

**COSEWIC**  
**Assessment and Status Report**

on the

**Redside Dace**  
*Clinostomus elongatus*

in Canada



**ENDANGERED**  
**2017**

**COSEWIC**  
Committee on the Status  
of Endangered Wildlife  
in Canada



**COSEPAC**  
Comité sur la situation  
des espèces en péril  
au Canada

COSEWIC status reports are working documents used in assigning the status of wildlife species suspected of being at risk. This report may be cited as follows:

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Parker, B., Mckee, P. and Campbell, R.R. 1987. COSEWIC status report on the redside dace *Clinostomus elongatus* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. 1-20 pp.

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## COSEWIC Assessment Summary

### Assessment Summary – November 2017

**Common name**

Redside Dace

**Scientific name**

*Clinostomus elongatus*

**Status**

Endangered

**Reason for designation**

This small, colourful minnow is highly susceptible to changes in stream flow and declines in water quality, such as occur in urban and agricultural watersheds. The Canadian range of this species largely overlaps with the Greater Toronto Area (GTA), where urban land use is widespread and projected to increase in the future. The continued expansion of the GTA has led to ongoing habitat degradation, causing serious declines in range and number of individuals and populations.

**Occurrence**

Ontario

**Status history**

Designated Special Concern in April 1987. Status re-examined and designated Endangered in April 2007 and November 2017.



## **COSEWIC**

### **Executive Summary**

#### **Redside Dace**

*Clinostomus elongatus*

#### **Wildlife Species Description and Significance**

Redside Dace is a colourful minnow that features a yellow lateral stripe extending the length of the body and a bright red stripe below the yellow. The back is a variable shade of green and the ventral surface is silvery white. The body is slender and laterally compressed. Maximum size is 120 mm. Redside Dace has a long snout with a projecting lower jaw. Pectoral fins are longer in males than females. The species is an indicator of habitat quality.

#### **Distribution**

Redside Dace has a discontinuous distribution that includes tributaries of the five Great Lakes, Ohio River, upper Mississippi River, and the Susquehanna River. The heart of the distribution includes much of New York, Pennsylvania, and Ohio. The western portion of the range includes parts of Wisconsin and an area in southeastern Minnesota. Small disjunct patches of range are also present in West Virginia, Kentucky, Iowa, and Michigan. In Canada, most populations occupy streams flowing through the Greater Toronto Area into Lake Ontario. Populations are also known from the Lake Erie watershed (Grand River), a few rivers in the Lake Huron watershed (Saugeen River, Gully Creek, South Gully Creek, Two Tree River), and two Lake Simcoe tributaries (Kettleby Creek, Sharon Creek).

#### **Habitat**

Redside Dace currently occupy small tributaries 5-10 m in width. During most of the year, including the winter, they are found in pools ranging in depth from 11 to 100 cm. Substrate is highly variable, ranging from silt to boulders. Redside Dace habitat usually has riparian vegetation consisting of overhanging grasses and shrubs considered important for production of terrestrial insects. Streams running through relatively open areas appear to be superior to those in forested areas. Redside Dace is a coolwater fish with a preference for clear water. Spawning occurs in riffle habitat with fine gravel substrate.

## **Biology**

Spawning occurs in late May at temperatures of 16-18°C. Eggs are normally deposited in nest depressions constructed by associate species such as Common Shiner or Creek Chub. The maximum age reported for Redside Dace in Ontario is three years (although a five-year-old individual has been identified; Drake pers. comm. 2017) and four years in New York and Pennsylvania. Most individuals mature after their second winter. Growth in Ontario populations is comparable to those in New York, Pennsylvania, and Wisconsin. First-year fish grow very rapidly; most individuals mature following their second winter. Dietary studies have revealed that Redside Dace are predominantly surface and supra-surface feeders. Gut content analyses are consistent in finding a very large proportion of terrestrial insects, particularly dipterans, in the diet.

## **Population Sizes and Trends**

Population sizes are unknown for most catchments. Quantitative estimates of abundance have been made on one occasion for five Ontario populations. Estimates range from 462-741 individuals in the Gully Creek to 21,530-38,582 individuals in the Humber River. Trends in abundance are usually based on presence/absence information determined in general fish surveys and, in recent years, in surveys targeting Redside Dace. Surveys suggest declining population sizes in several systems including Lynde Creek (east branch), Rouge River (east branch, Morningside tributary), Don River, Humber River, Credit River, Sixteen Mile Creek, Grand River (Irvine Creek), Spencer Creek, Saugeen River (main branch and Meux Creek), and Holland River (Kettleby Creek). Populations in Bronte Creek, Don River, and Sharon Creek are likely extirpated.

## **Threats and Limiting Factors**

The overall threat impact is very high. The greatest threats are natural system alterations that degrade habitat in both urban and rural settings. These include factors that alter flow regimes, including streambed alterations, surface hardening of watersheds, agricultural drain maintenance, reservoir development, and disruption of headwater features. Urban and rural habitat is frequently altered by removal of riparian vegetation, leading to warmer thermal regimes and reduced availability of terrestrial insects. Invasive predatory fishes, including centrarchids, salmonids, and Northern Pike, also threaten Redside Dace populations. Pollution from several sources is a threat across the range. Pollutants include chloride, leachate from landfill sites, and storm-water inputs in urban settings. In rural areas, siltation and nutrient inputs from agricultural runoff and manure mismanagement are especially relevant. Low-level and potential threats include incidental catch in the bait fishery and negative impacts from scientific monitoring.

## Protection, Status and Ranks

Redside Dace receives some protection from provisions of the *Fisheries Act*. Ontario statutes, including the *Endangered Species Act* and the *Planning Act*, also protect the species and its habitat. Redside Dace was assessed as Endangered by COSEWIC in 2007 and listed as such under the *Species at Risk Act* in May 2017 (Schedule 1). It is classified as Endangered under the Ontario *Endangered Species Act*. General status ranks are Global 3, National (N) 2 (Canada), N3/N4 (U.S.), and Subnational 2 in Ontario.

## TECHNICAL SUMMARY

*Clinostomus elongatus*

Redside Dace

Méné long

Range of occurrence in Canada (province/territory/ocean): Ontario

### Demographic Information

Generation time (usually average age of parents in the population; indicate if another method of estimating generation time indicated in the IUCN guidelines (2011) is being used)	2-3 yrs  Most mature at 2 y, all mature by 3 y.
Is there an [observed, inferred, or projected] continuing decline in number of mature individuals?	Yes  Inferred from continuing declines in quality of habitat, particularly in the Greater Toronto Area.
Estimated percent of continuing decline in total number of mature individuals within [5 years or 2 generations]	>50%  Based on overall threat impact of very high and an index of abundance appropriate to the taxon (area of occupancy based on 1 km x 1 km grids).
[Observed, estimated, inferred, or suspected] percent [reduction or increase] in total number of mature individuals over the last [10 years, or 3 generations].	81% reduction  Inferred from a decline in an index of abundance appropriate to the taxon (area of occupancy based on 1 km x 1 km grids).
[Projected or suspected] percent [reduction or increase] in total number of mature individuals over the next [10 years, or 3 generations].	>50% decrease  Suspected based on ongoing habitat loss in the Greater Toronto Area.
[Observed, estimated, inferred, or suspected] percent [reduction or increase] in total number of mature individuals over any [10 years, or 3 generations] period, over a time period including both the past and the future.	>50% reduction  Inferred from a decline in an index of abundance appropriate to the taxon (area of occupancy based on 1 km x 1 km grids) and ongoing habitat loss in the Greater Toronto Area.
Are the causes of the decline a. clearly reversible and b. understood and c. ceased?	a. Yes b. Yes c. No
Are there extreme fluctuations in number of mature individuals?	No

### Extent and Occupancy Information

Estimated extent of occurrence (EOO)	44,842 km <sup>2</sup>
Index of area of occupancy (IAO) (Always report 2x2 grid value).	332 km <sup>2</sup>

