

The recommended long-term recovery goal for the Davis's Shieldback is to ensure the persistence and viability of subpopulations and mitigate threats to the species and its

habitat in Ontario. To achieve the recovery goal, the following recovery and protection objectives are recommended:

1. Maintain and enhance existing habitat and mitigate threats at occupied sites.
2. Initiate research to fill knowledge gaps related to this species' biology, habitat needs and availability, population abundance and distribution, and threats in Ontario.
3. Create additional suitable habitat with an emphasis on increasing habitat connectivity and overall habitat patch size.
4. Increase awareness of and protection for Davis's Shieldback and its habitat.
5. Where appropriate and feasible, manage subpopulations through augmentation, reintroduction, or assisted colonization of previously unoccupied suitable habitats.

It is recommended that the area for consideration for a habitat regulation for Davis's Shieldback encompass all Ecological Land Classification vegetation types where the species is known to be extant and suitable contiguous vegetation communities within 170m (based on inferred dispersal capabilities). Only areas with physical barriers should be excluded.

Periodic disturbance is required to create and/or maintain these habitats and should be considered (e.g., allowances for prescribed fire, mowing, etc.) when assessing allowable activities within the habitat of Davis's Shieldback.

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1.0 Background information

1.1 Species assessment and classification

The following list provides assessment and classification information for Davis's Shieldback (*Atlantiscus davisii*). Note: The Glossary provides definitions for abbreviations and technical terms in this document.

- SARO List Classification: Threatened
- SARO List History: Threatened (2023)
- COSEWIC Assessment History: Threatened (2020)
- SARA Schedule 1: No schedule, no status
- Conservation Status Rankings: G-rank: Not ranked; N-rank: N1; S-rank: S1.

1.2 Species description and biology

Species description

The Davis's Shieldback is a flightless, non-migratory katydid in the family Tettigoniidae (Order Orthoptera). Adults measure approximately 20 to 25 mm in length and display a mottled brown and grey colouration (COSEWIC 2020). This species has a rounded head, large bulging abdomen, short leathery forewings (tegmina), and sculpted shield-like plate (pronotum) on the top and sides of the thorax. In females, the pronotum completely covers the forewings and a long sword-like ovipositor projects behind the abdomen (Figure 1). In adult males, the forewings extend a short distance beyond the pronotum and two short projections (cerci) are present at the end of the abdomen (Figure 2). Nymphs (immature forms) are similar in appearance to the adults but are smaller and have undeveloped tegmina in males (Figure 3). Eggs have not been described (COSEWIC 2020).



Figure 1. Female Davis's Shieldback (Photo: M. Gartshore)



Figure 2. Male Davis's Shieldback (Photo: M. Gartshore)



Figure 3. Davis's Shieldback Nymph (juvenile life stage) (Photo: M. Gartshore)

Species biology

No specific studies have been conducted on the biology and natural history of the Davis's Shieldback. To inform the COSEWIC status report (2020), information was surmised from studies of the closely related Protean Shieldback (*Atlantiscus testaceus*) (Gangwere 1966; 1967) as well as information on the general biology of eastern shieldback katydids (Davis 1915; Rehn and Hebard 1916; Blatchley 1920; Rehtz and Birchim 1968; Walker 1975; Vickery and Kevan 1985; Bland 2003). The reader is referred to the COSEWIC (2020) report for further details on general biology.

Canadian field observations of the Davis's Shieldback by the authors and other authorities consulted have also contributed to our understanding of their natural history and biology.

Davis's Shieldback grows through incomplete metamorphosis, with one generation per year (Vickery and Kevan 1985). Eggs most likely overwinter, hatching as nymphs in the spring and molting several times before maturing as adults in early summer (Vickery and Kevan 1985). In Ontario, nymphs have been observed between mid-May through early July (M. Gartshore pers. obs. 2019; E. Giles, pers. comm. 2019). Adults are active and mate from July through the fall, when the adults succumb to freezing temperatures (Gangwere 1966).

Both adults and nymphs are omnivores, feeding on other insects, scavenging dead insects, and consuming plant material. The species is most active from dusk until shortly after midnight, with intermittent activity during the day (COSEWIC 2020). Adult females use their ovipositor to insert eggs into the soil, however the number of eggs per female is currently unknown (COSEWIC 2020). Adult males produce a quiet but distinct song (stridulation) by rubbing their wings.

The following daily activity patterns were described by Gangwere (1966, 1967) for juvenile and adult Protean Shieldback and may be similar to Davis's Shieldback. Nymphs primarily stay on the ground among dry leaf litter, while adults climb vegetation at dusk to perch on leaves, branches, or stems. Females roam between plants, typically staying within 0.5 m of the ground. In contrast, males tend to be more sedentary, using only a few plants, but when singing they generally perch around 0.5 to 2 m above the ground. This behavior is consistent with observations by the authors of Davis's Shieldback.

