Canadian Journal of
Fisheries and
Aquatic Sciences

Perspective

Plight of the endangered redside dace (*Clinostomus elongatus*) in Canada: end of the road?

Donald A. Jackson[a] **and Nicholas E. Mandrak**[b]

[a]Department of Ecology and Evolutionary Biology, University of Toronto, Toronto, ON M5S 3B2, Canada; [b]Department of Biological Sciences, University of Toronto Scarborough, Toronto, ON M1C 1A4, Canada

Corresponding author: **Donald A. Jackson** (email: don.jackson@utoronto.ca)

Abstract

Conservation of biodiversity is recognized as a priority, with many jurisdictions having legislation protecting species at risk. Such protections are of value only if they are enforced, regardless of the strength of the laws. Redside dace (*Clinostomus elongatus*) is a fish listed as endangered by both the Canadian and Ontario governments. We review the biological characteristics and the threats that contribute to its vulnerability and the reductions in its population status during recent decades. Initiatives related to infrastructure developments present risks to core redside dace populations, raising questions regarding the future of this species, and other federally listed species, in Canada. Proposed developments and modifications of protection to at-risk species by the Government of Ontario show little regard for the Ontario *Endangered Species Act,* and it is unclear whether the Government of Canada will enforce protections of its own *Species at Risk Act*. Redside dace provides an exemplar of challenges facing conservation-based legislation and the willingness of governments to enforce their own legal frameworks or challenge those of lower levels of government.

Key words: conservation, endangered species, fish, species at risk

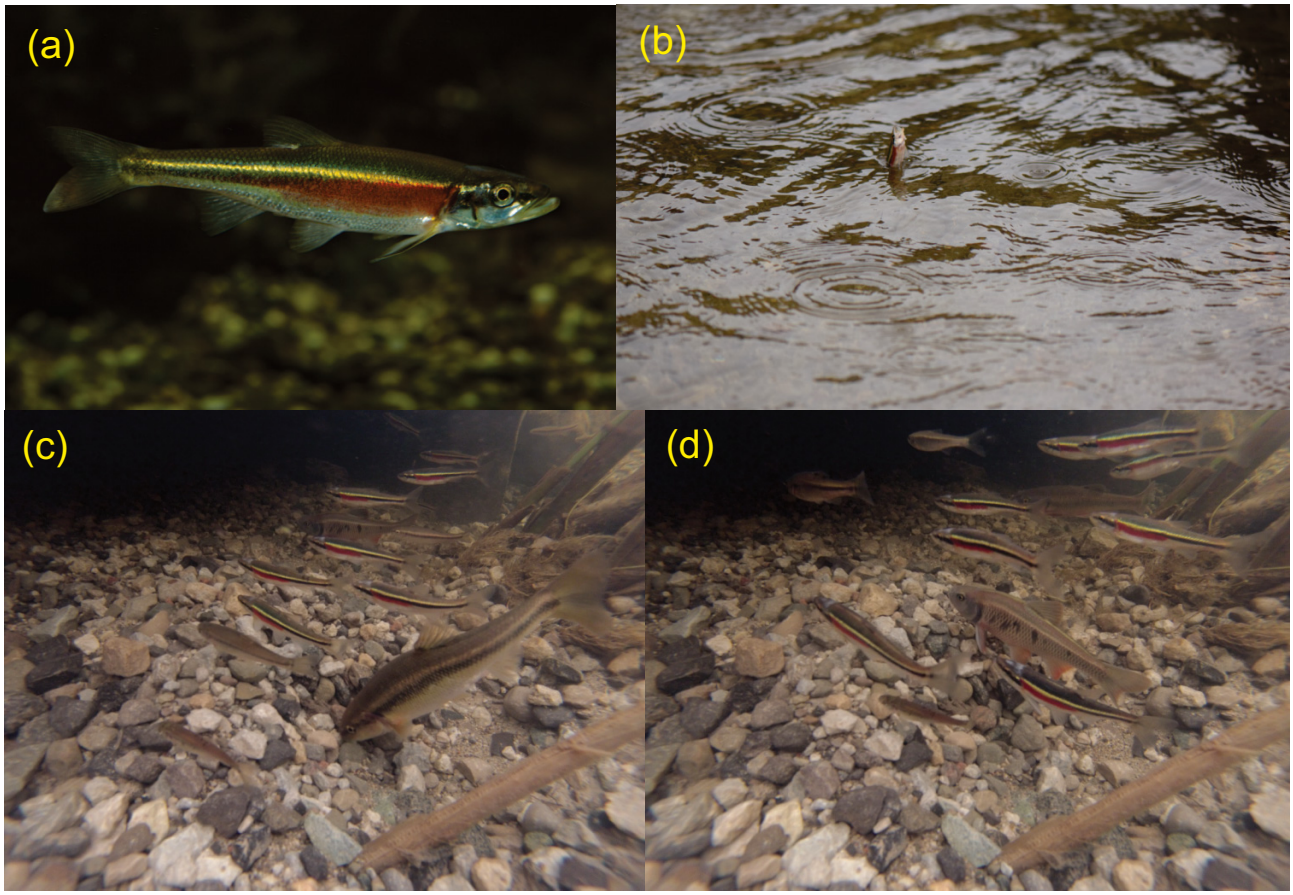
Introduction

The identification of species of conservation concern, their protection, and strategies for their recovery are critical issues to maintaining global biodiversity and addressing international agreements, such as the United Nations Convention on Biodiversity. Most countries signed this agreement, including Canada, which implemented its *Species at Risk Act* (2002) in 2003. The goal of the *Species at Risk Act* (SARA) is to "*prevent wildlife* [in Canada] *from being extirpated or becoming extinct, to provide for the recovery of wildlife species that are extirpated, endangered or threatened as a result of human activity and to manage species of special concern to prevent them from becoming endangered or threatened*." Most provinces and territories within Canada have some form of similar legislation and protection or formal agreements with the federal government to implement SARA (Gordon et al. 2024). For example, the stated purpose of the Ontario Endangered Species Act (2007) is "*[t]o identify species at risk based on the best available scientific information…[t]o protect species that are at risk and their habitats, and to promote the recovery of species that are at risk…*[and] *[t]o promote stewardship activities to assist in the protection and recovery of species that are at risk.*" With the passing of SARA and similar sub-national commitments to protect species at risk of extinction, there appeared to be a broad and strong commitment to the recognition, protection, and restoration of species of conservation concern. However, the processes of listing species assessed by the Committee on the Status of Wildlife in Canada (COSEWIC), developing recovery strategies, implementing recovery actions, and enforcing protections under SARA have been fraught with difficulties (e.g., Mooers et al. 2007; Ferreira et al. 2019; Mandrak 2025). Here, we exemplify these difficulties using redside dace (*Clinostomus elongatus*), listed federally as an Endangered species under SARA and similarly listed under the Ontario *Endangered Species Act* (ESA). We provide background information on the biology and conservation status assessments of this species and identify how both levels of government appear to be failing to uphold their legal responsibilities related to this species. While we focus on this species, both the anthropogenic threats leading to its listing and the current issues associated with its protection and recovery provide an example of what could happen more broadly to other taxa in Ontario, Canada, and elsewhere.