Is the population “severely fragmented” i.e., is >50% of its total area of occupancy in habitat patches that are (a) smaller than would be required to support a viable population, and (b) separated from other habitat patches by a distance larger than the species can be expected to disperse?	a. Yes b. Yes
Number of “locations”* (use plausible range to reflect uncertainty if appropriate)	6-15
Is there an [observed, inferred, or projected] decline in extent of occurrence?	Yes, observed 4.4% decline (46,900 km <sup>2</sup> in 2007; 44,842 km <sup>2</sup> currently)
Is there an [observed, inferred, or projected] decline in index of area of occupancy?	Yes, observed 47% decline (628 km <sup>2</sup> in 2007; 332 km <sup>2</sup> currently)
Is there an [observed, inferred, or projected] decline in number of subpopulations?	Yes, observed. Likely extirpation from Grand River and Don River since last report.
Is there an [observed, inferred, or projected] decline in number of “locations”*?	Yes, observed. Likely loss of Grand River location since last report. Likely loss of Don River location if Greater Toronto Area watersheds are considered separate locations (i.e., there are 15 extant locations).
Is there an [observed, inferred, or projected] decline in [area, extent and/or quality] of habitat?	Yes, observed
Are there extreme fluctuations in number of subpopulations?	No
Are there extreme fluctuations in number of “locations”*?	No
Are there extreme fluctuations in extent of occurrence?	No
Are there extreme fluctuations in index of area of occupancy?	No

#### Number of Mature Individuals (in each subpopulation)

Subpopulations (give plausible ranges)	N Mature Individuals
Duffins Creek Rouge River Don River Humber River Gully Creek	2398 mean (range 423 – 2466) 9180 (3887 – 14 443) 1607 (1218 – 1711) <sup>1</sup> 38 582 (24 569 – 41 542) 741 (206 – 1171)  Estimates include immature individuals and are not corrected for extrapolations in sub-optimal habitat. Ranges represent 25 and 75% quantiles. From Poos <i>et al.</i> 2012)  <sup>1</sup> Now considered to be much lower, probably 0. (Lawrie pers. comm. 2017)

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



Total	50 900 (29 086 – 59 622) Total for all watersheds unknown
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### Quantitative Analysis

Is the probability of extinction in the wild at least [20% within 20 years or 5 generations, or 10% within 100 years]?	Unknown
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### Threats (direct, from highest impact to least, as per IUCN Threats Calculator)

Was a threats calculator completed for this species? Yes. Overall, the threat impact score was very high.

- i. Natural system modifications (streambed alteration, agricultural drain maintenance, reservoir development, altered flow regimes, dewatering, riparian vegetation removal)
- ii. Invasive predators (Northern Pike, Largemouth Bass, Black Crappie, Brown Trout, Rainbow Trout)
- iii. Pollution (inputs resulting from poor storm-water management, chloride, leaching from landfill sites, nutrient inputs, siltation)

What additional limiting factors are relevant?

Redside Dace has limited environmental tolerance and very limited dispersal capability.

### Rescue Effect (immigration from outside Canada)

Status of outside population(s) most likely to provide immigrants to Canada.	Declining  Michigan (S1S2); New York (S3)
Is immigration known or possible?	No
Would immigrants be adapted to survive in Canada?	Probably
Is there sufficient habitat for immigrants in Canada?	No
Are conditions deteriorating in Canada? <sup>+</sup>	Yes
Are conditions for the source population deteriorating? <sup>+</sup>	Yes
Is the Canadian population considered to be a sink? <sup>+</sup>	No
Is rescue from outside populations likely?	No

### Data Sensitive Species

Is this a data sensitive species? No

### Status History

COSEWIC Status History: Designated Special Concern in April 1987. Status re-examined and designated Endangered in April 2007 and November 2017.

<sup>+</sup> See [Table 3](#) ( Guidelines for modifying status assessment based on rescue effect)

**Status and Reasons for Designation:**

<b>Status:</b> Endangered	<b>Alpha-numeric codes:</b> A2b+3bc+ 4bc; B2ab(i,ii,iv,v)
<b>Reasons for designation:</b> This small, colourful minnow is highly susceptible to changes in stream flow and declines in water quality, such as occur in urban and agricultural watersheds. The Canadian range of this species largely overlaps with the Greater Toronto Area (GTA), where urban land use is widespread and projected to increase in the future. The continued expansion of the GTA has led to ongoing habitat degradation, causing serious declines in range and number of individuals and populations.	

**Applicability of Criteria**

<b>Criterion A (Decline in Total Number of Mature Individuals):</b> Meets Endangered: A2b, since there is an inferred reduction in total number of mature individuals greater than 50% over the last 10 years based on (b) an index of abundance appropriate to the taxon (1km <sup>2</sup> area of occupancy grids); A3bc, since there is a projected reduction in total number of mature individuals greater than 50% over the next 10 years based on (b) an index of abundance appropriate to the taxon and (c) a decline in the index of area of occupancy and quality of habitat; and, A4bc, since there is an observed and projected reduction in total number of mature individuals greater than 50% over a 10-year period spanning the past and future based on (b) an index of abundance appropriate to the taxon and (c) a decline in the index of area of occupancy and quality of habitat.
<b>Criterion B (Small Distribution Range and Decline or Fluctuation):</b> Meets Endangered. Greater than 50% of its total area of occupancy is in habitat patches that are smaller than required to support a viable population and separated by distances larger than the known dispersal capability of the species. It fulfills B2ab(i,ii,iii,iv,v), since the IAO is below the threshold and there is a decline in i) EOO, ii) IAO, iii) area, extent and quality of habitat, iv) number of subpopulations, v) and number of mature individuals.
<b>Criterion C (Small and Declining Number of Mature Individuals):</b> Not applicable. Exceeds thresholds.
<b>Criterion D (Very Small or Restricted Population):</b> Not applicable. Exceeds thresholds.
<b>Criterion E (Quantitative Analysis):</b> Not available.

## PREFACE

The status of Redside Dace was last assessed by COSEWIC in 2007. The assessed status was Endangered due to continuing declines, sensitivity to habitat alterations, and the likelihood of further development in the remaining areas of relatively undisturbed habitat. Since then, important information about the species has become available, including quantitative estimates of population size in five watersheds (Poos *et al.* 2012), dispersal patterns in the Rouge River (Poos and Jackson 2012), and the distribution of population genetic variation across the range (Serrao 2016). New methods for detection and, potentially, estimating population size have also been developed, including deployment of underwater video cameras (Castaneda pers. comm. 2016) and amplification of environmental DNA (Serrao 2016; Reid *et al.* 2017). The status of Redside Dace has not improved since 2007 and continued declines, including likely extirpation in Don River and Grand River, are anticipated unless factors threatening the species are mitigated.



## COSEWIC HISTORY

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) was created in 1977 as a result of a recommendation at the Federal-Provincial Wildlife Conference held in 1976. It arose from the need for a single, official, scientifically sound, national listing of wildlife species at risk. In 1978, COSEWIC designated its first species and produced its first list of Canadian species at risk. Species designated at meetings of the full committee are added to the list. On June 5, 2003, the *Species at Risk Act* (SARA) was proclaimed. SARA establishes COSEWIC as an advisory body ensuring that species will continue to be assessed under a rigorous and independent scientific process.

## COSEWIC MANDATE

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) assesses the national status of wild species, subspecies, varieties, or other designatable units that are considered to be at risk in Canada. Designations are made on native species for the following taxonomic groups: mammals, birds, reptiles, amphibians, fishes, arthropods, molluscs, vascular plants, mosses, and lichens.

## COSEWIC MEMBERSHIP

COSEWIC comprises members from each provincial and territorial government wildlife agency, four federal entities (Canadian Wildlife Service, Parks Canada Agency, Department of Fisheries and Oceans, and the Federal Biodiversity Information Partnership, chaired by the Canadian Museum of Nature), three non-government science members and the co-chairs of the species specialist subcommittees and the Aboriginal Traditional Knowledge subcommittee. The Committee meets to consider status reports on candidate species.