A mark-recapture study on Protean Shieldback (Gangwere 1966) demonstrated that some individuals are relatively sedentary, associated with a single plant for days at a time, while others make larger movements. The maximum distance observed for an individual was 168 m. It is not clear from the study if the maximum distance observed could be related to habitat suitability or study area surveyed, but it likely represents an underestimate of actual dispersal capability.

In general, predators of shieldback katydids include other insects, including Great Golden-digger Wasp (*Sphex ichneumoneus*), birds and reptiles, spiders (Davis 1915;

Blatchley 1920; Bland 2003). Because they are flightless, aerial insectivorous predators such as bats and some birds likely do not feed on Davis's Shieldback (COSEWIC 2020). Information on direct or indirect competition is not available for this species.

1.3 Distribution, abundance and population trends

The Davis's Shieldback occurs in eastern North America, with their primary range being south of the Great Lakes and extending from Iowa east to Vermont, southwards to North Carolina and west to Arkansas (COSEWIC 2020). Two disjunct populations occur within the Great Lakes basin, in northern Michigan and southern Ontario.

In Canada, Davis's Shieldback occurs only in southern Ontario in a small area in Norfolk County, north of Lake Erie (Figure 4) (COSEWIC 2020). As of 2020 when the COSEWIC status assessment was completed, the Canadian range consisted of six extant subpopulations¹: Simcoe West (#1); Turkey Point (#2); St. Williams Forest (#3); Nixon East (#4), Bill's Corners West (#5), and Pine Grove (#6) (COSEWIC 2020). A new subpopulation, Backus Woods (#7) has been added based on more recent survey effort. The current status of the Simcoe West subpopulation is uncertain as the extent of woodland habitat has been severely reduced since the species was last confirmed present in 2019 (COSEWIC 2020). All habitat in the vicinity of the known occurrence was removed in 2020 for industrial development leaving only 2 ha of potential habitat on an adjacent land parcel. Therefore, the persistence of the subpopulation is unknown. Three other subpopulations (Nixon East, Bill's Corners West, and Pine Grove) are each represented by a single known site². The Turkey Point, St. Williams Forest, and Backus Woods subpopulations include multiple sites across multiple land ownership/management parcels.

The landscape between subpopulations presents a number of barriers to movement including extensive agricultural areas and other unsuitable habitats as well as a road network.

¹ Subpopulations are defined based on a 1km separation distance (NatureServe 2023).

² "Site" is defined as contiguous area of potentially suitable habitat.

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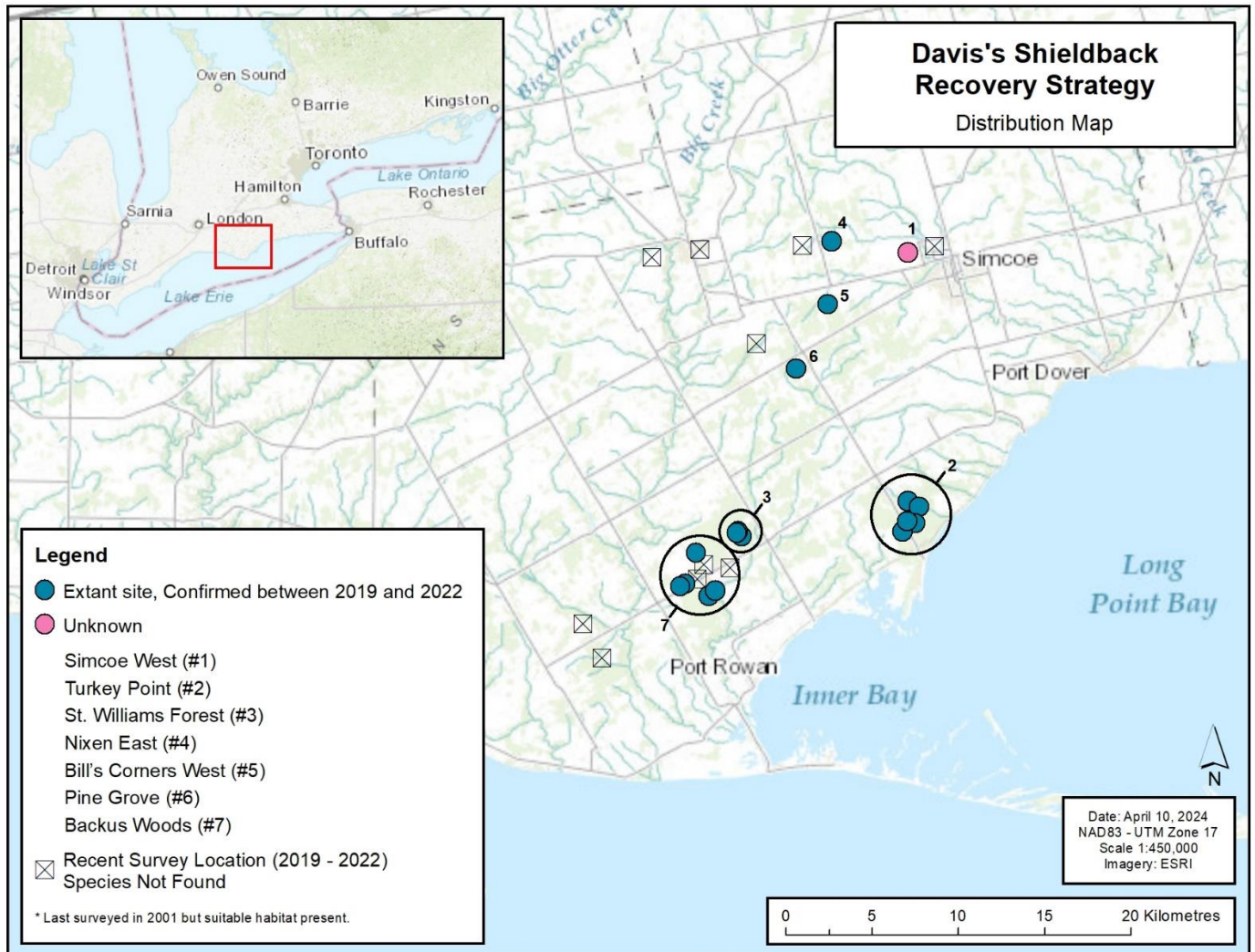