Biology

Redside dace is a small, colourful minnow (mean length 7.5 cm, maximum length 12 cm, Fig. 1) in the family Leuciscidae (Holm et al. 2022). It is found in streams and smaller rivers within its North American geographic range, frequently in slower-moving, deeper reaches (e.g., headwater stream pools, McKee and Parker 1982; Poos et al. 2012). Individuals have been shown to use a sequence of pools as their primary habitat, with movements among pools frequently

Fig. 1. Photographs showing (*a*) redside dace; (*b*) feeding by redside dace on aerial insects; and (*c–d*) redside dace with Creek Chub and Common Shiner. Redside dace spawn in the nests of both species. Photo credits: (*a*) Shuterstock and (*b–d*) Jon Clayton, Credit Valley Conservation.



occurring (Poos and Jackson 2012), and exhibit a degree of synchronization of such movements in different tributaries (Drake and Poesch 2020). The species occupies shallow systems where ice may be a dominant feature during winter and spring break-up; however, little is known about the spatial dynamics of this species during winter, e.g., does it remain in these areas or seasonally move to deeper waters where ice and scouring present lower risks?

Redside dace is a coolwater species preferring temperatures less than 24 °C (McKee and Parker 1982; Fisheries and Oceans Canada 2024*b*), and adults are more tolerant of higher water temperatures than juveniles (Leclair et al. 2020; Turko et al. 2020). Given its coolwater requirements, groundwater contributions to streams may be important in regulating suitable thermal habitat during summer months. The species is found in streams having high water clarity and, infrequently, with higher levels of turbidity (McKee and Parker 1982; COSEWIC 2017; Fisheries and Oceans Canada 2024*b*). Redside dace is typically found in streams with high dissolved oxygen (e.g., >7 mg/L; McKee and Parker 1982; Fisheries and Oceans Canada 2024*b*). Laboratory studies have shown acute hypoxia can reduce tolerance to elevated water temperatures (Reemeyer and Chapman 2024), but longer-term acclimation reduced this effect.

Redside dace is known to feed extensively on insects on the water surface or airborne with the fish leaping out of the water to capture flying prey (McKee and Parker 1982; Daniels and Wisniewski 1994). Schwartz and Norvell (1958) reported dietary items to be >75% terrestrial insects, primarily dipterans. Adjacent and overhanging terrestrial vegetation likely provide important roles as sources of terrestrial insects to the diet of redside dace (McKee and Parker 1982) and as cover from predation (Novinger and Coon 2000). Individuals tend to locate mid-water column within these relatively shallow pools, likely due to their feeding strategy (McKee and Parker 1982). Winter diet is unknown (Fisheries and Oceans Canada 2024*b*).

Redside dace is a nest associate in its reproductive behavior. During spring, spawning occurs at water temperatures of 16–18 °C typically (COSEWIC 2017; Watt et al. (2023) reported 14.5–16 °C for two populations in southern Ontario), and it deposits its eggs in nests of Common Shiner (*Luxilus cornutus*) and Creek Chub (*Semotilus atromaculatus*) (COSEWIC 2017). These host species excavate shallow nests in gravel substrate, and redside dace time their spawning activities to coincide with those of the host species. The host species keep the nest free of silt and protect eggs from predators by guarding the nests during egg devel-

opment, thus enhancing the survivorship of redside dace eggs.

Decline in redside dace and associated threats

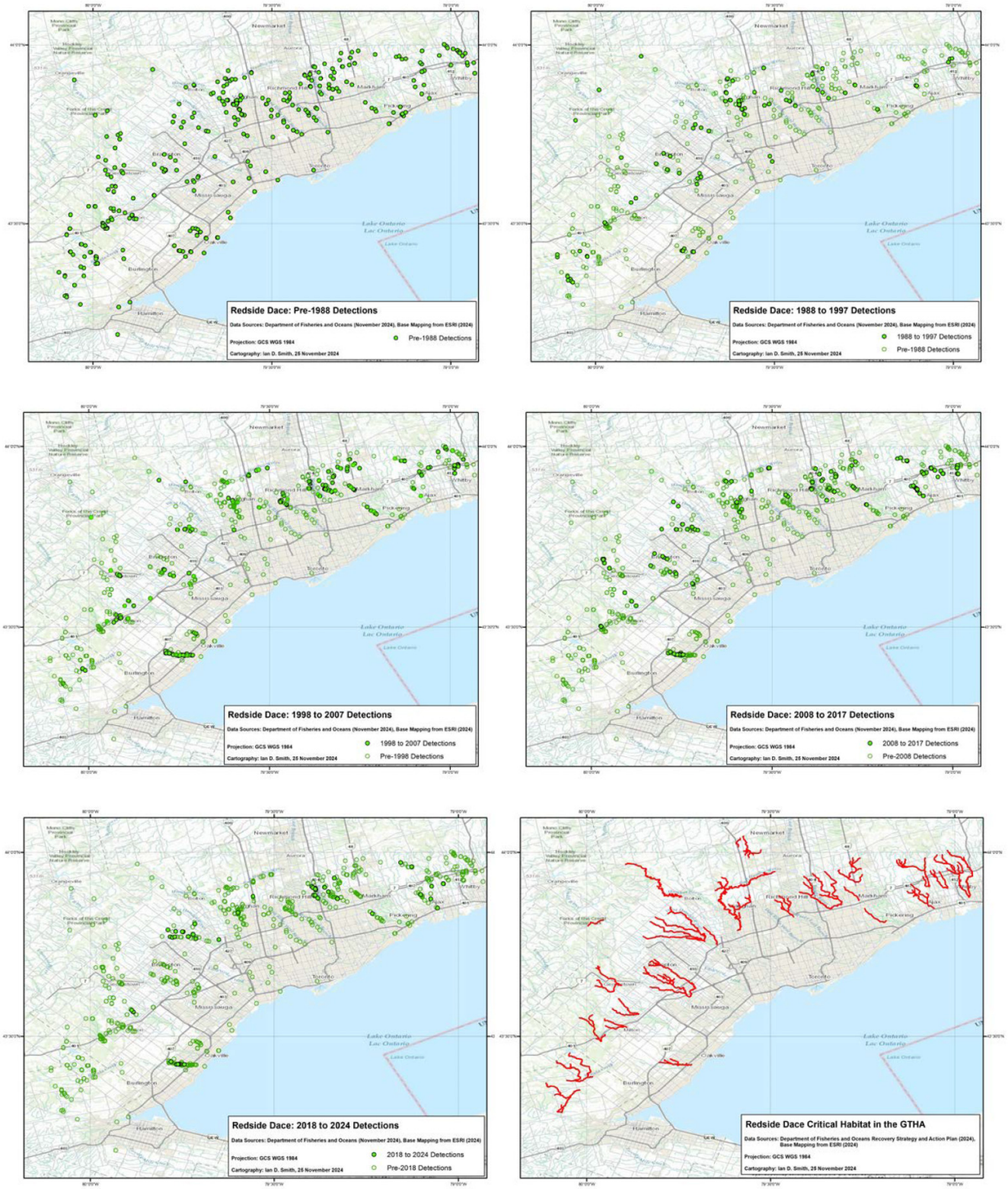
The distribution of the species is both patchy and decreasing throughout its North American range, with consequent declines in its conservation status occurring in many regions. Redside dace has a discontinuous range found entirely within North America, primarily in the upper Mississippi River and Laurentian Great Lakes basins, but ranges from Minnesota in the northwest to Kentucky in the south and Pennsylvania and New York in the northeast. Within Canada, it is restricted to Ontario, predominantly in watersheds draining into western Lake Ontario, with small populations in several Lake Huron watersheds, and one Lake Erie watershed (Fig. 2). Its NatureServe status is: Apparently Secure (S4) in Kentucky, Ohio, and Pennsylvania; Vulnerable (S3) in Minnesota, New York, and Wisconsin; Imperiled (S2) in Michigan; Critically Imperiled (S1) in Indiana, Ontario, and West Virginia; and presumed extirpated in Iowa and Maryland (NatureServe Explorer, accessed 18 July 2024). Within Canada, it was most recently assessed by the Committee on the Status of Endangered Wildlife in Canada in 2017, and listed under SARA in 2017, as Endangered.