## DEFINITIONS (2017)

Wildlife Species	A species, subspecies, variety, or geographically or genetically distinct population of animal, plant or other organism, other than a bacterium or virus, that is wild by nature and is either native to Canada or has extended its range into Canada without human intervention and has been present in Canada for at least 50 years.
Extinct (X)	A wildlife species that no longer exists.
Extirpated (XT)	A wildlife species no longer existing in the wild in Canada, but occurring elsewhere.
Endangered (E)	A wildlife species facing imminent extirpation or extinction.
Threatened (T)	A wildlife species likely to become endangered if limiting factors are not reversed.
Special Concern (SC)*	A wildlife species that may become a threatened or an endangered species because of a combination of biological characteristics and identified threats.
Not at Risk (NAR)**	A wildlife species that has been evaluated and found to be not at risk of extinction given the current circumstances.
Data Deficient (DD)***	A category that applies when the available information is insufficient (a) to resolve a species' eligibility for assessment or (b) to permit an assessment of the species' risk of extinction.

\* Formerly described as "Vulnerable" from 1990 to 1999, or "Rare" prior to 1990.

\*\* Formerly described as "Not In Any Category", or "No Designation Required."

\*\*\* Formerly described as "Indeterminate" from 1994 to 1999 or "ISIBD" (insufficient scientific information on which to base a designation) prior to 1994. Definition of the (DD) category revised in 2006.



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

# **COSEWIC Status Report**

on the

## **Redside Dace**

*Clinostomus elongatus*

**in Canada**

2017

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## WILDLIFE SPECIES DESCRIPTION AND SIGNIFICANCE

### Name and Classification

Class	Actinopterygii
Order	Cypriniformes
Family	Cyprinidae
Genus/Species	<i>Clinostomus elongatus</i>
English Common Name	Redside Dace
French Common Name	Méné long

Redside Dace is one of two species in the genus *Clinostomus* (Page *et al.* 2013). The other member of the genus, Rosyside Dace (*C. funduloides*) occupies upland Atlantic slope drainages from southern Pennsylvania to the Savannah River. It is also present in the Ohio and northeast Mississippi drainages (Page and Burr 2011). No subspecies of Redside Dace are recognized. Phylogenetic analysis of mitochondrial DNA sequences (control region and cytochrome-b) and an intron of a nuclear gene (ribosomal protein S7) suggest that *Clinostomus* is the sister group of a lineage containing the genera *Richardsonius* and *Iotichthys* (Houston *et al.* 2010).

### Morphological Description

Redside Dace is a colourful minnow that features a yellow lateral stripe, above the lateral line, extending from the head to the caudal peduncle (Figure 1). A bright red stripe situated below the yellow stripe extends, above and below the lateral line, from just posterior to the operculum to a point below the dorsal fin where it is replaced by a black line that extends to the caudal peduncle. The back is a variable shade of green and the ventral surface is silvery white. Colours are brightest during the spawning season (Scott and Crossman 1973; Page and Burr 2011).



Figure 1. Male Redside Dace from Macochee Creek, Ohio, on 9 June 2011. Photo courtesy of Brian Zimmerman, Ohio State University; used with permission.

The body is slender and laterally compressed. Maximum size is 120 mm (COSEWIC 2007), but average size is 75 mm (Holm *et al.* 2009). Redside Dace has a long snout and a large mouth with a projecting lower jaw. Pectoral fins are longer in males than females. Lateral-line scales number 63-75 (Holm *et al.* 2009). As in many other minnows, reproductive male and female Redside Dace develop nuptial tubercles, particularly on the top of the head and pectoral fins (Scott and Crossman 1973; Holm *et al.* 2009; Page and Burr 2011).

## **Population Spatial Structure and Variability**

Range-wide population genetic structure has been described based on analysis of variation of mitochondrial DNA (ATPase 6 and 8) and 10 microsatellite loci across 28 populations in Ontario and the United States (Serrao 2016; Serrao *et al.* 2017). Globally, the species displays strong phylogeographic structure. Three principal mitochondrial DNA lineages were identified that are strongly concordant in distribution with three population clusters revealed by microsatellite loci. The likely basal lineage (haplogroup 3) is distributed in the eastern Ohio River drainage (Allegheny and Monongahela rivers). Haplogroup 1 is present in the lower Ohio River drainage and tributaries of the lower Great Lakes. It also co-occurs with haplogroup 3 variants at sampling sites in the Allegheny drainage. Haplogroup 2 is present in the western portion of the species' range, specifically in the upper Mississippi drainage and at sites along the south shore of Lake Superior. Analysis of molecular variance (AMOVA) revealed that differences among haplogroups accounted for the largest fraction of mitochondrial DNA variation (71.1%). Smaller fractions of variation were accounted for by differences among populations within haplogroups (21.9%) and differences within populations (7.0%). Thus, most of the variation is revealed among higher-level groupings, i.e., across regional comparisons.

Microsatellite variation revealed three population clusters that largely overlap geographically with the distribution of mitochondrial DNA haplogroups. Microsatellites also revealed more fine-scale population structuring. Genetic assignment testing showed virtually every sample site to be differentiated from all other sites, even within regional population clusters. Pairwise  $F_{ST}$  estimates ranged from 0.08 to 0.62 and all were statistically significant. AMOVA showed, in contrast to the mitochondrial DNA, the largest proportion of variation to be within populations (59.2% p) with less variation partitioned among populations within regional clusters (21.1%) and among regional clusters (19.7%; Serrao 2016). In summary, the information revealed by nuclear microsatellite loci is largely consistent with information derived from mitochondrial DNA. Microsatellites revealed additional information about fine-scale genetic structure of Redside Dace populations, specifically, that populations are unique at local, as well as, regional levels.

## **Designatable Units**

Designatable units (DUs) must be both distinct and evolutionarily significant (COSEWIC 2016). Canadian populations of Redside Dace can be considered distinct because all are genetically unique (Serrao 2016; Serrao *et al.* 2017). However, it is unclear whether they meet the significance criterion. All populations occur within tributaries of the

Great Lakes, and hence all occupy the Great Lakes – Upper St. Lawrence freshwater biogeographic zone. The genetic uniqueness of each population is likely the result of small population effects rather than local adaption to stream-specific environmental conditions. Redside Dace has limited dispersal capability (see Dispersal and Migration section), so the homogenizing effects of gene flow among watersheds is almost certainly very limited. Furthermore, the species typically occupies relatively small waterways that, in many cases, support small populations. The latter are particularly subject to population bottlenecks, founder events, and/or genetic drift, all of which could result in non-adaptive genetic differentiation.

One Canadian population is a geographic outlier. The Two Tree River population near Sault Ste. Marie is geographically removed from the southern Ontario populations and is genetically allied to Upper Mississippi River/Lake Superior populations (Serrao 2016; Serrao *et al.* 2017). While this population likely has a different history in terms of glacial refugia and postglacial dispersal than southern Ontario populations, it does occupy the same biogeographic zone (see Figure 2 in COSEWIC 2016) as all other populations, and there is no compelling evidence of adaptive differentiation. For these reasons, all Canadian populations are considered to be within a single DU.

