

DRAFT Recovery Strategy for the
Davis's Shieldback
(*Atlantiscus davisii*)
in Ontario



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27 Heritage Information Centre).

28

29

30 **Declaration**

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

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

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

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

47 **Responsible jurisdictions**

48 Ministry of the Environment, Conservation and Parks
49 Environment and Climate Change Canada – Canadian Wildlife Service, Ontario
50

51 **Executive summary**

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

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

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

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

75 In Canada, the Davis's Shieldback is associated with remnant oak woodland, oak
76 savanna and sand barrens, occupying their habitat throughout their annual cycle. Key
77 habitat features that are thought to be important to the species include well-drained
78 sandy soils, dry leaf litter, low shrubs or saplings, and availability of sunlight at ground
79 level. The dispersal capabilities of Davis's Shieldback are unknown, however, the recent
80 (2021) discovery of new locations in restored habitats suggest that colonization of new
81 areas is possible where habitat connectivity is present.

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

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

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

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

102
103 It is recommended that the area for consideration for a habitat regulation for Davis's
104 Shieldback encompass all ecosites where the species is known to be extant and
105 suitable contiguous ecosites within 170m (based on inferred dispersal capabilities). The
106 biophysical attributes of these habitats include:

- 107 • Tallgrass Woodland (e.g., TPW1), Tallgrass Savanna (TPS1), and Sand Barren
108 (SB) Ecological Land Classification vegetation communities on well-drained
109 sandy soils;
- 110 • presence of low-growing shrubs and/or saplings and dry leaf litter in or near open
111 areas;
- 112 • forest edges, forest openings, and along access roads and trails that allow for
113 light penetration to ground-level.

114
115 Periodic disturbance is required to create and/or maintain these habitats and should be
116 considered (i.e., allowances for prescribed fire, mowing, etc.) when assessing allowable
117 activities within the habitat of Davis's Shieldback.

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151 **1.0 Background information**

152 **1.1 Species assessment and classification**

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

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

161 **1.2 Species description and biology**

162 **Species description**

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



174

175

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



176

177

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



178

179

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

180 **Species biology**

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

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

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

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

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

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

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

220 Blatchley 1920; Bland 2003). Because they are flightless, aerial insectivorous predators
221 such as bats and some birds likely do not feed on Davis's Shieldback (COSEWIC
222 2020). Information on direct or indirect competition is not available for this species.