Figure 4. Canadian Range of Davis's Shieldback (adapted from COSEWIC 2020)

During field studies conducted by the authors between 2019 and 2022, the majority of the known extant sites were confirmed to be occupied and 11 other areas of suitable habitat were surveyed for Davis's Shieldback (Figure 4). In 2021, adult Davis's Shieldback were identified at three new sites representing a new subpopulation (Backus Woods) on properties owned by Nature Conservancy of Canada (NCC) (NRSI 2023). Other than the possible loss of the Simcoe West subpopulation, the Canadian range of the Davis's Shieldback has remained unchanged since its initial reported occurrence at Simcoe, Ontario in 1939 (COSEWIC 2020).

Abundance estimates for the Davis's Shieldback are unavailable, however the species seems to be local and rare within its Canadian range. Extrapolation from visual and

audio observations during targeted surveys estimated the number of mature individuals in Canada to be in the order of 300 to 1,310 individuals (COSEWIC 2020).

There is no information on subpopulation trends or fluctuations available for the Davis's Shieldback. However, this species is inferred to have experienced declines over the last century due to habitat loss and degradation (COSEWIC 2020). Dry oak woodland, savanna, and sand barren habitats in southern Ontario have decreased by over 90 percent over the last 150 years (Bakowsky and Riley 1992; Tallgrass Ontario 2019). Habitat degradation and loss of savanna communities to agriculture and development likely caused the extirpation of many undocumented subpopulations prior to this species' discovery (COSEWIC 2020). The Davis's Shieldback population in Ontario is presumed to be in decline due to the ongoing habitat loss and degradation. Rescue or recolonization from the United States population is unlikely due to its limited dispersal capacity to move long distances as a flightless katydid and unsuitable surrounding habitat (COSEWIC 2020).

1.4 Habitat needs

In Canada, the Davis's Shieldback is associated with remnant Tallgrass Woodland (TPW1), Tallgrass Savanna (TPS1), and Sand Barrens (SB) (COSEWIC 2020). Individuals are localized and occupy the same habitat throughout their life cycle. The authors have observed that key features of its habitat include well-drained sandy soils, dry leaf litter, low shrubs or saplings, and availability of sunlight at ground level. As a result, most observations of this species are along forest edges, in forest openings, and along forest access roads and trails (COSEWIC 2020). Based on negative searches for this species in restored³ oak savanna habitat, the COSEWIC status report suggests that the species is slow (or unable) to colonize newly available habitat patches, or that these restored habitats are not suitable. However, the discovery of Davis's Shieldback at restored habitats adjacent to forests or hedgerows in 2021 suggest that colonization is possible where habitat connectivity is present. At all newly discovered sites, Davis's Shieldback individuals were observed along edge habitats, perched on low-growing vegetation (often saplings of Black Oak (*Quercus velutina*)) in areas with sandy substrates.

1.5 Limiting factors

The limiting factors affecting the persistence of the Davis's Shieldback are uncertain. In Canada, the species is located at the northern limit of its range, where factors such as climate, soil conditions, ground cover and vegetation may limit its occurrence (COSEWIC 2020). Being a flightless katydid, this species has a limited dispersal capacity. In highly fragmented agricultural landscapes, insect species with limited dispersal capability may be susceptible to localized events or management activities,

³ Restored habitat refers the purposeful rehabilitation of an area to recreate a functioning tallgrass ecosystem.

such as wildfires and prescription burns (Panzer 2002); however, habitat management actions such as appropriately timed prescribed burning may be warranted for the species (see 1.6 Threats to survival and recovery).