In Canada, its disjunct distribution within and among watersheds likely reflects a broader, more continuous original distribution, subsequently fragmented by ongoing human threats. Approximately 80% of its Canadian range lies within the Greater Toronto Area (GTA), where urbanization and its effects degraded and destroyed habitat, and most of these now disjunct populations have experienced significant reductions in both distribution and abundance (COSEWIC 2017). Redside dace was known to occur in 25 watersheds in Ontario but is now extirpated from 9 of them (Table 1). Some of these extirpations occurred as early as the 1920s, but many occurred during the 1950s and, more recently, coincident with urban expansion in the GTA (COSEWIC 2017). As a result of increased targeted sampling effort, a new population was discovered in 2008 in South Gully Creek, a Lake Huron watershed (COSEWIC 2017). Based on local mark-recapture studies (Poos et al. 2012), the population estimate per pool was the highest for the Don River among the watersheds sampled, but was found in very few pools (2 of 27 sampled), and more recent sampling failed to detect the species in the Don River, where it is now considered extirpated (COSEWIC 2017). Redside dace is now considered to be extirpated or in decline in most Ontario watersheds, with population status considered to be stable at only 6 (possibly 7 given lack of recent sampling in South Gully Creek) localities (Fisheries and Oceans Canada 2024*b*). However, sampling at many of the localities in the GTA has been restricted in recent years, making it difficult to assess current population status.

Loss of habitat is the most likely factor contributing to declines in redside dace (COSEWIC 2017; Fisheries and Oceans Canada 2024*b*). The main threats identified for most populations were natural system modifications, pollution, and residential/commercial development—these are closely connected to urbanization (COSEWIC 2017; Lebrun et al. 2020). Surprisingly, the impact of climate change, very likely to exacerbate these threats through changes in water level and both air and water temperatures, was deemed to be largely speculative (Lebrun et al. 2020).

Over the last 50 years, GTA streams with extirpated or declining redside dace populations exhibited trends of decreased contributions of groundwater inputs and increasing variability in hydrological regimes (Reid and Parna 2017). Decreased groundwater contributions will lead to increased water temperatures during summer, potentially proving stressful, or lethal (Hare et al. 2021). Increased hydrologic variability leads to increased erosion, suspended sediments, and turbidity during high flows, but also reduced baseflow conditions between precipitation events (Walsh et al. 2005). Greater flow variability may impact spawning through destruction of nesting sites during high flows and through deposition of fine sediment after flows diminish. Reduced baseflow may contribute to elevated temperatures and to fragmented connections of pool environments (e.g., Juracek et al. 2017), thereby limiting movements among pools with consequences for feeding by, and predation on, redside dace. Land-cover changes during urbanization will increase watershed imperviousness (i.e., covering of ground surfaces with concrete, asphalt, and other impermeable materials), thereby reducing infiltration and groundwater recharge required to moderate water temperatures (Hare et al. 2021). These threats are likely exacerbated by the urban heat island effect and climate change (Naujokaitis-Lewis et al. 2021), but the impacts of these confounding threats on redside dace have not been well studied (COSEWIC 2017). While reduced groundwater contributions will occur as a consequence of these confounding threats, the urban heat island effect can increase temperatures in urban areas by several degrees above the surrounding non-urbanized regions (Tzavali et al. 2015), including up to 3.5 °C increase in groundwater temperatures of urban versus rural sites (Yalcin and Yetemen 2009). The urban heat island effect, coupled with global climate change, will contribute to warmer water temperatures in general, but with greater variability in temperature and precipitation, consistent with the trends identified by Reid and Parna (2017). As a means of mitigating high stream discharges and the resulting flooding, erosion, and sewage by-pass during storm events, storm-water management ponds have been required in new developments in Ontario for several decades. These include areas with redside dace in the GTA currently (e.g., Brampton, Oakville, Pickering) and in the near future in GTA headwaters based on strategic development plans (e.g., York region; York Region 2024). These ponds are designed to retain water for up to 24 h following precipitation events (OMOE 2003) and can contribute to increased temperature of water discharging into the streams during this period of time. In addition, these ponds can serve as reservoirs containing high concentrations of chloride and anoxic waters (Loewen and Jackson 2024) that may be flushed into streams during the initial periods of storm events, providing combinations of multiple stressors (e.g., elevated temperature and chloride concentrations, low dissolved oxygen), particularly during nighttime when anoxic conditions become more prevalent (D.A. Jackson, unpublished data).

Fig. 2. Distribution of redside dace in the Greater Toronto Area, historical to 2024 (A–E), and critical habitat (F) identified in Fisheries and Oceans Canada (2024*b*).



The COSEWIC has done a poor job of incorporating the threat of climate change into conservation assessments, and the redside dace assessment is no exception. Based on a review of the COSEWIC assessment reports, Woo-Durand et al. (2020) found climate change to be the least important threat to the 814 species at risk across 10 taxonomic groups included in their study. Naujokaitis-Lewis et al. (2021) found climate change was identified as a threat for 44.1%,

Table 1. Most recent year of collection, subsequent sampling events, and population status of redside dace in Canada based on Lebrun et al. (2020) and the redside dace distribution database (DFO, unpubl. data).