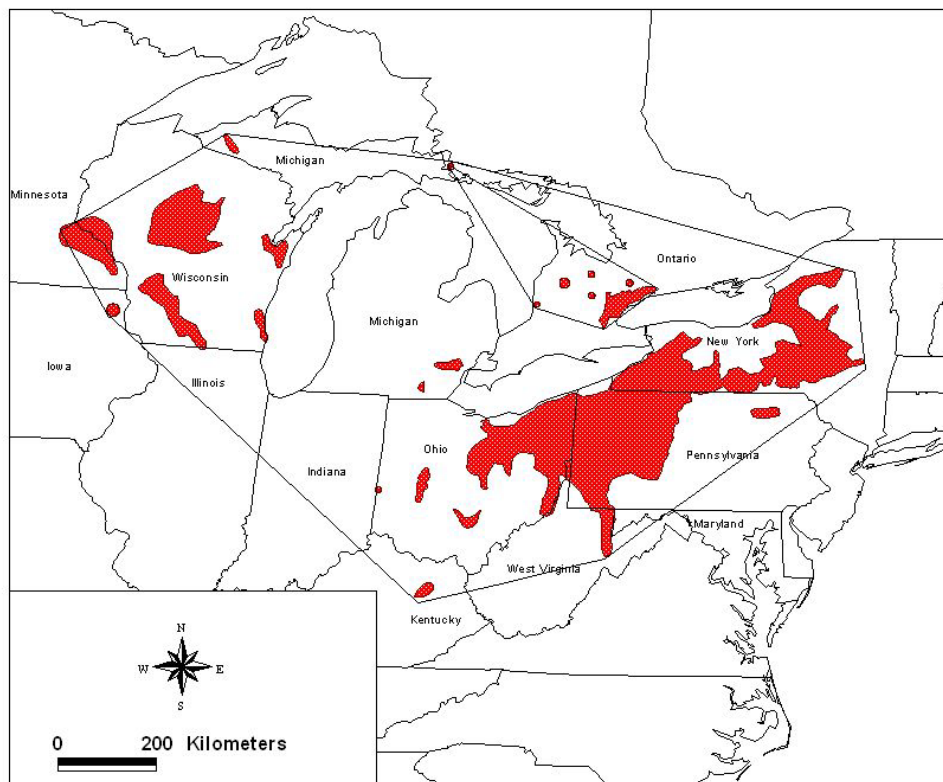


Figure 2. Global range of the Redside Dace. Based on Gilbert 1980, updated with data from Lyons *et al.* 2000, MDNR 2004, Mandrak 2003, Cooper 1983, Meade *et al.* 1986, and NYDEC 2004. Extent of occurrence in Canada and globally are outlined. Note that the Iowa population is extirpated. From COSEWIC (2007).

## **Special Significance**

In Canada, much of the habitat historically occupied by Redside Dace has become urbanized as Ontario's Greater Toronto Area (GTA) has been developed. The usual association of Redside Dace with cool, clear waters suggests the species is an indicator of good habitat quality. The large component of flying insects, particularly dipterans that are caught on-the-wing, in the diet is unique among Canadian cyprinids and represents a conduit for transfer of energy from terrestrial to aquatic habitats.

## **DISTRIBUTION**

### **Global Range**

Redside Dace has a patchy distribution that includes tributaries of the five Great Lakes, Ohio River, upper Mississippi River, and the Susquehanna River (Figure 2). The heart of the distribution includes much of New York, western Pennsylvania, and northeastern Ohio. The western portion of the range includes parts of Wisconsin and an area in southeastern Minnesota. Small, disjunct range patches are also present in West Virginia, Kentucky, and Michigan. The species is thought to be extirpated in Iowa (Iowa Fish Atlas 2004-2006). A single record exists for Maryland from the Monongahela drainage, but this may represent a human-mediated introduction (Fuller 2016).

### **Canadian Range**

Most Canadian populations occupy streams flowing through the Greater Toronto Area into Lake Ontario (Figure 3). This series of streams is bounded on the east by Pringle Creek (Whitby) and on the west by Spencer Creek (Hamilton). Populations are also known from the Lake Erie drainage (Grand River), Lake Huron drainage (Saugeen River, Gully Creeks, Two Tree River), and Lake Simcoe drainage (Holland River).

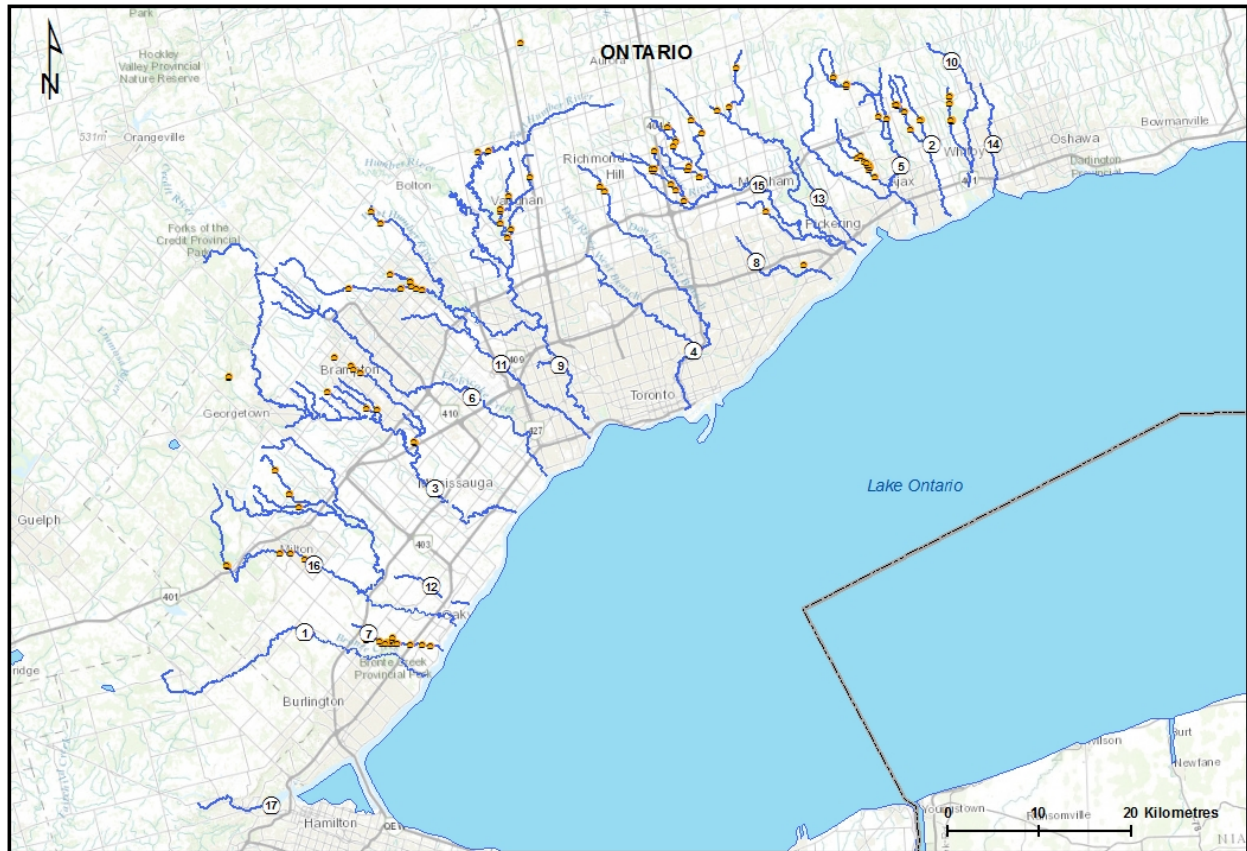


Figure 3. Watersheds in the Greater Toronto Area that contain Redside Dace either currently or historically. Watersheds are identified as follows: 1-Bronte Creek, 2-Carruthers Creek, 3-Credit River, 4-Don River, 5-Duffins Creek, 6-Etobicoke Creek, 7-Fourteen Mile Creek, 8-Highland Creek, 9-Humber River, 10-Lynde Creek, 11-Mimico Creek, 12-Morrison Creek, 13-Petticoat Creek, 14-Pringle Creek, 15-Rouge River, 16-Sixteen Mile Creek, 17-Spencer Creek. Orange circles indicate recent Redside Dace records (2008 – 2016).

## Extent of Occurrence and Area of Occupancy

Since the last status update (COSEWIC 2007), the extent of occurrence has declined slightly (4.4%; 46,900 km<sup>2</sup> versus 44,842 km<sup>2</sup> currently), whereas IAO has declined substantially (53%; 628 km<sup>2</sup> versus 332 km<sup>2</sup> currently) (Figure 4).