1.6 Threats to survival and recovery

Due to the limited detailed information on the species biology, assessing direct threats to the Davis's Shieldback is challenging. However, habitat loss and degradation are considered the most significant threats to all Canadian subpopulations (COSEWIC 2020). In general, Orthopterans that are large bodied, flightless, and habitat specialists tend to be threatened by habitat loss and resulting anthropogenic influences (Samways and Lockwood 1998). Historical habitat loss associated with widescale agricultural development and the loss of grasslands and shrublands are a commonly cited threat to Orthopteran communities (Krištín and Štefan 2014; Hochkirch et al. 2016). Factors contributing to habitat degradation and indirect loss for Davis's Shieldback include fire suppression, natural forest succession, inappropriate afforestation and invasive alien plant and forest pest species (COSEWIC 2020). In addition to habitat type (e.g., oak woodland, savanna, sand barren), the structure of the vegetation appears to be an important consideration for Davis's Shieldback. Low growing shrubs and availability of sunlight have been observed to be of importance to the species. Therefore, any activities or processes that alter habitat composition and/or structure could negatively impact Davis's Shieldback.

Succession - Fire and Fire Suppression

The most widespread and continuing threat to Davis's Shieldback (and their rare habitats generally) is ecosystem modifications associated with fire suppression and resulting canopy closure and/or changes in vegetation structure. Fire suppression practices can degrade the open woodland, savanna, and sand barren habitats of the Davis's Shieldback, as fire-sensitive native and non-native trees and shrubs such as pine (*Pinus spp.*), dogwood (*Cornus spp.*) and poplar (*Populus spp.*) invade openings and create a dense understory. Fire itself is not considered a threat to Davis's Shieldback (COSEWIC 2020). Prescription burns in southern Ontario are usually carried out in early spring when this species is inactive and underground in its egg stage. Late-season prescribed fire, which would be unusual in Norfolk County, could potentially harm nymphs and adults, which would be vulnerable to fast moving ground fires (COSEWIC 2020). *Conducting Prescribed Burns in Species at Risk Habitats* (Linton and Deacon 2023) provides specific Best Management Practices for insect species at risk that occur in tallgrass habitats to help mitigate direct risk of fire.

Succession - Oak Regeneration Failure

There is extensive literature describing widespread oak regeneration failures and the replacement of oaks by mesophytic hardwood species (Abrams and Downs 1990; Aldrich et al. 2005; Healy et al. 1997; Schuler and Gillespie 2000; Woodall et al. 2008; Nowacki and Abrams 2008). These large-scale changes in habitat structure have

resulted in oak-pine dominated woodlands and forests being replaced with fire-resistant hardwood forests. The increased shading and mesophication alters the vegetation structure and composition, rendering the habitat unsuitable for the Davis's Shieldback (COSEWIC 2020). One study in Norfolk County, Ontario (Backus Woods), demonstrated a significant decline in White Oak (*Quercus alba*) over the last 30 years, while Red Maple (*Acer rubrum*) has significantly increased (Kirk et al. 2020). This has a direct impact not only on the vegetation assemblage but also the diversity of wildlife, as American Beech (*Fagus grandifolia*) and maple (*Acer* spp.), common oak-replacement trees, support considerably fewer native insect and bird species (Brose et al. 2013).

Invasive species

Some of the most problematic invasive woody plants of Ontario tallgrass ecosystems are Scotch Pine (*Pinus sylvestris*), Black Locust (*Robinia pseudoacacia*), non-native honeysuckles (*Lonicera* spp.), Common Buckthorn (*Rhamnus cathartica*), Autumn Olive (*Elaeagnus umbellata*), and Russian Olive (*Elaeagnus angustifolia*) (Tallgrass Ontario 2019). These aggressive alien species can out-compete native tallgrass species for resources and can quickly take over entire habitats, displacing species at risk that depend on them (Linton and Deacon 2023). Their presence is therefore a likely threat to Davis's Shieldback.

Given that mature and immature oaks are an important structural component of Davis's Shieldback habitat, Oak Wilt (*Bretziella fagacearum*) is considered an important emerging threat to the species. Oak Wilt is a fungal pathogen that kills thousands of oak trees in North America each year and is spread through underground root grafts, and over longer distances by sap beetles and bark-feeding beetles (Ontario Invasive Species Awareness Program 2012). Trees in the Red Oak group (Red Oak, Black Oak, Northern Pin Oak (*Quercus ellipsoidalis*), and Pin Oak (*Q. palustris*)) are particularly susceptible to the disease and can die very quickly. Members of the White Oak group (White Oak, Bur Oak (*Q. macrocarpa*) and Dwarf Chinquapin Oak (*Q. prinoides*)) are less susceptible and show a slower decline (DiGasparro 2022). This pathogen has recently spread into Ontario with localized detections in Niagara Region and Simcoe County in June 2023 (Invasive Species Centre 2023). It has also been documented in Detroit USA, in close proximity to the international border at Windsor, Ontario (DiGasparro 2022).

Spongy Moth (*Lymantria dispar*) may negatively impact Davis's Shieldback due to severe oak defoliation during cyclical outbreaks occurring at approximately 8 to 10 year intervals (MNR 2023). Spongy Moth is a non-native forest pest that has been established in Norfolk County for over 40 years (COSEWIC 2020). It can cause increased (but not extreme) oak mortality and can substantially alter canopy cover and oak leaf availability in outbreak years. Both Spongy Moth and Oak Wilt can impact Davis's Shieldback habitat quality and quantity (COSEWIC 2020).