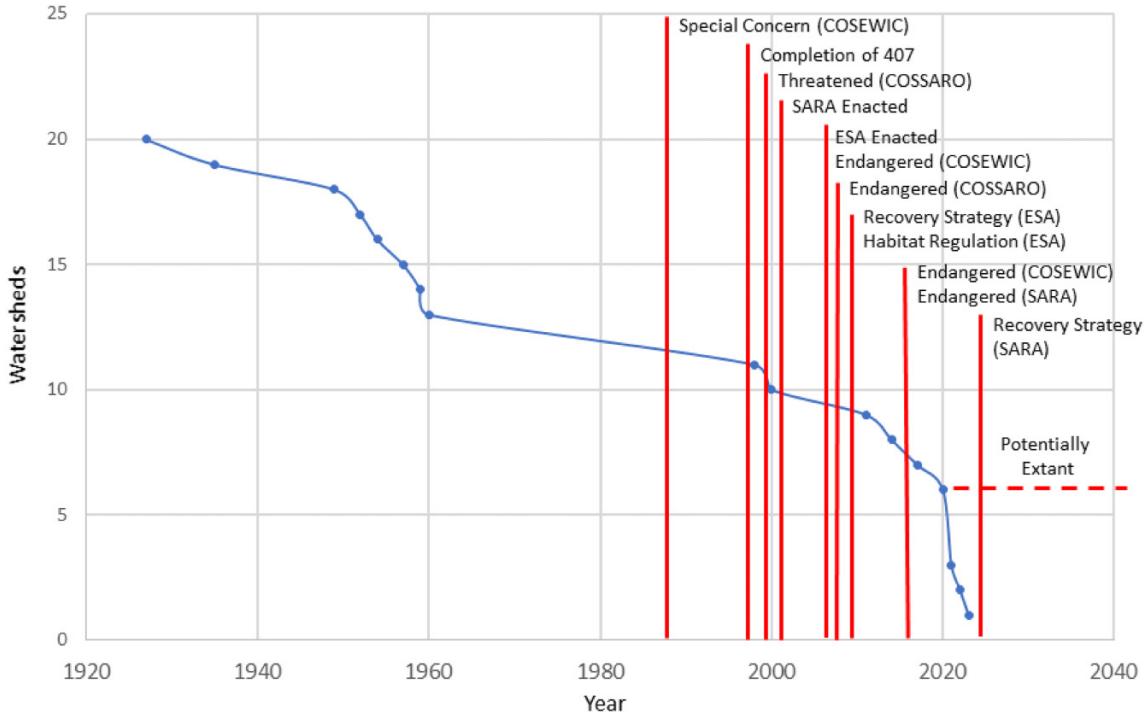
Watershed	Last collected	More recent sampling events	Population status
Lake Ontario Drainage			
Pringle Creek	1959	1985, 1999	Extirpated
Lynde Creek	2014	2014–2023 (following a 2014 chemical spill)	Poor
Carruthers Creek	2020	2021	Fair
Duffins Creek	2021	2023	Poor
Petticoat Creek	1954	1975, 2003, 2005, 2010, 2013, 2016	Extirpated
Rouge River	2022	2023	Poor
Highland Creek	1952		Extirpated
Don River	2011	2017, 2020 (eDNA; Sandhu et al. submitted), 2023	Poor (Extirpated?)
Humber River	2023		Fair
Mimico Creek	1949	Multiple surveys	Extirpated
Etobicoke Creek	1935	Multiple surveys	Extirpated
Clarkson Creek	1927	Multiple surveys	Extirpated
Credit River	2017	2018–2023	Poor
Morrison Creek	2000	2015, 2016	Extirpated
Sixteen Mile Creek	2021	2022, 2023	Poor
Fourteen Mile Creek	2021		Fair
Bronte Creek	1998	Multiple efforts, most recent 2023	Poor (Extirpated?)
Wedgewood Creek	1957		
Spencer Creek	1998	Multiple efforts, most recent 2023	Poor (Extirpated?)
Niagara Peninsula	1960s	Stream no longer exists	Extirpated
Lake Simcoe Drainage			
Holland River	2013, 2014 (eDNA)	2020 (eDNA; Sandhu et al. submitted)	Poor
Lake Erie Drainage			
Irvine Creek	2003	2016, 2018, 2019, 2022	Poor
Lake Huron Drainage			
Gully Creek	2010	2019–2021	Poor
Saugeen River	2004	2006, 2007, 2013, 2019, 2021–2023	Poor
South Gully Creek	2016		Unknown
Unknown Stan J	2020		Unknown
Two Tree River	2019		Fair

and not identified at all for 43.5%, of listed species, and McKelvey and Mandrak (2023) found that climate change was the primary threat for only 35% of 65 freshwater fish species at risk. The most recent COSEWIC (2017) assessment report for redside dace identified that two important components of the species' habitat, water temperature and groundwater discharge, were expected to be impacted by climate change and that the scope for impact in the next 10 years was pervasive and the timing continuous. However, because the severity of impact was deemed unknown, the overall impact of climate change was assessed as unknown.

The Natural System Modifications category in the COSEWIC's threat assessment includes anthropogenic changes to the stream channel or impacts to surrounding areas that may contribute to changes within the channel. Within the channel, there may be low-head dams or perched culverts that contribute to fragmentation of populations and the inability of individuals to move seasonally (e.g., spawning or avoidance of ice during winter and spring break-up) (Edge et al. 2017). Stream water levels may be impacted through removal of water for agricultural irrigation or changes to the water table and ground water contributions to streams as a result of aggregate mining (Fisheries and Oceans Canada 2024*b*). Urbanization also leads to land-use changes that often result in losses of riparian vegetation critical for the insect populations upon which redside dace feed (McKee and Parker 1982).

Pollution from urbanization and agricultural practices represents a significant threat. Chemicals from domestic wastewater treatment plants and surface runoff contribute to chloride loadings (de-icing salt, water softeners—both of which contribute to elevated chloride levels year round; e.g., Lawson and Jackson (2021, 2024)), fertilizers, and pesticides, all of which can directly or indirectly impact redside dace and its habitat and food resources. Some of these impacts may

Fig. 3. Number of watersheds in which redside dace were found in the Greater Toronto Area, 1927–2024, and key conservation events. Counts are based on date of last record in each watershed with subsequent sampling events (see Table 1 for details). Redside dace is potentially extant in watersheds with date of last record since 2020 as limited more recent sampling has occurred.



be chronic, others acute. For example, no individuals have been detected in Lynde Creek since a manure spill occurred in 2014, despite multiple years of targeted sampling (Table 1; COSEWIC 2017; Fisheries and Oceans Canada 2024*b*).

Strictly speaking, the Residential/Commercial Development threat category only relates to the direct loss of habitat, for example, the moving, filling in, burying of urban streams, to residential or commercial development. A major historical factor impacting many of the headwater streams in this area was stream burial where stream flows were directed into underground pipes and the surface area then urbanized. Some large urban areas have experienced the loss of two-thirds of their streams and 70% of the small catchments (Elmore and Kaushal 2008). Stream burial would likely have resulted in the loss of numerous streams in the GTA that were suitable habitat for redside dace (https://www.lostrivers.ca/disappearing.html). As such practices infrequently occur in the GTA now, the species is now more likely to be impacted by modifications to streams than to total loss of habitat. Throughout the headwaters of the GTA streams containing redside dace and/or its critical habitat, there is ongoing residential and commercial development, both at small and large scales, including as parts of the official development plans (e.g., York Region 2024), that further degrades or destroys critical habitat.

We highlight these three threat categories, but additional ones include agriculture (e.g., loss of suitable riparian vegetation, cattle in streams contributing to elevated turbidity), invasive species (e.g., competitors, predators, pathogens), human intrusion (e.g., mortality due to scientific sampling; Castañeda et al. 2020), and biological resource use (e.g., by-catch of bait-fish harvesting) (Fisheries and Oceans Canada 2024*b*). Many of these threats increase together as areas become increasingly urbanized, presenting environments of both multiple stressors and cumulative effects along watercourses.