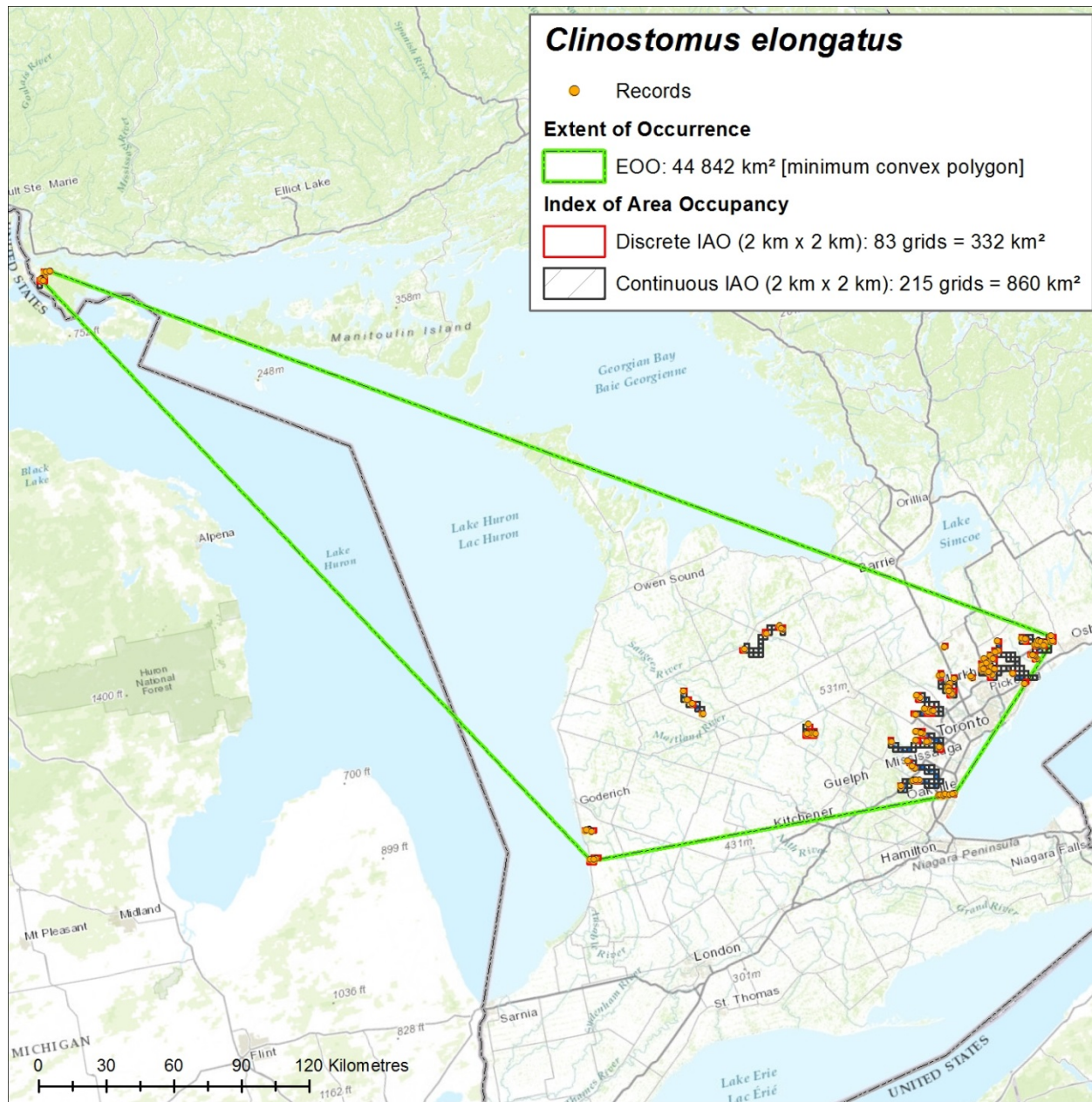


Figure 4. Recent occurrence records for Redside Dace in Ontario (2008 - 2016). Extent of occurrence is outlined in green. Squares represent 2 km x 2 km grids used for calculating continuous IAO.

## Search Effort

An account of historical sampling effort for Redside Dace in Ontario is given in COSEWIC (2007). Until the late 1970s, Canadian records were derived from general watershed surveys rather than from searches specifically targeting Redside Dace.

Sampling effort varies over time and among watersheds. For many watersheds, the baseline information was collected over a 10-year period (1949 through 1959) in wide-ranging surveys by the Ontario Department of Planning and Development (ODPD). Subsequent sampling was done mostly by the Ministry of Natural Resources and Forestry (MNR), Fisheries and Oceans Canada, Royal Ontario Museum, local Conservation Authorities, and academic institutions. Sampling has not always been done systematically through time, although many sites sampled by ODPD, as well as additional sites, were resampled by subsequent workers from other agencies. In recent years systematic sampling rotations have been established in some watersheds. Fisheries sampling occurs in systems under jurisdiction of the Toronto Regional Conservation Authority on a three-year rotation (150 fixed sites across nine watersheds; (Lawrie pers. comm. 2017). Redside Dace is not specifically targeted under this regime and many sampling stations cannot be considered optimal Redside Dace habitat. The Lake Simcoe Region Conservation Authority surveys fish communities annually, although Redside Dace has not been specifically targeted in its monitoring for the last five years (Wilson pers. comm. 2017). Watersheds under the Central Lake Ontario Conservation Authority are also monitored regularly (five-year rotation since approximately 1999; Kelsey pers. comm. 2017). Similarly, Credit Valley Conservation has established approximately 100 stations, 50 of which are sampled annually (Morris pers. comm. 2016) and Conservation Halton monitors approximately 100 sampling stations in catchments under its authority (Dunn pers. comm. 2016). In contrast, routine sampling does not occur in several other watersheds in which Redside Dace is present currently or historically. This is the case in the Grand River (Barnucz pers. comm. 2016), and Saugeen River (Scheifley pers. comm. 2016). A summary of sampling effort is presented in Table 1.

University researchers have been sampling several watersheds in recent years using conventional detection methods as well as novel approaches including eDNA detection in water samples (Serrao 2016) and deployment of underwater video cameras (Castaneda pers. comm. 2016). Poos and Jackson (2012) surveyed selected reaches of five streams using depletion sampling (seining) and extrapolated their results to produce stream-wide population estimates (see Fluctuations and Trends). Appendix Tables 1-26 summarize information contained in a database of catch records maintained by MNR and the Redside Dace Recovery Team.

**Table 1. Summary of effort expended to sample Redside Dace in Ontario watersheds since 2008.**

Watershed	Year	Number of Sites Surveyed	Gear	Area sampled (m <sup>2</sup> )	Seconds shocked	Agency	Reference
Pringle Creek	2008	1	E	174	1062	CLOCA	Moore 2017
	2010	11	E	1414	6124	CLOCA	Moore 2017
	2013	1	E	266	1026	CLOCA	Moore 2017
	2015	9	E	1316	6778	CLOCA	Moore 2017
	2016	1	E	289	860	CLOCA	Moore 2016

Watershed	Year	Number of Sites Surveyed	Gear	Area sampled (m <sup>2</sup> )	Seconds shocked	Agency	Reference
Lynde Creek	2009	45	E	8811	40351	CLOCA	Moore 2016
	2010	1	E	414	1236	CLOCA	Moore 2016
	2011	3	E	n/a	n/a	CLOCA	Moore 2016
	2012	1	E	436	1068	CLOCA	Moore 2016
	2013	5	eDNA	n/a	n/a	MNRF	Serrao 2016
	2013	5	E/S	176	n/a	MNRF	Serrao 2016
	2013	1	E	438	1272	CLOCA	Moore 2016
	2013	48	eDNA	n/a	n/a	MNRF	Reid <i>et al.</i> 2017
	2014	48	E	8352	33684	CLOCA	Moore 2016
	2014	24	eDNA	n/a	n/a	MNRF	Reid <i>et al.</i> 2017
	2015	20	E	n/a	n/a	MNRF	Reid 2016
	2016	20	E	n/a	n/a	MNRF	Reid 2016
Carruthers Creek	2009	3	E	n/a	n/a	TRCA	Lawrie 2017
	2012	3	E	n/a	n/a	TRCA	Lawrie 2017
	2013	2	eDNA	n/a	n/a	MNRF	Serrao 2016
	2013	1	E/S	58	n/a	MNRF	Serrao 2016
	2015	3	E	n/a	n/a	TRCA	Lawrie 2017
	2016	1	E	n/a	230	GEO Morphix	Villard and Heaton 2016
Duffins Creek	2008	6	E	n/a	n/a	TRCA	Lawrie 2017
	2008	10 pools	S	2105 m	n/a	U. of Toronto	Poos <i>et al.</i> 2012
	2009	19	E	n/a	n/a	TRCA	Lawrie 2017
	2010	2	E	n/a	n/a	TRCA	Lawrie 2017
	2012	22	E	n/a	n/a	TRCA	Lawrie 2017
	2013	3	eDNA	n/a	n/a	MNRF	Serrao 2016
	2013	3	E/S	119	n/a	MNRF	Serrao 2016
	2014	11	E	n/a	n/a	TRCA	Lawrie 2017
	2015	26	E	n/a	n/a	TRCA	Lawrie 2017
	2015	9	eDNA	n/a	n/a	MNRF	Reid <i>et al.</i> 2017
Petticoat Creek	2010	3	E	n/a	n/a	TRCA	Lawrie 2017
	2013	3	E	n/a	n/a	TRCA	Lawrie 2017
	2016	3	E	n/a	n/a	TRCA	Lawrie 2017
Rouge River	2008	5	E	n/a	n/a	TRCA	Lawrie 2017