Recreational Activities

Unauthorized motorized recreational vehicles and ATV use can have detrimental effects, including direct mortality, soil disturbance and the introduction of invasive plants (COSEWIC 2020). The COSEWIC Status report describes that frequent unauthorized motorized recreational vehicle use is ongoing in occupied habitat at two sites and occasional ATV use is ongoing at several other sites, however the impact of these activities is low. This is because only parts of the sites are affected, the activity is typically during the day when katydids are not as active, and relatively few individuals are anticipated to be directly harmed (COSEWIC 2020). Walking and light trail use occurs at most known locations in or adjacent to Davis's Shieldback habitat, however, this activity is not considered a threat to the species.

Industrial and Commercial Development

Ongoing industrial development near the Simcoe West subpopulation poses a threat to the persistence of Davis's Shieldback in this area due to the direct loss of habitat and indirectly through habitat degradation (e.g., increase in invasive species and recreational activities) (COSEWIC 2020). The extent of suitable habitat remaining is very limited and the current occupancy of the species is unknown. Davis's Shieldback is unlikely to be impacted by noise or light pollution associated with industrial development as its acoustic signaling occurs over short distances and this species is not attracted to lights (COSEWIC 2020).

Afforestation

Inappropriate afforestation with conifer trees, sometimes driven by government incentive programs encouraging carbon sequestering and increased forest cover, can also result in loss of open habitats required by the Davis's Shieldback (COSEWIC 2020). This is a continuing threat at some privately owned sites occupied by Davis's Shieldback within the Turkey Point and St. Williams Forest-Backus Woods subpopulations (COSEWIC 2020).

1.7 Knowledge gaps

In general, there is a lack of knowledge about Davis's Shieldback biology. This lack of knowledge directly influences recovery efforts. For example, specific habitat needs for Davis's Shieldback are difficult to determine, aside from assuming a general trend of loss due to historical or ongoing land conversion and improper habitat management across the species' range. Other uncertainties exist about this species' biology, including its habitat use, microhabitat requirements, specific food preference, and interactions with pathogens and parasites. Furthermore, there is currently no direct information on abundance or population trends available for this species. As a result, demographic trends are inferred based on the known threats of habitat loss and degradation. The rate at which invasive species, fire suppression and afforestation are degrading dry oak woodlands, savannas, and sand barren habitats, which are vital for

the Davis's Shieldback, is uncertain. Similarly, the effectiveness of management activities such as prescription burns in mitigating these threats is also uncertain.

There are currently no formalized survey protocols for Davis's Shieldback and the species would benefit from filling in knowledge gaps about the most effective survey methods to detect adult males and females as well as nymphs.

As a result of recent field surveys, general information on the current distribution of Davis's Shieldback in Norfolk County is available. Additional surveys in this region are needed to:

- determine the status of Davis's Shieldback at the Simcoe West subpopulation;
- monitor persistence, population size, and habitat use at occupied sites;
- monitor for natural dispersal in areas where habitat connectivity and habitat availability have increased.

Suitable habitat (barrens) in the Frontenac Arch and Thousand Islands areas in eastern Ontario should also be surveyed as the species is present in New York state within 20 km of the international border.

1.8 Recovery actions completed or underway

Conservation Planning and Habitat Improvements

The Long Point Walsingham Forest Priority Place (LPWF PP), which encompasses all known subpopulations of Davis's Shieldback, is designated as one of the 11 priority places in Canada by Environment and Climate Change Canada (ECCC). LPWF PP has many species at risk and a highly-engaged local conservation community that has prioritized the restoration of tallgrass prairie and oak savanna ecosystems (NRSI 2023).

Several organizations and agencies have been working to protect and restore tallgrass habitats, including oak savanna and oak woodlands, in Norfolk County for many decades. Prescribed burns to restore and improve oak savanna habitat have been carried out by provincial government agencies at Turkey Point Provincial Park and what is now the St. Williams Conservation Reserve since 1994 (A. Heagy, pers. obs.). The Nature Conservancy of Canada is managing over 2,400 hectares of land in Norfolk County for biodiversity conservation and have installed tallgrass habitat on more than 800 hectares of former marginal agricultural lands (L. Monck-Whipp, pers. comm. 2023). ALUS Norfolk is working with the local agricultural community to establish and maintain pockets of tallgrass habitat in Norfolk County (ALUS 2023).

The restoration of these threatened ecosystems, especially oak savanna habitat, is likely contributing to the conservation and recovery of Davis's Shieldback. The three newly discovered sites for Davis's Shieldback all occur within restored habitats owned and managed by the Nature Conservancy of Canada, within close proximity (~3 km) to known sites at the St. Williams Conservation Reserve (J. Linton and M. Gartshore pers.

obs.). These sites were likely colonized by existing subpopulations hanging on in degraded habitat (i.e., oak woodland edges adjacent to tobacco fields). The Nature Conservancy of Canada considers species at risk in their property management planning which can trigger a variety of conservation actions, often related to provincial government response statements or recovery strategies, and federal recovery strategies such as additional targeted land securement, habitat restoration, documenting new occurrences, supporting research/monitoring of the species, and/or seeking expert advice on how to support the species (L. Monck-Whipp pers. comm. 2023).