Past, present, and future of redside dace protection

Past

Redside dace was first assessed by the COSEWIC in 1987 (Parker et al. 1988) as Special Concern (Fig. 3). Because it had not been assessed within the previous five years, the species was not automatically listed under the *Species at Risk Act* when it was enacted in 2002. The COSEWIC reassessed the species as Endangered in 2007 as a result of the loss of three populations and large decline in abundance in eight populations since 1987 (COSEWIC 2007). Despite the SARA requirement of deciding whether to list the species under SARA within nine months after the COSEWIC assessment, redside dace was not listed until 10 years after (13 April 2017) its 2007 assessment. During that time, an additional two populations were lost (Fig. 3). More importantly, during those 10 years, there was no federal recovery strategy nor identification of critical habitat and, hence, no mandated federal funds (e.g., internal, Aboriginal Fund for Species at Risk, Habitat Stewardship Fund) avail-

able for the protection and recovery of the species. Despite being to the detriment of protecting and recovering species at risk of extinction in Canada, delays in SARA listings decisions are the norm (Ferreira et al. 2019) and were highlighted as a major problem by a federal audit of the SARA program (OAG 2022). No reason for the delay was given in the 2017 Order amending Schedule 1 of SARA that outlined the decision to list redside dace. The Order indicated that 90% of the 74 respondents to public consultation (to a consultation workbook with a deadline of 25 April 2007) were in favour of listing and that socio-economic impacts of listing were negligible, which further questions the delay in the listing decision. The Order explicitly indicated that the impact of listing on infrastructure projects is, "*expected to be negligible, as restrictions imposed on infrastructure projects that affect redside dace habitat are already in place due to this species being listed under Ontario's* Endangered Species Act 2007 *and the prohibitions under* SARA *are not anticipated to result in any additional impacts to the delivery and implementation of infrastructure projects.*"

Upon listing as an Endangered species, redside dace became protected by section 32 of SARA, which prohibits killing, harming, harassing, or capturing listed species (Fisheries and Oceans Canada 2024*b*). Under section 73 of SARA, the competent Minister may enter into an agreement or issue a permit authorizing an activity affecting a listed species or any part of its critical habitat if reasonable alternatives have been considered, feasible measures are taken to minimize the impacts of the activity, and the activity will not jeopardize the survival or recovery of the species. Such agreements and permits can only be issued if the activity: (a) is scientific research relating to the conservation of the species and conducted by qualified persons; (b) benefits the species or is required to enhance its survival; or (c) affecting the species is incidental to the carrying out of the activity. Fisheries and Oceans Canada (2020) concluded that all redside dace populations in the GTA, except for Carruthers Creek, had no scope for allowable harm and, hence, agreements or permits could not be issued unless all impacts were fully mitigated. Since 2017, 155 SARA permits related to redside dace have been issued (SARA Registry 2024). A total of 84 were for development projects in or near water, 57 for redside dace monitoring, research, and restoration activities, and 14 for other activities. The extent to which compliance monitoring was undertaken to ensure that the permitted activities did not harm the species or its habitat is not publicly available.

Critical habitat and activities that can be undertaken to protect and recover the species are provided in recovery strategies, which SARA requires to be completed within one year after the SARA listing of endangered species. However, the final redside dace recovery strategy and action plan was not released until July 2024 (Fisheries and Oceans Canada 2024*b*) and the critical habitat order subsequently in December 2024, 7 years after the species was listed under SARA and 6 years after its legal deadline, during which time another three populations were lost, and only after the government was threatened with a lawsuit to release it (Environmental Defence, pers. comm.). Perhaps as troubling as the delays, are the changes in the priorities of the recovery measures in the recovery strategy between the draft posted for public consultation in January 2024 (Fisheries and Oceans Canada 2024*a*) and the final draft posted in July 2024 (Fisheries and Oceans Canada 2024*b*) without associated publicly available explanations for the changes. The changes decreased the priority of 10 of the 23 recovery measures: high to medium for four recovery measures (2, 9, 10, 18); high to low for four measures (7, 13, 21, 22); and, medium to low for two measures (8, 23) (Table A1; Fisheries and Oceans Canada 2024*a*, 2024*b*).

Investigating the impacts of introduced species is one recovery measure that decreased in priority from high to medium despite round goby (*Neogobius melanostomus*), a species well-known to be highly invasive (Kornis et al. 2013), being first found in 2021 in what is now identified as critical habitat in the Rouge River watershed. The recovery strategy recognizes that, "*although there are no studies on Round Goby/Redside Dace interactions, potential impacts of Round Goby on the fish community and on Redside Dace are of concern*", but this recovery measure is not deemed high priority nor is round goby included in the species listed in the measure. In the recovery strategy, the threat level for invasive species in the Rouge watershed is classified as "Low" with high uncertainty; however, because the likelihood of threat occurrence is known and the level of impact is unknown (see above), the threat level should be "Unknown" based on the threat matrix used to determine threat level (Lebrun et al. 2020). More importantly, it appears that no actions have been undertaken to eradicate, control, or, at the very least, study round goby in the critical habitat. Eradication and control measures are generally focused on species perceived as high risk (e.g., round goby) and assets perceived to be of high value (e.g., redside dace (Reaser et al. 2020)) and should be undertaken as soon as possible after detection to maximize effectiveness (Pluess et al. 2012), even if knowledge of potential impacts is limited (Simberloff 2003).

In 2000, the Committee on the Status of Species at Risk in Ontario (COSSARO) assessed redside dace as Threatened and retained its status under the provincial Endangered Species Act (2007) when it came into force in 2008. COSSARO reassessed redside dace as Endangered in 2009 and reaffirmed this status in 2020 (COSSARO 2020). The 2020 reassessment of redside dace by COSSARO found that its status had not improved; its small, declining range has become severely fragmented and population appears to have declined by over 50% in the last decade (COSSARO 2020). Because of overlap with continued development in the GTA, future decline in its range, number of sites, and habitat quality was predicted, resulting in a continued decrease in its abundance. Recovering redside dace will require threats to the extent and quality of its habitat to cease, and the number of viable populations to increase.

A provincial recovery strategy (Redside Dace Recovery Team 2010) and government response statement was published in 2010 and a habitat regulation developed in 2011 (Ontario Regulation 242/08, section 29.1). These regulatory actions initially protected the species and its habitat, and provided recovery funding opportunities under the provincial Species-at-Risk Research Fund for Ontario (discontinued

in 2020) and ongoing Species-at-Risk Stewardship Fund. For the only time period for which data are available, 2007–2014, 40 projects were funded $310 803 specifically for redside dace and $874 095 for multiple species including redside dace, with $1 758 590 provided in-kind (Ontario 2015)—in comparison, the price of a detached home in these regions is typically $1 000 000–$3 00 000. An American study calculated the mean annual funding per ESA-listed species in 2020 to be $814 014, which was identified as insufficient for recovery (Eberhard et al. 2022). This comparison suggests that funding to recover redside dace, and other species (Mandrak 2025), in Canada has been woefully inadequate. More recently, SAR funding levels in general (e.g., Drake et al. 2021) have been declining (OAG 2021), and little action or funding is being provided to maintain or facilitate redside dace recovery.