223 **1.3 Distribution, abundance and population trends**

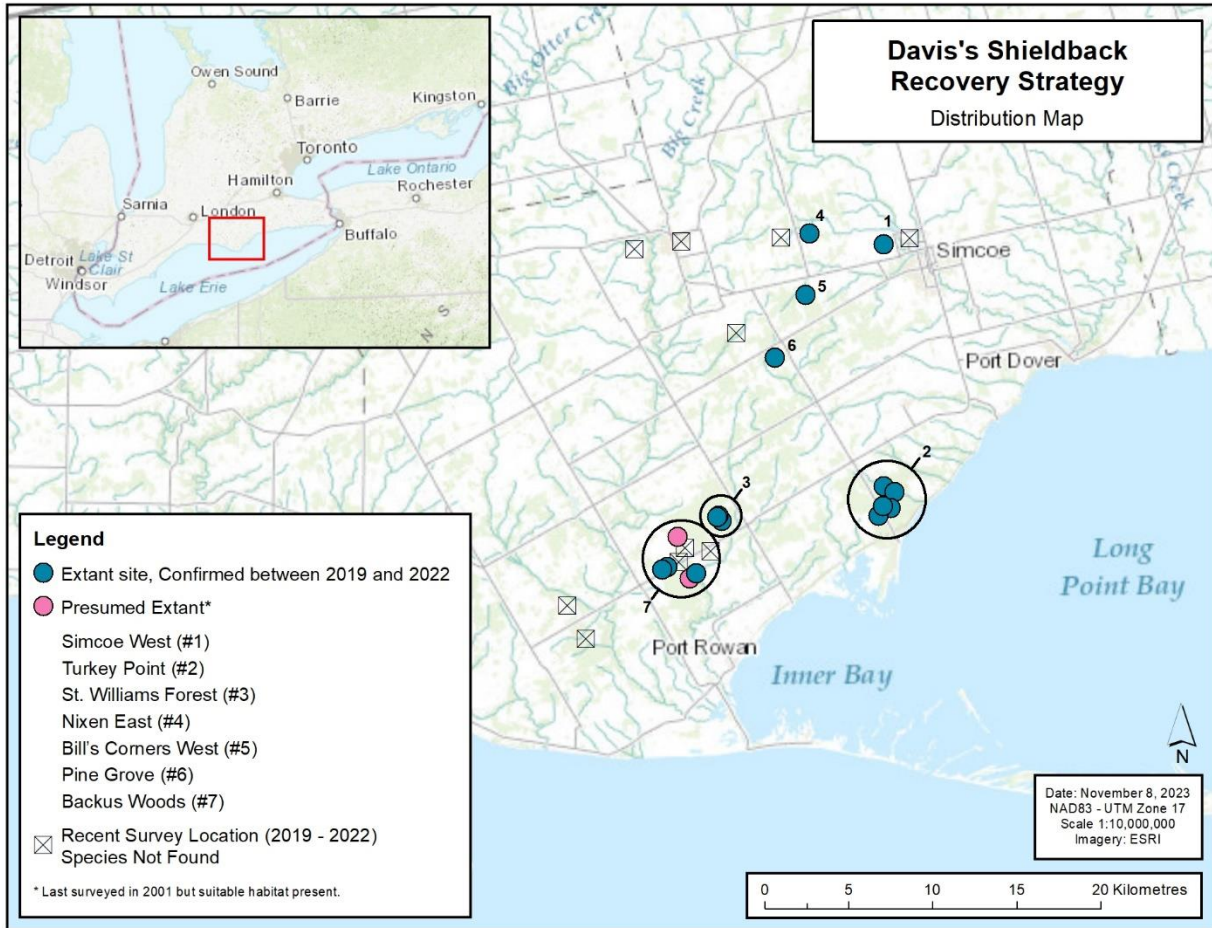
224 The Davis's Shieldback occurs in eastern North America, with their primary range being
225 south of the Great Lakes and extending from Iowa east to Vermont, southwards to
226 North Carolina and west to Arkansas (COSEWIC 2020). Two disjunct populations occur
227 within the Great Lakes basin, in northern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

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

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

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

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



245

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

247

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

256 Abundance estimates for the Davis's Shieldback are unavailable, however the species
 257 seems to be local and rare within its Canadian range. Extrapolation from visual and
 258 audio observations during targeted surveys estimated the number of mature individuals
 259 in Canada to be in the order of 300 to 1,310 individuals (COSEWIC 2020).

260 There is no information on subpopulation trends or fluctuations available for the Davis's
 261 Shieldback. However, this species is inferred to have experienced declines over the last

262 century due to habitat loss and degradation (COSEWIC 2020). Dry oak woodland,
263 savanna, and sand barren habitats in southern Ontario have decreased by over 90%
264 over the last 150 years (Bakowsky and Riley 1992; Tallgrass Ontario 2019). Habitat
265 degradation and loss of savanna communities to agriculture and development likely
266 caused the extirpation of many undocumented subpopulations prior to this species'
267 discovery (COSEWIC 2020). The Davis's Shieldback population in Ontario is presumed
268 to be in decline due to the ongoing habitat loss and degradation. Rescue or
269 recolonization from the United States population is unlikely due to its limited dispersal
270 capacity to move long distances as a flightless katydid and unsuitable surrounding
271 habitat (COSEWIC 2020).