The St. Williams Conservation Reserve is managed by the province and the St. Williams Conservation Reserve Community Council (SWCRCC) to protect and restore the historical vegetation types, including sand barrens, oak savanna and oak woodlands (OMNR 2005). Since 2007, SWCRCC has been undertaking active habitat management at some of the Davis's Shieldback sites, including removal of planted pines, prescribed burning and invasive plant control (SWCR 2017).

Filling in Knowledge Gaps on Distribution

In 2021, the Environment and Climate Change Canada, Canadian Wildlife Service provided funding to the authors (Mary Gartshore and Jessica Linton) to conduct targeted surveys for Davis's Shieldback in southwestern Ontario. This resulted in the known areas thought to contain suitable habitat for the species being surveyed and the discovery of three newly occupied sites (Figure 4).

2.0 Recovery

2.1 Recommended recovery goal

The recommended long-term recovery goal for the Davis's Shieldback is to ensure the persistence and viability of subpopulations and mitigate threats to the species and its habitat in Ontario.

2.2 Recommended protection and recovery objectives

1. Maintain and enhance existing habitat and mitigate threats at occupied sites.
2. Initiate research to fill knowledge gaps related to this species' biology, habitat needs and availability, population abundance and distribution, and threats in Ontario.
3. Create additional suitable habitat with an emphasis on increasing habitat connectivity and overall habitat patch size.
4. Increase awareness of and protection for Davis's Shieldback and its habitat.
5. Where appropriate and feasible, manage subpopulations through augmentation, reintroduction, or assisted colonization of previously unoccupied suitable habitats.

2.3 Recommended approaches to recovery

Table 1. Recommended approaches to recovery of the Davis's Shieldback in Ontario.

Objective 1: Maintain and enhance existing habitat and mitigate threats at occupied sites.

Relative priority	Relative timeframe	Recovery theme	Approach to recovery	Threats or knowledge gaps addressed
Critical	Ongoing	Protection, Management	<p>1.1 At extant sites, actively manage habitat to ensure persistence and expansion of Davis's Shieldback.</p> <ul style="list-style-type: none"> • Develop and modify management activities based on research results as they become available. • Develop site-specific habitat management goals. • Periodic disturbance is required to create and/or maintain habitat for Davis's Shieldback and should be considered (e.g., allowances for prescribed fire, mowing, etc.) in the development of a management plan. • Undertake appropriate management actions (e.g., invasive species control, control woody encroachment, etc.) to maintain and improve existing habitat. • Monitor habitat quantity and quality. • Monitor the effectiveness of management activities. • Identify opportunities to enhance and/or expand existing habitats. 	<p>Threats:</p> <ul style="list-style-type: none"> • Succession - Fire and Fire Suppression • Succession - Oak Regeneration Failure • Invasive species

Recovery Strategy for the Davis's Shieldback in Ontario

Relative priority	Relative timeframe	Recovery theme	Approach to recovery	Threats or knowledge gaps addressed
Necessary	Ongoing	Protection, Management	<p>1.2 At extant sites, actively mitigate threats to ensure the persistence of Davis's Shieldback.</p> <ul style="list-style-type: none"> • Identify site-specific threats and develop appropriate mitigation strategies. • Develop and implement monitoring programs to document success of threat mitigation strategies. • Where appropriate, implement Best Management Practices for conducting prescribed burns in species at risk habitat (e.g., Linton and Deacon 2023). • Monitor the effectiveness of mitigation strategies implemented. 	<p>Threats:</p> <ul style="list-style-type: none"> • All threats

Objective 2: Initiate research to fill knowledge gaps related to this species' biology, habitat needs and availability, population abundance and distribution, and threats in Ontario.

Relative priority	Relative timeframe	Recovery theme	Approach to recovery	Threats or knowledge gaps addressed
Necessary	Short-term	Research	<p>2.1 Conduct research on the general biology, life history and population dynamics of Davis's Shieldback.</p> <ul style="list-style-type: none"> • Collect data on courtship, reproduction, density dependence, mobility, and general life cycle biology. • Conduct research on oviposition to determine clutch size, survival in the wild, typical egg stage length. • Examine relationships with other species (e.g., predators, invasive species, diseases). • Determine what Davis's Shieldback feed on as adults and nymphs. 	<p>Knowledge gaps:</p> <ul style="list-style-type: none"> • General biology • Interactions with other species