Watershed	Year	Number of Sites Surveyed	Gear	Area sampled (m <sup>2</sup> )	Seconds shocked	Agency	Reference
	2008	43 pools	S	3225 m	n/a	U. of Toronto	Poos <i>et al.</i> 2012
	2009	22	E	n/a	n/a	TRCA	Lawrie 2017
	2010	4	E	n/a	n/a	TRCA	Lawrie 2017
	2012	28	E	n/a	n/a	TRCA	Lawrie 2017
	2013	4	E	n/a	n/a	TRCA	Lawrie 2017
	2013	7	eDNA	n/a	n/a	MNRF	Serrao 2016
	2013	7	E/S	179	n/a	MNRF	Serrao 2016
	2014	6	E	n/a	n/a	TRCA	Lawrie 2017
	2015	33	E	n/a	n/a	TRCA	Lawrie 2017
	2016	4	E/S	30m	305	U. of Toronto/ GEO Morphix	Castaneda 2016; Villard and Heaton 2016
	2016	6	eDNA	n/a	n/a	MNRF	Serrao 2016
Highland River	2008	15	E	n/a	n/a	TRCA	Lawrie 2017
	2010	6	E	n/a	n/a	TRCA	Lawrie 2017
	2011	11	E	n/a	n/a	TRCA	Lawrie 2017
	2014	13	E	n/a	n/a	TRCA	Lawrie 2017
	2015	6	E	n/a	n/a	TRCA	Lawrie 2017
Don River	2008	24	E	n/a	n/a	TRCA	Lawrie 2017
	2008	27 pools	S	678m	n/a	U. of Toronto	Poos <i>et al.</i> 2012
	2009	1	E	n/a	n/a	TRCA	Lawrie 2017
	2010	2	E	n/a	n/a	TRCA	Lawrie 2017
	2011	23	E	n/a	n/a	TRCA	Lawrie 2017
	2013	1	eDNA	n/a	n/a	MNRF	Serrao 2016
	2013	1	E/S	25	n/a	MNRF	Serrao 2016
	2014	27	E	n/a	n/a	TRCA	Lawrie 2017
	2015	3	E	n/a	n/a	TRCA	Lawrie 2017
	2017	2	S	n/a	n/a	MNRF/TRCA	Lawrie 2017
Humber River	2008	12	E	n/a	n/a	TRCA	Lawrie 2017
	2008	10 pools	S	426m	n/a	U. of Toronto	Poos <i>et al.</i> 2012
	2009	3	E	n/a	n/a	TRCA	Lawrie 2017
	2010	36	E	n/a	n/a	TRCA	Lawrie 2017
	2013	4	eDNA	n/a	n/a	MNRF	Serrao 2016

Watershed	Year	Number of Sites Surveyed	Gear	Area sampled (m <sup>2</sup> )	Seconds shocked	Agency	Reference
	2013	4	E/S	409	n/a	MNRF	Serrao 2016
	2013	31	E	n/a	n/a	TRCA	Lawrie 2017
	2014	6	eDNA	n/a	n/a	MNRF	Reid <i>et al.</i> 2017
	2015	12	E	n/a	n/a	TRCA	Lawrie 2017
	2015	5	eDNA	n/a	n/a	MNRF	Reid <i>et al.</i> 2017
Mimico River	2008	7	E	n/a	n/a	TRCA	Lawrie 2017
	2009	4	E	n/a	n/a	TRCA	Lawrie 2017
	2011	5	E	n/a	n/a	TRCA	Lawrie 2017
	2013	2	E	n/a	n/a	TRCA	Lawrie 2017
	2014	5	E	n/a	n/a	TRCA	Lawrie 2017
	2015	4	E	n/a	n/a	TRCA	Lawrie 2017
Etobicoke Creek	2008	6	E	n/a	n/a	TRCA	Lawrie 2017
	2009	2	E	n/a	n/a	TRCA	Lawrie 2017
	2010	14	E	n/a	n/a	TRCA	Lawrie 2017
	2013	15	E	n/a	n/a	TRCA	Lawrie 2017
	2015	8	E	n/a	n/a	TRCA	Lawrie 2017
Credit River	2008-2016	50 sites annually	E	n/a	n/a	CVCA	Morris 2016
	2013	1	eDNA	n/a	n/a	MNRF	Serrao 2016
	2013	1	E/S	58	n/a	MNRF	Serrao 2016
	2015	2	video	n/a	n/a	GEO Morphix	Davis <i>et al.</i> 2015
	2016	2	E	180m	946	GEO Morphix	Villard and Heaton 2016
Morrison Creek	2008	1				HC	Dunn 2016
	2010	2				HC	Dunn 2016
	2012	1				HC	Dunn 2016
	2014	1				HC	Dunn 2016
	2015	9	eDNA	n/a	n/a	MNRF	Reid <i>et al.</i> 2017
Sixteen Mile Creek	2008	25				HC	Dunn 2016
	2009	24				HC	Dunn 2016
	2010	4				HC	Dunn 2016
	2011	38				HC	Dunn 2016
	2012	7				HC	Dunn 2016
	2013	59				HC	Dunn 2016

Watershed	Year	Number of Sites Surveyed	Gear	Area sampled (m <sup>2</sup> )	Seconds shocked	Agency	Reference
	2013	1	eDNA	n/a	n/a	MNRF	Serrao 2016
	2013	1	E/S	24	n/a	MNRF	Serrao 2016
	2014	2				HC	Dunn 2016
	2015	46				HC	Dunn 2016
	2016	4				HC	Dunn 2016
	2016	5	E	n/a	n/a	U. of Toronto	Castaneda 2016
Fourteen Mile Creek	2008	4				HC	Dunn 2016
	2010	5				HC	Dunn 2016
	2012	19				HC	Dunn 2016
	2013	2				HC	Dunn 2016
	2013	3	eDNA	n/a	n/a	MNRF	Serrao 2016
	2013	1	E/S	120	n/a	MNRF	Serrao 2016
	2014	6				HC	Dunn 2016
	2015	5				HC	Dunn 2016
	2016	4				HC	Dunn 2016
	2016	5	E	n/a	n/a	U. of Toronto	Castaneda 2016
Bronte Creek	2008	7				HC	Dunn 2016
	2009	1				HC	Dunn 2016
	2010	16				HC	Dunn 2016
	2011	7				HC	Dunn 2016
	2012	32				HC	Dunn 2016
	2014	10				HC	Dunn 2016
	2014	17	eDNA	n/a	n/a	MNRF	Reid <i>et al.</i> 2017
	2016	7				HC	Dunn 2016
Spencer Creek	2015	11	eDNA	n/a	n/a	MNRF	Reid <i>et al.</i> 2017
Grand River	2016	13	E	n/a	n/a	U. of Toronto	Castaneda 2016
Saugeen River	2013	1	S/E	n/a	n/a	MNRF	Serrao 2016
	2016	5	E	n/a	n/a	U. of Toronto	Castaneda 2016
Gully Creek	2008	10 pools	S	491m	n/a	U. of Toronto	Poos <i>et al.</i> 2012
	2008	1	n/a	n/a	n/a	n/a	Redside Dace Recovery Team
	2009	4	n/a	n/a	n/a	n/a	Redside Dace Recovery Team