A series of changes to the *Endangered Species Act* has diminished protections for listed species at risk. In 2013, regulatory changes were made to allow some types of harmful activities to be conditionally exempted from the prohibitions of the *Act* rather than requiring a permit. Conditions for exemptions can include activities exempted if measures are taken to minimize the adverse effects of the activity on, or complete beneficial actions for, a species, a mitigation plan is created and followed, and effectiveness of mitigation measure is monitored and reported. During 2007–2014, 26 overall benefit and 53 protection/recovery permits were issued for activities related to redside dace, and two charges were laid, including one resulting in 15 days jail time for destroying redside dace habitat (Ontario 2015). In 2021, the Office of the Auditor General of Ontario concluded that permit applications to harm SAR are always approved and that, in 2020, 96% (893) of approvals to harm SAR and their habitats were conditional exemptions (OAG 2021). Excluding permits that have the main purpose of protection and recovery, as of 2020, 306 permits had been issued, 74% of which was in the areas around the GTA, where a significant amount of development activity occurs provincially, and redside dace was identified as one of the five most impacted species (OAG 2021). The OAG (2021) also found an increasing use of social or economic benefit permits to allow harmful activities, which contravened Section 73 of SARA since 2017, and noted that inspections are not conducted to ensure compliance with the requirements of agreements, permits, and conditional exemptions. Therefore, the extent to which these requirements were not met, and Section 73 potentially contravened, is unknown. In 2019, the *More Homes, More Choice Act* included changes to weaken the ESA protection of at-risk species, including allowing landscape agreements to approve multiple harmful activities across a broader area, and a project proponent to pay into a Species-at-Risk Conservation Trust in lieu of implementing conservation actions to protect species at risk (aka "pay to slay"), initially for three bird, one tree, and one turtle species at risk. Although this provision does not yet seem to apply to redside dace, it would contravene Section 73 of SARA in general unless there was scope for harm that would not jeopardize the survival and recovery of the species, which is not the case for redside dace in the GTA (Fisheries and Oceans Canada 2020).

Present

Above, we summarized threats to redside dace habitat, noting that there are existential concerns, such as climate change, that will both elevate water temperature and increase variability in stream flows. While these global threats require internationally coordinated strategies and actions to deal with them, there are critical local, small-scale changes to habitat occurring due to land-use changes and urbanization. Land-use changes can further impact water temperatures and flow levels. However, choices in the form of land-use modifications and maintaining protected areas in headwaters can minimize or mitigate these effects and aid in both protecting and restoring populations of redside dace.

Both the Government of Canada and the Government of Ontario have committed to support biodiversity initiatives (Ontario Biodiversity Council 2023; Environment and Climate Change Canada 2024) and to protect species of special conservation concern (Government of Canada's SARA, Ontario's ESA). With the decline in, or extirpation of, many populations within Canada and the listing as Endangered by both governments, redside dace clearly is "at risk", and the principal threats to the species are those related to human activity. Given its status and risk, both governments indicate that the protection of redside dace and its habitat are priorities, and they are responsible to protect conditions (e.g., habitat) necessary for the recovery of the species.

In 2022, the Government of Ontario announced that it would remove nearly 3000 ha of environmentally protected areas from various regions within the GTA Greenbelt to allow housing development. Areas of northeastern GTA, including subwatersheds of the Rouge River containing redside dace, were included in this removal of protection. These included areas adjacent to the Rouge National Urban Park, thereby engaging the federal government due to the potential impacts of the proposed developments on biodiversity and species at risk. The Government of Canada responded that, *"due to the widespread concerns expressed by Indigenous Peoples and the general public"*, it would require an environmental assessment through the Rouge National Urban Park Study. However, during fall 2023, under public pressure and with significant concerns expressed regarding the questionable selection and approval process of lands removed from protected status (including various independent investigations and the resignation of the Minister responsible for the approvals), the Government of Ontario reversed position on these changes and returned the lands to protected status.

In 2020, the Government of Ontario announced that a major highway (Highway 413; 4–6 lanes with potential expansion to 10 lanes) would be developed in the northwest area of the GTA (Fig. 2). The proposed location of this highway would cross the headwaters of several watersheds, including the Credit and Humber rivers, containing redside dace and its recently recognized critical habitat (Fig. 2; Fisheries and Oceans Canada 2024*b*). To understand the potential impact to redside dace, one need only look at the actual impact of Highway 407 that parallels the proposed highway to the south (Fig. 2). Highway 407 crosses many GTA watersheds in which the species was present and, following its completion

in 1997, many redside dace populations downstream of the highway were lost (Fig. 2). These populations were impacted by modifications in stream flow and resulting changes to in-stream habitat and declines in water quality (COSEWIC 2007, 2017) directly related to the construction and operation of Highway 407.

In 2021, the federal Minister of Environment and Climate Change announced that the proposed highway would be subject to the federal *Impact Assessment Act* as the route would include habitat for many species at risk (11 currently, 31 historically, present), including redside dace. In fall 2023, following a challenge to the *Impact Assessment Act* related to a project in Alberta, the Supreme Court of Canada indicated that the *Act* was "unconstitutional in part". Following this decision, the Minister indicated the federal government would continue enforcing the *Act* on projects such as the Highway 413, leading the Government of Ontario to ask a federal court to prevent the federal government from using the *Act* to prevent progress on the Highway 413. In March 2024, the federal and provincial governments withdrew from the court action via a joint consent order and subsequently stated they had established a joint working group to minimize environmental impacts in areas of federal environmental jurisdiction. At present, no public information exists regarding the form and extent of this collaboration. In October 2024, the federal Minister of Environment and Climate Change received a request to designate the Highway 413 Project for a federal Impact Assessment given multiple issues related to federal jurisdication (e.g., fishes and fish habitat, migratory birds, species at risk). The Minister delegated authority to the Impact Assessment Agency of Canada (IAAC) to determine whether a federal Impact Assessment was required. In December 2024, the President of the IAAC announced the decision to not designate the proposed Highway 413 development for an Assessment, removing this hurdle from the project's advancement. While the joint provincial-federal working group continues to examine the associated issues of the proposal, much of the authority and legal responsibility resting with the federal Minister of Environment and Climate Change appears to have been waived. However, it is not clear whether the Government of Canada may yet invoke its authority under other environmental protection acts such as SARA and the *Fisheries Act*.