Recovery Strategy for the Davis's Shieldback in Ontario

Relative priority	Relative timeframe	Recovery theme	Approach to recovery	Threats or knowledge gaps addressed
Critical	Short-term	Research	<p>2.2 At extant sites, determine specific habitat characteristics supporting the persistence of Davis's Shieldback.</p> <ul style="list-style-type: none"> • Determine habitat requirements for different life stages. • Determine microhabitat requirements (soil moisture, sunlight, leaf litter depth, etc.) to carry out specific life processes (e.g., mating, oviposition). • Determine minimum habitat patch size to support a subpopulation. 	<p>Knowledge gaps:</p> <ul style="list-style-type: none"> • General biology • Habitat use • Microhabitat requirements
Beneficial	Short-term	Research	<p>2.3 Conduct research on dispersal capabilities of Davis's Shieldback.</p> <ul style="list-style-type: none"> • Determine dispersal distance and dispersal habitat connectivity requirements to inform habitat creation/enhancement work. 	<p>Knowledge gaps:</p> <ul style="list-style-type: none"> • General biology • Habitat use

Relative priority	Relative timeframe	Recovery theme	Approach to recovery	Threats or knowledge gaps addressed
Critical	Short-term	Monitoring	<p>2.4 Develop a standardized survey protocol for Davis's Shieldback.</p> <ul style="list-style-type: none"> • The protocol should include a consistent method for documenting both positive (confirmed occurrences) and negative search effort (suitable habitat surveyed but no occurrences documented), presence/absence survey methods, a standardized monitoring protocol, and direction on submission of results to the Natural Heritage Information Centre. • The protocol should also include the most effective detection methods for identifying males, females, and nymphs. • The protocol should identify the most effective way to estimate population size. 	<p>Knowledge gaps:</p> <ul style="list-style-type: none"> • General biology • Microhabitat requirements • Habitat use • Population size and trends • Distribution
Necessary	Short-term	Research	<p>2.5 Conduct research on site-specific threats to Davis's Shieldback.</p> <ul style="list-style-type: none"> • Determine the effects of specific threats and success of mitigation strategies. • Develop and modify management activities based on research results as they become available. 	<p>Threats:</p> <ul style="list-style-type: none"> • All threats <p>Knowledge gaps:</p> <ul style="list-style-type: none"> • Threats

Objective 3: Create additional suitable habitat with an emphasis on increasing habitat connectivity and overall habitat patch size.

Relative priority	Relative timeframe	Recovery theme	Approach to recovery	Threats or knowledge gaps addressed
Necessary	Short-term	Management	<p>3.1 Identify suitable sites for habitat creation or enhancement within the known range of Davis's Shieldback.</p> <ul style="list-style-type: none"> • Focus on areas that result in an overall increase to existing habitat patch size. • Focus on areas that result in increased connectivity between habitat patches to facilitate dispersal. 	<p>Threats:</p> <ul style="list-style-type: none"> • All threats

Objective 4: Increase awareness of and protection for Davis's Shieldback and its habitat.

Relative priority	Relative timeframe	Recovery theme	Approach to recovery	Threats or knowledge gaps addressed
Beneficial	Short-term	Education and Outreach, Communication or Stewardship	<p>4.1 Develop outreach materials about Davis's Shieldback, threats they currently face and opportunities to mitigate threats.</p> <ul style="list-style-type: none"> • Erect educational signage at existing sites with public access. • Engage and train landowners on identifying and reporting occurrences. 	<p>Threats:</p> <ul style="list-style-type: none"> • All threats <p>Knowledge gaps:</p> <ul style="list-style-type: none"> • Distribution

Recovery Strategy for the Davis's Shieldback in Ontario

Relative priority	Relative timeframe	Recovery theme	Approach to recovery	Threats or knowledge gaps addressed
Necessary	Short-term	Education and Outreach, Communication or Stewardship	<p>4.2 Engage landowners in vicinity of extant subpopulations in habitat creation and stewardship for Davis's Shieldback.</p> <ul style="list-style-type: none"> • Develop and distribute outreach materials about the importance and benefits of creating and maintaining habitat for Davis's Shieldback and threats they currently face. • Engage local landowners in monitoring activities. • Offer incentive programs and landowner support for habitat creation or management. 	<p>Threats:</p> <ul style="list-style-type: none"> • All threats <p>Knowledge gaps:</p> <ul style="list-style-type: none"> • Distribution

Objective 5: Where appropriate and feasible, manage subpopulations through augmentation, reintroduction, or assisted colonization of previously unoccupied suitable habitats.

Relative priority	Relative timeframe	Recovery theme	Approach to recovery	Threats or knowledge gaps addressed
Necessary	Long-term	Management, Protection, Research	<p>5.1 Research the feasibility of captive breeding, to augment existing populations, and/or assist colonization of extirpated sites or previously unoccupied sites using captured mated females from extant sites.</p> <ul style="list-style-type: none"> • Based on research on species population viability, dispersal capabilities and/or success of habitat connectivity enhancements, determine if augmentation and/or human-assisted colonization is appropriate to support recovery of Davis's Shieldback. • If deemed appropriate, research the possibility of captive breeding to augment existing populations and/or assisted colonization of unoccupied sites using captured mated females from extant sites. 	<p>Threats:</p> <ul style="list-style-type: none"> • Habitat loss and fragmentation <p>Knowledge gaps:</p> <ul style="list-style-type: none"> • General biology

2.4 Area for consideration in developing a habitat regulation

Under the ESA, a recovery strategy must include a recommendation to the Minister of the Environment, Conservation and Parks on the area that should be considered if a habitat regulation is developed. A habitat regulation is a legal instrument that prescribes an area that will be protected as the habitat of the species. The recommendation provided below by the author will be one of many sources considered by the Minister, including information that may become newly available following the completion of the recovery strategy should a habitat regulation be developed for this species.