272 **1.4 Habitat needs**

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

287 **1.5 Limiting factors**

288 The limiting factors affecting the persistence of the Davis's Shieldback are uncertain. In
289 Canada, the species is located at the northern limit of its range, where factors such as
290 climate, soil conditions, ground cover and vegetation may limit its occurrence
291 (COSEWIC 2020). Being a flightless katydid, this species has a limited dispersal
292 capacity. In highly fragmented agricultural landscapes, insect species with limited
293 dispersal capability may be susceptible to localized events or management activities,
294 such as wildfires and prescription burns (Panzer 2002); however, habitat management
295 actions such as appropriately timed prescribed burning may be warranted for the
296 species (see 1.6 Threats to survival and recovery).

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

297 **1.6 Threats to survival and recovery**

298 Due to the limited detailed information on the species biology, assessing direct threats
 299 to the Davis's Shieldback is challenging. However, habitat loss and degradation are
 300 considered the most significant threats to all Canadian subpopulations (COSEWIC
 301 2020). In general, Orthopterans that are large bodied, flightless, and habitat specialists
 302 tend to be threatened by habitat loss and resulting anthropogenic influences (Samways
 303 and Lockwood 1998). Historical habitat loss associated with widescale agricultural
 304 development and the loss of grasslands and shrublands are a commonly cited threat to
 305 Orthopteran communities (Krištín and Štefan 2014; Hochkirch et al. 2016). Factors
 306 contributing to habitat degradation and indirect loss for Davis's Shieldback include fire
 307 suppression, natural forest succession, inappropriate afforestation and invasive alien
 308 plant and forest pest species (COSEWIC 2020). In addition to habitat type (e.g., oak
 309 woodland, savanna, sand barren), the structure of the vegetation appears to be an
 310 important consideration for Davis's Shieldback. Low growing shrubs and availability of
 311 sunlight have been observed to be of importance to the species. Therefore, any
 312 activities or processes that alter habitat composition and/or structure could negatively
 313 impact Davis's Shieldback.

314 ***Succession - Fire and Fire Suppression***

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

329 ***Succession - Oak Regeneration Failure***

330 There is extensive literature describing widespread oak regeneration failures and the
 331 replacement of oaks by mesophytic hardwood species (Abrams and Downs 1990;
 332 Aldrich et al. 2005; Healy et al. 1997; Schuler and Gillespie 2000; Woodall et al. 2008;
 333 Nowacki and Abrams 2008). These large-scale changes in habitat structure have
 334 resulted in oak-pine dominated woodlands and forests being replaced with fire-resistant
 335 hardwood forests. The increased shading and mesophication alters the vegetation
 336 structure and composition, rendering the habitat unsuitable for the Davis's Shieldback
 337 (COSEWIC 2020). One study in Norfolk County, Ontario (Backus Woods),
 338 demonstrated a significant decline in White Oak (*Quercus alba*) over the last 30 years,

339 while Red Maple (*Acer rubrum*) has significantly increased (Kirk et al. 2020). This has a
340 direct impact not only on the vegetation assemblage but also the diversity of wildlife, as
341 American Beech (*Fagus grandifolia*) and maple (*Acer* spp.), common oak-replacement
342 trees, support considerably fewer native insect and bird species (Brose et al. 2013).

343 ***Invasive species***

344 Some of the most problematic invasive woody plants of Ontario tallgrass ecosystems
345 are Scotch Pine (*Pinus sylvestris*), Black Locust (*Robinia pseudoacacia*), non-native
346 honeysuckles (*Lonicera* spp.), Common Buckthorn (*Rhamnus cathartica*), Autumn Olive
347 (*Elaeagnus umbellata*), and Russian Olive (*Elaeagnus angustifolia*) (Tallgrass Ontario
348 2019). These aggressive alien species can out-compete native tallgrass species for
349 resources and can quickly take over entire habitats, displacing species at risk that
350 depend on them (Linton and Deacon 2023). Their presence is therefore a likely threat to
351 Davis's Shieldback.