In late December 2023, the Government of Ontario proposed an amendment to the Ontario *Endangered Species Act* to "*improve implementation of the species at risk program*"; an amendment that had significant and specific implications for the protection of redside dace habitat. Currently, the defined habitat protected under the ESA for redside dace includes "*areas that are considered occupied by redside dace—e.g., areas that are currently being used or have been used within the last 20 years by redside dace. ("occupied" habitat—paragraph 1 of section 29).*" The 20-year time period is consistent with many international guidelines for species not recently collected at a locality, but their habitat is extant (e.g., NatureServe; Hammerson et al. 2020). Exceeding this 20-year period leads to an "Historical" classification for the species at that locality based on adequately sampling for it and the species not being found. The amendment to the ESA proposed to "*shorten the timeframe from 20 to 10 years such that any part of a stream or other watercourse that was used by redside dace at any time during the previous 10 years would be considered to be "occupied" habitat under the regulation.*" This proposed halving of the timeframe for habitat to be considered as "occupied" has no scientific basis. Furthermore, the ability to adequately sample sites has been hindered by increased difficulties in obtaining government-issued permits to sample for redside dace in recent years. Sampling permit requests have been declined, often without explanations for why they have been declined. Therefore, there was the concurrent situation of the provincial government not granting requests to sample localities to determine species status while the same government was proposing to halve the length of time during which the species is not detected needed to consider the locality to be no longer "occupied" habitat; i.e., delist habitat previously considered as "occupied" and remove the associated protection of the locality and species. These proposed amendments would have resulted in localities in 13 of 44 subcatchments (2 of 14 watersheds), currently considered as "occupied", being reclassified as "historical", often without adequate sampling to support such a change. Furthermore, capture of individuals or underwater photographic records are required as evidence of the species occurrence (per Ontario Ministry of the Environment, Conservation, and Parks policy); environmental DNA (eDNA) detection does not provide a location-specific occurrence as it may be transported from upstream.

In addition, the proposed amendment to the ESA would have changed how recovery habitat was classified too. Currently, "*areas that would support re-establishment of the species to formerly occupied areas*" are considered to be "recovery" habitat (paragraph 2 of section 29). The proposed amendment would have restricted "recovery" habitat to be "*streams or other watercourses directly adjacent to occupied habitat and areas that are currently suitable for redside dace to carry out its life processes.*" This would have resulted in many areas to have been no longer considered to be "recovery" habitat, nor areas eligible to be considered for the reintroduction of the species (e.g., via a breeding program and stocking). However, as these amendments would have changed from 20-year to 10-year "occupied" habitat **and** required "recovery" habitat to be directly adjacent to "occupied" habitat, together they would have resulted in even more habitat to have been no longer considered as "recovery" habitat. Watersheds where redside dace had not been detected within the past 10 years (as a consequence of: local decline and loss of the population; failure to detect a population of low abundance; or, inability to sample due to permitting restrictions) would have no longer been considered as "occupied", and they would no longer have been considered to contain "recovery" habitat where habitat should be maintained or restored or reintroductions could be considered.

The proposed amendments appear to have been intended to remove impediments to large infrastructure projects, such as development on the GTA Greenbelt and building new highways such as the proposed Highway 413 (see below). While ultimately these specific amendments were withdrawn by the Government of Ontario following public consultation, if any future amendments or exemptions to the provision of the

ESA that are implemented to facilitate large infrastructure projects, then one of the rationales used in the federal listing Order would no longer be valid: *"This impact expected to be negligible, as restrictions imposed on infrastructure projects that affect redside dace habitat are already in place due to this species being listed under Ontario's* Endangered Species Act 2007 *and the prohibitions under SARA are not anticipated to result in any additional impacts to the delivery and implementation of infrastructure projects"* (Government of Canada 2017).

In September 2024, the Government of Ontario indicated that it would not be moving ahead with implementing the ESA amendments specific to redside dace. However, the species may still not be safe from further impacts as the Government of Ontario is planning significant infrastructure development (housing, highways) within watersheds containing redside dace. It may choose to exempt such projects from environmental impact assessments or propose ESA amendments in the future. In November 2024, the Government of Ontario passed *Bill 212* that will exempt itself from the provincial *Environmental Assessment Act* for the construction of Highway 413 project, including extensions of, and connections to, other regional highways. Furthermore, the Government of Ontario, at the discretion of the Minister may withhold *"studies or updates of studies [that] contain information about sensitive natural or cultural heritage matters."* The Government of Ontario has been sensitive to criticism regarding its consideration of species at risk, and it is unclear whether studies related to status of, and impacts on, such species will be considered to represent "sensitive natural heritage matters" and, therefore, withheld from the public.

Future

Despite its legal obligations to do so under Section 73 of SARA, the Government of Canada has yet to indicate whether it would enforce SARA as a safety net in the event that provincial protections are weakened to remove potential barriers to major infrastructure projects. Even if such a decision is made, it would not be immune from future changes, particularly if there is a change in the political leadership of the federal government, including weakening of SARA.

Conclusion

Given the actions of the Government of Ontario, "endangered" accurately represents the status of redside dace. The Government of Ontario has detailed goals to facilitate economic development, with no commitment to protecting redside dace or any other federally or provincially listed species at risk of extinction or extirpation from proposed development projects. While the Government of Canada has both authority and responsibility to protect redside dace and other federally listed species at risk, and has additional authority and responsibility under the *Fisheries Act*, it is unclear whether it is willing to exercise this responsibility. Given the high profile of redside dace, the actions of this provincial government and corresponding limited response by the federal government should serve as a broader warning about the lack of will to meaningfully protect any endangered species perceived to be an inconvenient impediment to economic development. Although endangered species legislation exists at both federal and provincial levels, the will to meaningful protect endangered species appears questionable given (lack of) actions to date.

Acknowledgements

We are grateful to many colleagues for discussions we have had regarding redside dace, including both challenges for the species and its potential for recovery. We thank Andrew Drake, Julia Colm, and Kari Jean for providing us with the most current status information for the species in various watersheds throughout Ontario. We thank Jon Clayton for permission to use his photographs and Ian Smith, University of Toronto Scarborough, for drafting Fig. 2. DAJ and NEM are both supported through NSERC Discovery Grants.

Article information

History dates

Received: 5 December 2024
Accepted: 20 February 2025
Version of record online: 31 March 2025

Copyright

Data Availability

Data were obtained from Fisheries and Oceans Canada (DFO). Given the data represent information about specific locations of an endangered species of fish, they will not be made public but DFO can be contacted for authorized access.

Author information

Author ORCIDs

Donald A. Jackson https://orcid.org/0000-0002-6107-0753
Nicholas E. Mandrak https://orcid.org/0000-0001-8335-9681

Author contributions

Conceptualization: DAJ, NEM
Data curation: NEM
Project administration: DAJ
Writing – original draft: DAJ, NEM
Writing – review & editing: DAJ, NEM

Competing interests

The authors indicate no competing interests.

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Appendix A

Table A1. Comparison of priorities for recovery measures between draft recovery strategy (Fisheries and Oceans Canada 2024*a*) and final recovery strategy (Fisheries and Oceans Canada 2024*b*) for redside dace. Bold text represents recovery measures with priorities that changed between recovery strategy versions.