It is recommended that the area for consideration for a habitat regulation for Davis's Shieldback encompass all Ecological Land Classification vegetation types where the species is known to be extant⁴, which are typically natural or cultural (restored) Tallgrass Woodland (e.g., TPW1), Tallgrass Savanna (TPS1), and/or Sand Barrens (SBO1, SBS1, SBT1) as defined by Lee et al. (1998). The key attributes required within these vegetation communities are the presence of low-growing shrubs and/saplings (especially Black Oak), well-drained sandy soils, dry leaf litter in or near open areas, and a canopy structure that allows light to penetrate the ground. Based on the inferred dispersal capabilities of Davis's Shieldback, all suitable vegetated areas within 170 metres of the reported occurrence⁵ should also be included in the habitat regulation. Because openings that allow light in are important, forest edges, forest openings, and access roads and trails within these areas should not be excluded from the habitat regulation. Only areas with physical barriers should be excluded⁶.

Periodic disturbance is required to create and/or maintain these habitats and should be considered (e.g., allowances for prescribed fire, mowing, etc.) when assessing allowable activities within the habitat of Davis's Shieldback.

Given that Davis's Shieldback are very localized and occupy the same habitat throughout their life cycle, protecting vegetation communities that support known subpopulations is considered critical to preservation of the species.

⁴ To demonstrate absence at formally occupied sites it is recommended that targeted surveys occur for three consecutive years if suitable habitat is still present.

⁵ Based on a mark-recapture study by Gangwere (1966) which found *Atlanticus testaceus* dispersal/movement up to 168 m and that movements were random (i.e., included unsuitable habitat such as marsh and an orchard).

⁶ No physical barriers exist at known sites at the time of this writing.

Glossary

Afforestation: The re-establishment of forested habitat in an area with no tree cover previously.

Committee on the Status of Endangered Wildlife in Canada (COSEWIC): The committee established under section 14 of the *Species at Risk Act* that is responsible for assessing and classifying species at risk in Canada.

Committee on the Status of Species at Risk in Ontario (COSSARO): The committee established under section 3 of the *Endangered Species Act, 2007* that is responsible for assessing and classifying species at risk in Ontario.

Conservation status rank: A rank assigned to a species or ecological community that primarily conveys the degree of rarity of the species or community at the global (G), national (N) or subnational (S) level. These ranks, termed G-rank, N-rank and S-rank, are not legal designations. Ranks are determined by NatureServe and, in the case of Ontario's S-rank, by Ontario's Natural Heritage Information Centre. The conservation status of a species or ecosystem is designated by a number from 1 to 5, preceded by the letter G, N or S reflecting the appropriate geographic scale of the assessment. The numbers mean the following:

- 1 = critically imperiled
- 2 = imperiled
- 3 = vulnerable
- 4 = apparently secure
- 5 = secure
- NR = not yet ranked

Endangered Species Act, 2007 (ESA): The provincial legislation that provides protection to species at risk in Ontario.

Mesophytic: Terrestrial plants adapted to moderate habitats, neither particularly wet or particularly dry habitats.

Ovipositor: A tubular organ of female insects used for depositing eggs.

Species at Risk Act (SARA): The federal legislation that provides protection to species at risk in Canada. This Act establishes Schedule 1 as the legal list of wildlife species at risk. Schedules 2 and 3 contain lists of species that at the time the Act came into force needed to be reassessed. After species on Schedule 2 and 3 are reassessed and found to be at risk, they undergo the SARA listing process to be included in Schedule 1.

Species at Risk in Ontario (SARO) List: The regulation made under section 7 of the *Endangered Species Act, 2007* that provides the official status classification of

species at risk in Ontario. This list was first published in 2004 as a policy and became a regulation in 2008 (Ontario Regulation 230/08).

List of abbreviations

COSEWIC: Committee on the Status of Endangered Wildlife in Canada

COSSARO: Committee on the Status of Species at Risk in Ontario

ESA: Ontario's *Endangered Species Act, 2007*

ISBN: International Standard Book Number

MECP: Ministry of the Environment, Conservation and Parks

SARA: Canada's *Species at Risk Act*

SARO List: Species at Risk in Ontario List

spp.: species

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Personal communications

Giles, E. 2019. In-person correspondence to Mary Gartshore. Naturalist, Norfolk County.

Monck-Whipp, L. 2023. Email correspondence to J. Linton. July 12, 2023. Coordinator, Conservation Biology (Norfolk and Niagara), Nature Conservancy of Canada.