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

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

373 ***Recreational Activities***

374 Unauthorized motorized recreational vehicles and ATV use can have detrimental
375 effects, including direct mortality, soil disturbance and the introduction of invasive plants
376 (COSEWIC 2020). The COSEWIC Status report describes that frequent unauthorized
377 motorized recreational vehicle use is ongoing in occupied habitat at two sites and
378 occasional ATV use is ongoing at several other sites, however the impact of these
379 activities is low. This is because only parts of the sites are affected, the activity is

380 typically during the day when katydids are not as active, and relatively few individuals
381 are anticipated to be directly harmed (COSEWIC 2020). Walking and light trail use
382 occurs at most known locations in or adjacent to Davis's Shieldback habitat, however,
383 this activity is not considered a threat to the species.

384 ***Industrial and Commercial Development***

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

393 ***Afforestation***

394 Inappropriate afforestation with conifer trees, sometimes driven by government
395 incentive programs encouraging carbon sequestering and increased forest cover, can
396 also result in loss of open habitats required by the Davis's Shieldback (COSEWIC
397 2020). This is a continuing threat at some privately owned sites occupied by Davis's
398 Shieldback within the Turkey Point and St. Williams Forest-Backus Woods
399 subpopulations (COSEWIC 2020).

400 **1.7 Knowledge gaps**

401 In general, there is a lack of knowledge about Davis's Shieldback biology. This lack of
402 knowledge directly influences recovery efforts. For example, specific habitat needs for
403 Davis's Shieldback are difficult to determine, aside from assuming a general trend of
404 loss due to historical or ongoing land conversion and improper habitat management
405 across the species' range. Other uncertainties exist about this species' biology,
406 including its habitat use, microhabitat requirements, specific food preference, and
407 interactions with pathogens and parasites. Furthermore, there is currently no direct
408 information on abundance or population trends available for this species. As a result,
409 demographic trends are inferred based on the known threats of habitat loss and
410 degradation. The rate at which invasive species, fire suppression and afforestation are
411 degrading dry oak woodlands, savannas, and sand barren habitats, which are vital for
412 the Davis's Shieldback, is uncertain. Similarly, the effectiveness of management
413 activities such as prescription burns in mitigating these threats is also uncertain.

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

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

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

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

427 **1.8 Recovery actions completed or underway**

428 **Conservation Planning and Habitat Improvements**

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

434 Several organizations and agencies have been working to protect and restore tallgrass
435 habitats, including oak savanna and oak woodlands, in Norfolk County for many
436 decades. Prescribed burns to restore and improve oak savanna habitat have been
437 carried out by provincial government agencies at Turkey Point Provincial Park and what
438 is now the St. Williams Conservation Reserve since 1994 (A. Heagy, pers. obs.). The
439 Nature Conservancy of Canada is managing over 2,400 hectares of land in Norfolk
440 County for biodiversity conservation and have installed tallgrass habitat on more than
441 800 hectares of former marginal agricultural lands (L. Monck-Whipp, pers. comm.
442 2023). ALUS Norfolk is working with the local agricultural community to establish and
443 maintain pockets of tallgrass habitat in Norfolk County (ALUS 2023).

444 The restoration of these threatened ecosystems, especially oak savanna habitat, is
445 likely contributing to the conservation and recovery of Davis's Shieldback. The three
446 newly discovered sites for Davis's Shieldback all occur within restored habitats owned
447 and managed by the Nature Conservancy of Canada, within close proximity (~3 km) to
448 known sites at the St. Williams Conservation Reserve (J. Linton and M. Gartshore pers.
449 obs.). These sites were likely colonized by existing subpopulations hanging on in
450 degraded habitat (i.e., oak woodland edges adjacent to tobacco fields). The Nature
451 Conservancy of Canada considers species at risk in their property management
452 planning which can trigger a variety of conservation actions, often related to provincial
453 government response statements or recovery strategies, and federal recovery
454 strategies such as additional targeted land securement, habitat restoration,
455 documenting new occurrences, supporting research/monitoring of the species, and/or

456 seeking expert advice on how to support the species (L. Monck-Whipp pers. comm.
457 2023).