Recovery measure	Draft		Final	
Work with municipal planning authorities such that they consider the protection of critical habitat for redside dace within municipal planning documents (for example, Official Plans, Secondary Plans, Subwatershed Management Plans, Block Plans, and Stormwater Management Plans). This measure will provide additional urban stormwater impact mitigation for redside dace when development proposals are planned and reviewed.	1	High	1	High
Ensure that the potential invasion of aquatic invasive species and non-indigenous species into redside dace waters is considered during project reviews by Fisheries and Oceans Canada (DFO) when removal of barriers is contemplated. This measure will reduce potential negative impact of these species on redside dace.	**2**	**High**	**2**	**Medium**
Maintain redside dace distribution database to identify critical habitat and coordinate with appropriate planning authorities and the Natural Heritage Information Centre to ensure the comparability of map data among organizations. This measure will provide current information on the distribution of redside dace for the protection of habitat during the planning and review of proposals for development and work in, or adjacent to, streams where Redside Dace is present.	3	High	3	High
Work with drainage superintendents, drainage engineers, and contractors, to avoid, minimize, or eliminate the effects of any new or maintenance-related drainage works in redside dace habitat. This measure will protect redside dace habitat that may be impacted by drain maintenance activities.	4	Medium	4	Medium
Review existing fisheries partitions and identify candidate partitions within the range of redside dace. This measure will allow for the protection of redside dace populations from potential invasions of aquatic invasive species and non-indigenous species.			**5**	**Medium**
Continue to coordinate with OMNRF, OMECP, and conservation authorities to establish a standard redside dace monitoring program to assess presence/absence through time in streams throughout the species' Ontario range. This program will provide an ongoing assessment of occupied range in Ontario, including population and habitat assessments. Establish a monitoring program using a standardized sampling protocol to assess temporal changes in population abundance and habitat conditions resulting from human activities. This measure will allow for an assessment of the efficacy of restorative actions and the condition of redside dace populations and habitats at specific sites. A two-tiered sampling approach may beprescribed, including both low-effort and labour-intensive methods. The more labour-intensive measures, such as density estimates, could be applied to smaller spatial scales for research, such as habitat associations. In contrast, less intensive presence/absence data could be collected over larger spatial scales to assess the distributional extent of populations within watersheds.	5	High	6	High
Evaluate health of all redside dace stream corridors, as well as supporting habitat, by watershed, and investigate the feasibility of restoring stream water quality, riparian vegetation, headwater features and hydrologic functions. This measure will allow for the identification of priorities for rehabilitation projects.	**6**	**High**	**7**	**Low**
Examine global and local variation in genetic diversity of redside dace populations through DNA and microsatellite analysis. This measure will provide information regarding effects of fragmentation and inbreeding depression, and the importance of source strains for re-introductions. Examine local adaptations and variation in functional genes related to the expression of important biological traits such as thermal tolerance or colouration. Employ eDNA, followed by traditional sampling methods, to detect and confirm, respectively, the presence of redside dace within stream reaches.	**7**	**Medium**	**8**	**Low**
Investigate the impacts of species that have been introduced into redside dace streams (non-native salmonids, centrarchids, Northern Pike, other leuciscids). This measure will allow for the protection and recovery of populations from harmful impacts of introductions.	**8**	**High**	**9**	**Medium**
Identify key factors associated with urban development and agricultural practices that contribute to declines in redside dace populations. Investigate effective mitigation of these factors on redside dace population dynamics as well as the impact of water-taking and urban stormwater. This measure will lead to improved ability to both protect and rehabilitate redside dace habitat through urban planning, infrastructure retrofits, and the improvement of best management practices in both urban and agricultural environments.	**9**	**High**	**10**	**Medium**
Investigate the feasibility of artificial propagation versus wild fish transfers for redside dace re-introductions. This measure will provide guidance on when and how re-introduction should be considered, on alternatives for redside dace re-introductions, and potentially on a refuge for endangered native populations.	10	High	11	High

Table A1. (*concluded*).

Recovery measure	Draft		Final	
Identify candidate streams for re-establishing redside dace through a feasibility analysis. Re-introductions should be restricted to areas of former occurrence where suitable habitat occurs or has been restored and where no obvious impediments to re-establishment exist. Donor populations should be sourced from locations with healthy populations as close as possible to the recipient stream, given the genetic differences at the regional and local scale. These actions will increase the number and range of redside dace occurrences.	11	High	12	High
Continue to develop a redside dace awareness plan to guide awareness efforts in urban and rural areas. The plan will identify audiences, develop conservation messages, and encourage media support to deliver the awareness program.	**12**	**High**	**13**	**Low**
Foster public support and awareness by developing appropriate materials and programs identified in the awareness plan. This measure will improve understanding of conservation messages within the general public, Indigenous Nations, landowners, urban development industry, municipalities, and other stakeholders, and stimulate community support for recovery efforts.	13	High	14	High
Secure lands that support healthy populations of redside dace. Species conservation reserves with healthy populations can serve as a source for re-introductions elsewhere, providing genetic rescue to small populations.	14	High	15	High
Work with planning authorities to ensure that geographically appropriate management plans are completed for areas where development is forecasted within redside dace subwatersheds. Plans should incorporate the guidelines for development in redside dace habitat. This measure will provide additional protection for redside dace when development proposals are planned and reviewed.	15	High	16	High
Continue to educate and work with licenced baitfish harvesters to help reduce the possibility of incidental harvest of redside dace.	16	Low	17	Low
Review locations where intentional introductions of non-indigenous species have established or are proposed to occur in redside dace habitat, and consider stocking in alternative locations. In locations with established populations of non-indigenous species, consider methods to reduce potential impacts on redside dace.	**17**	**High**	**18**	**Medium**
Continue/complete riparian rehabilitation, water quality monitoring, stormwater management retrofits, and in-stream works on existing rehabilitation projects, and initiate rehabilitation projects on top priority streams. This measure will improve redside dace habitat in streams where its abundance/range has been reduced, allowing for population growth, recolonization, or re-introduction. All rehabilitation efforts should include an evaluation component to assess effectiveness.	18	High	19	High
Encourage the use of best management practices (BMPs) in rural streams to restore healthy riparian vegetation, reduce livestock access, establish manure storage and run-off collection systems, encourage conservation tillage, and reduce the impact of tile drains. Riparian rehabilitation should focus on the re-establishment of grasses and shrubs. These BMPs will improve redside dace habitat by reducing agricultural run-off and bank erosion, thereby limiting the input of sediments and nutrients from agricultural lands.	19	High	20	High
Encourage development of Environmental Farm Plans and Nutrient Management Plans where these are not required by law. This measure will provide for additional habitat protection and improvement in relation to farming practices.	**20**	**Low**	**21**	**High**
Conduct detailed fluvial geomorphological and hydrological assessments of urbanized and rural redside dace streams (good sites versus poor sites) as per recommendations of Parish (2004). This measure will describe redside dace habitat with regard to channel form and flow necessary from a geomorphic perspective, to refine species-specific stream restoration and urban development guidelines, and contribute to the design of habitat for restoration projects.	**21**	**High**	**22**	**Low**
Make landowners aware of existing incentive programs for conservation lands (for example, Habitat Stewardship Program for Aquatic Species at Risk, Aboriginal Fund for Species at Risk, Conservation Land Tax Incentive Program). These incentives will increase the number of landowners participating in incentive programs that protect habitat.	**22**	**Medium**	**23**	**Low**