Watershed	Year	Number of Sites Surveyed	Gear	Area sampled (m <sup>2</sup> )	Seconds shocked	Agency	Reference
	2010	2	n/a	n/a	n/a	n/a	Redside Dace Recovery Team
	2013	1	eDNA	n/a	n/a	MNRF	Serrao 2016
	2013	1	E/S	62	n/a	MNRF	Serrao 2016
	2016	4	E	n/a	n/a	U. of Toronto	Castaneda 2016
South Gully Creek	2011	4 (sampled twice)	n/a	n/a	n/a	n/a	Redside Dace Recovery Team
	2013	2	E/S	24		MNRF	Serrao 2016
	2016	1	E	n/a	n/a	U. of Toronto	Castaneda 2016
Two Tree River	2009	4	n/a	n/a	n/a		Redside Dace Recovery Team
	2010	12	n/a	n/a	n/a		Redside Dace Recovery Team
	2011	4	n/a	n/a	n/a		Redside Dace Recovery Team
	2013	1	E/S	n/a	n/a	MNRF	Serrao 2016
	2015	1	n/a	n/a	n/a		Redside Dace Recovery Team
Kettleby Creek	2013	1	E/S	n/a	n/a	MNRF	Serrao 2016
	2014	11	eDNA	n/a	n/a	MNRF	Reid 2017
Sharon Creek	2014	3	eDNA	n/a	n/a	MNRF	Reid 2017
	2015	6	eDNA	n/a	n/a	MNRF	Reid 2017

## HABITAT

### Habitat Requirements

Redside Dace occupy small tributaries 5-10 m in width with pool and riffle areas (McKee and Parker 1982; Meade *et al.* 1986). During most of the year, including the winter, they are found in midwater positions of pools (Novinger and Coon 2000; Zimmerman 2009; Poos *et al.* 2012; Villard and Heaton 2016) 11-100 cm deep (Coon 1993). Substrate of occupied stream reaches is highly variable, ranging from silt to boulders (Koster 1939; Trautman 1957; McKee and Parker 1982). Redside Dace habitat usually has riparian vegetation consisting of overhanging grasses and shrubs such as alder (Koster 1939). Production of its principal food supply, largely dipterans (Daniels and Wisniewski 1994), depends on presence of this vegetation. Streams running through relatively open areas are considered superior to those in forested areas provided riparian vegetation is present (Andersen 2002; Parish 2004).

Redside Dace is considered to be a cool-water fish. McKee and Parker (1982) reported the maximum temperature experienced by the species during August/September in Ontario to be 23°C, although usually below 20°C. Maintaining these conditions depends on the presence of intact headwater features and groundwater seepage (Redside Dace Recovery Team 2010). Dissolved oxygen concentration is usually greater than 7 mg/L. Streams are usually clear; those with significant amounts of organic material on the substrate are sometimes brown tinged. Despite these habitat preferences, Redside Dace were found by McKee and Parker (1982) at two sites with elevated turbidity (i.e., 0.3 m Secchi disc transparency). by Holm (pers. comm. 2016) in turbid water in Fourteen Mile Creek, and by Castaneda (pers. comm. 2017) in very turbid water (10-20 NTU) in Two Tree River. Records from turbid waters in the GTA are more likely the result of temporary high flow events than tolerance of poor water quality.

Spawning has been observed in riffle, run, and the tail-end of pool habitats (Koster 1939; Zimmerman 2009; Lawrie pers. comm. 2017). McKee and Parker (1982) noted the absence of Redside Dace in pools of the East Humber River in early May and suggested the pre-spawning fish had relocated to riffle areas. Koster (1939) noted adults moving from pool to gravelly riffle areas to spawn in late May when water temperature was 18°C or higher.

## **Habitat Trends**

Most of the waterways containing Redside Dace flow through the GTA, one of the most highly developed, and developing, regions in Canada. Habitat degradation associated with urbanization is considered the most important cause of decline in the species (COSEWIC 2007). In general, as development has proceeded inland from the Lake Ontario shoreline, most populations of Redside Dace have been lost from higher-order stream reaches, relegating the remaining populations to ever-decreasing stretches of headwater habitat (Figure 5; Reid and Parna 2017). While Redside Dace is sometimes considered to be a headwater specialist, this perception is likely an artifact of the loss of the species from previously suitable downstream habitat (Redside Dace Recovery Team 2010). In addition to urbanization, habitat degradation has been associated with other causes such as agriculture and aggregate and water extraction. Specific factors that have been implicated in the decline of Redside Dace throughout its range include, elimination or alteration of riparian vegetation, siltation, elevated turbidity, channel alteration, increased variation in water flow regimes, altered temperature regimes, instream barriers, pollutant inputs, and exotic species introductions (Daniels and Wisniewski 1994; COSEWIC 2007; Redside Dace Recovery Team 2010).