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

464 **Filling in Knowledge Gaps on Distribution**

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

470

471 **2.0 Recovery**

472 **2.1 Recommended recovery goal**

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

476 Recommended protection and recovery objectives

- 477 1. Maintain and enhance existing habitat and mitigate threats at occupied sites.
478 2. Initiate research to fill knowledge gaps related to this species' biology, habitat
479 needs and availability, population abundance and distribution, and threats in
480 Ontario.
481 3. Create additional suitable habitat with an emphasis on increasing habitat
482 connectivity and overall habitat patch size.
483 4. Increase awareness of and protection for Davis's Shieldback and its habitat.
484 5. Where appropriate, augment existing subpopulations and/or assist colonization in
485 previously unoccupied suitable habitats.

486 **2.2 Recommended approaches to recovery**

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

488 Objective 1: Maintain and enhance existing habitat and mitigate threats at occupied
489 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 (i.e., 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 • Invasive species

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

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492 Objective 2: Initiate research to fill knowledge gaps related to this species' biology,
 493 habitat needs and availability, population abundance and distribution, and threats in
 494 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

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

496 Objective 3: Create and enhance suitable habitat with an emphasis on increasing
 497 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

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511 Objective 4: Increase awareness of and protection for Davis's Shieldback and its
 512 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

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

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516 Objective 5: Where appropriate and feasible, manage populations through
 517 augmentation, reintroduction, or assisted colonization of previously unoccupied suitable
 518 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"> • Feasibility of conservation management tools

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521 **2.3 Area for consideration in developing a habitat regulation**

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

529
530 It is recommended that the area for consideration for a habitat regulation for Davis's
531 Shieldback encompass all ecosites where the species is known to be extant⁴, which are
532 typically natural or cultural (restored) Tallgrass Woodland (e.g., TPW1), Tallgrass
533 Savanna (TPS1), and/or Sand Barren (SB) Ecological Land Classification ecosites as
534 defined by Lee et al. (1998). The key attributes required within these ecosites required
535 are the presence of low-growing shrubs and/saplings (especially Black Oak), well-
536 drained sandy soils, dry leaf litter in or near open areas, and a canopy structure that
537 allows light to penetrate the ground. Based on the inferred dispersal capabilities of
538 Davis's Shieldback, all unoccupied contiguous suitable ecosites within 170 metres of
539 the reported occurrence⁵ should also be included in the habitat regulation. Because
540 openings that allow light in are important, forest edges, forest openings, and access
541 roads and trails within these ecosites should not be excluded from the habitat
542 regulation.

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

547
548 Given that Davis's Shieldback are very localized and occupy the same habitat
549 throughout their life cycle, protecting ecosites that support known populations is
550 considered critical to preservation of the species.

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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 *Atlantiscus testaceus* dispersal/movement up to 168 m and that movements were random (i.e., included unsuitable habitat such as marsh and an orchard).

555 **Glossary**

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

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

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

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

- 572 1 = critically imperiled
- 573 2 = imperiled
- 574 3 = vulnerable
- 575 4 = apparently secure
- 576 5 = secure
- 577 NR = not yet ranked

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

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

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

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

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

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

593 **List of abbreviations**

594 COSEWIC: Committee on the Status of Endangered Wildlife in Canada

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

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

597 ISBN: International Standard Book Number

598 MECP: Ministry of the Environment, Conservation and Parks

599 SARA: Canada's *Species at Risk Act*

600 SARO List: Species at Risk in Ontario List

601 spp.: species

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