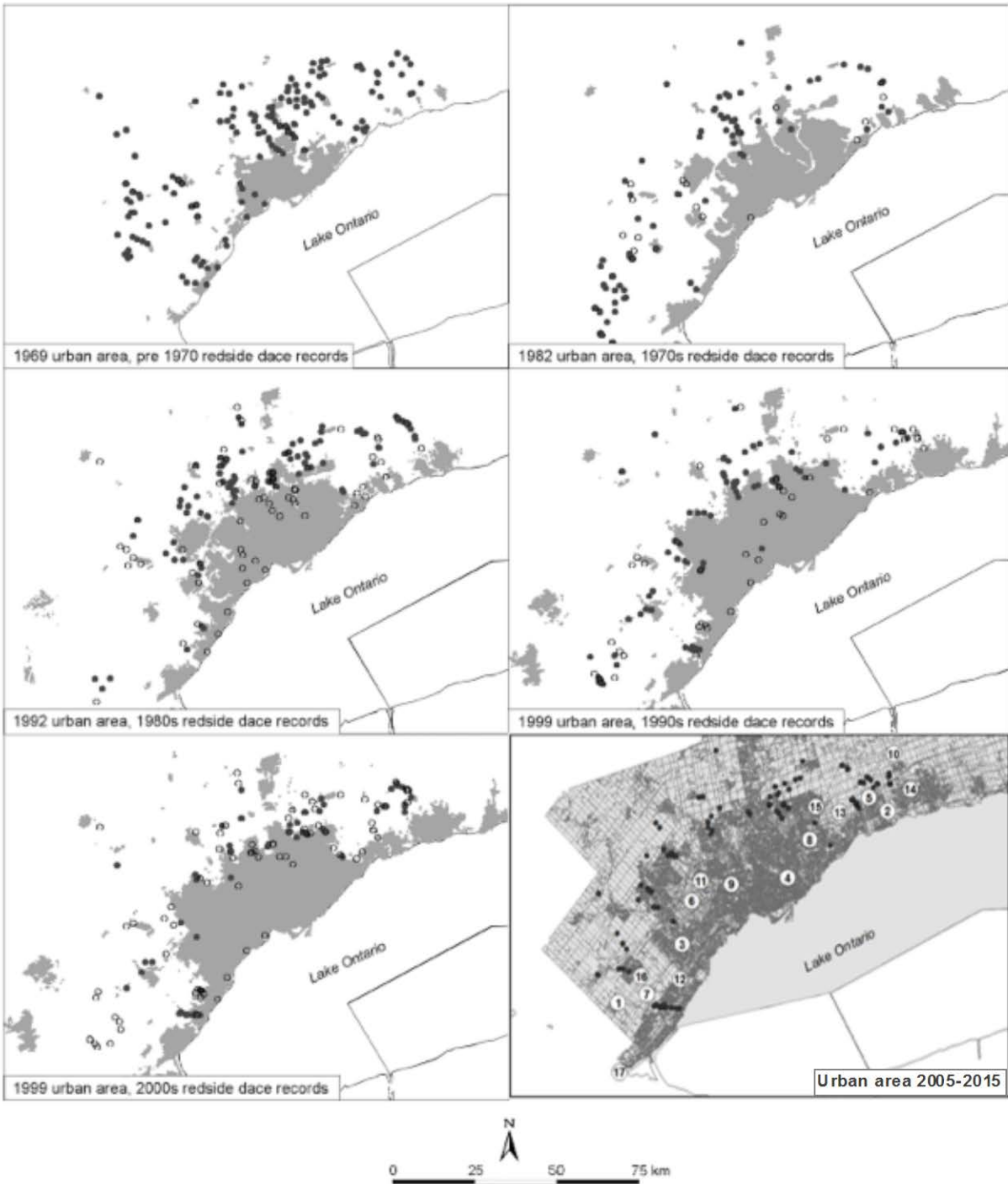


Figure 5. Distribution of Redside Dace (*Clinostomus elongatus*) in the Greater Toronto Area over time. Closed circles represent sites where Redside Dace were captured; open circles represent sites of former Redside Dace occurrence where sampling occurred, but no Redside Dace were captured; dark grey shading represents extent of urban area. Numbers in lower right panel correspond to GTA watersheds numbered in Figure 3.

The most immediate concerns about habitat trends apply to catchments in the GTA, several of which are expected to undergo additional development, or are adjacent to areas where development is planned (COSEWIC 2007). One particularly notable project planned in Pickering is the Seaton Community, to be situated in the headwaters of Duffins Creek. The community will house up to 70,000 residents in an area of 2785 hectares. Some 53% of the area, including forest, wetlands, valley, and floodplains, has been designated as a Natural Heritage System and a monitoring program has been established to evaluate the impact of the development and the water management measures to be implemented (TRCA 2016). The ultimate impact on Redside Dace in Duffins Creek remains to be determined. Additional future development is also expected in the headwater region of Fourteen Mile Creek, although details are not available (Dunn pers. comm. 2016). Population projections by the Government of Ontario suggest an increase of 42.3% (from 6.7 to 9.6 million) in the GTA between 2016 and 2041 (Ontario Ministry of Finance 2017), with growth likely occurring into the remaining range of Redside Dace in the GTA.

Water-quality parameters in the Credit River are deteriorating (Morris pers. comm. 2016). Elevated levels of bacteria and contaminants, including nutrients and chlorides, were reported in Fletcher's Creek and Silver Creek (CVC 2002). Declines in Redside Dace in these tributaries have been attributed to poor water quality. Water quality in Lynde Creek, based on phosphorus loading, is rated fair (CLOCA 2016).

The range of Redside Dace in Canada is severely fragmented as greater than 50% of the populations likely occur in habitat patches that are smaller than required to support a viable population and are separated from other habitat patches by a distance greater than the species can disperse (<500 m; Poos and Jackson 2012) and, in most cases, by physical watersheds. In 2007, DFO conducted a recovery potential workshop for Redside Dace (DFO 2009; Mandrak pers. comm. 2017). In that workshop, 14 participants evaluated among other things, the population status of Redside Dace by watershed. Population status was evaluated by assessing spatial extent, abundance, and trajectory. Population size was assessed as small (<100 individuals), medium (100-1,000 individuals), and large (>1,000 individuals). Of the 24 populations considered, five were considered extirpated and four were not assessed. Of the 15 populations assessed, 10 were assessed as small populations, three as medium populations, and two as large populations (Table 4). Velez-Espino and Koops (2009), recommended a recovery target of 4,711. Based on this recovery target, at least 13 of 15 assessed populations are not viable. As Redside Dace is a habitat specialist, and habitat degradation and loss is the greatest threat to the species, it can be inferred that the habitat patches for at least 13 of the populations are smaller than required to support a viable population.

## BIOLOGY

### Life Cycle and Reproduction

Spawning was observed in Danby Creek, a headwater stream of the Susquehanna River, in late May when water temperature reached 18°C (Koster 1939). Similar timing of spawning in the East Humber River was reported by Parker and McKee (1982) and in Fourteen Mile Creek (COSEWIC 2007; Holm pers. comm. 2016). Males, followed soon after by females, leave pool habitat and enter shallow areas with fine gravel substrate just prior to spawning. Males establish small territories just downstream of nest depressions constructed by Common Shiner (*Luxilus cornutus*) or Creek Chub (*Semotilus atromaculatus*). Ripe females, accompanied by one to several males, enter the depression and deposit non-adhesive eggs in the gravel (Koster 1939). Host species may enhance survivorship of Redside Dace eggs by providing some protection from predators and by removing debris from the nest.

The maximum age reported for Redside Dace in New York (Koster 1939) and Pennsylvania (Schwartz and Norvell 1958) is four years. In Ontario, the maximum age observed is five years (Drake pers. comm. 2017) although most do not survive beyond three years (McKee and Parker 1982). Growth in Ontario populations is comparable to those in New York, Pennsylvania, and Wisconsin (Becker 1983). First-year fish grow very rapidly, followed by annual decrease in growth increments of approximately 5% (Schwartz and Norvell 1958). Most individuals mature following their second winter and all are mature after three winters (Koster 1939; McKee and Parker 1982); therefore, the generation time is 2-3 years.

### Physiology and Adaptability

Little information is available about physiology of Redside Dace. Novinger and Coon (2000) reported that metabolic rate increases with temperature and that critical thermal maximum increases with acclimation temperature. McKee and Parker (1982) found Redside Dace at oxygen concentrations as low as 4.0 mg/L although, at most sites, oxygen concentration was greater than 7.0 mg/L.

Redside Dace is not generally considered to be tolerant of habitat disturbance. The species has disappeared from many streams in which conditions have been altered. For example, the species has disappeared from some Ohio streams that have been affected by domestic, agricultural, and industrial pollution (Trautman 1957). Water-quality requirements have been described as “stringent” and the species is usually found in clear streams (McKee and Parker 1982).

Dietary studies have revealed that Redside Dace is predominantly a surface feeder. Gut-content analyses are consistent in finding a large proportion of terrestrial insects, particularly Dance Flies (Empididae), in the diet (Schwartz and Norvell 1958; McKee and Parker 1982; Daniels and Wisniewski 1994).



## Dispersal and Migration

Redside Dace spend most of their time in pools. Until specific studies were conducted, dispersal was thought to be restricted to springtime movement between pool habitat and adjoining riffle spawning habitat (Koster 1939; McKee and Parker 1982). Using mark-recapture methods, Poos and Jackson (2012) determined that movement of Redside Dace in two tributaries of the Rouge River is generally restricted. By tracking movements of 2141 individuals over a one-year period, they reported that dispersal does appear to be limited, but more extensive than previously thought. In Berczy Creek, 41% of recaptures were in the same pool, while 31% of recaptures in the Leslie tributary were in the same pool. Individuals dispersing among pools usually moved less than 100 m, and an average of only 3.8% of inter-pool movement involved displacement greater than 300 m. However, dispersal models suggest that the probability of moving >500 m is 0.4-5%, and varies seasonally, while the probability of moving >1000m varies between very rare and 1%. Unpublished results from this study indicate that the magnitude of movement (both dispersal distance and frequency) differed seasonally in the two creeks. Substantial movement was observed during July/August in Berczy Creek, and during September/October in Leslie tributary. Movements were correlated with high catch-per-unit-effort of cyprinid and catostomid species in the destination pool (Creek Chub, Bluntnose Minnow *Pimephales notatus*, White Sucker *Catostomus commersonii*, Common Shiner), suggesting that Redside Dace may be responding directly to the presence of these species (i.e., signifying a schooling effect or capitalizing on nest-building potential), or may be responding to habitat conditions that benefit the set of species (Drake pers. comm. 2017).

Schwartz and Norvell (1958) found that the sex ratio of Redside Dace sampled in a Pennsylvania stream changed seasonally. Specifically, the proportion of males decreased in samples taken during the spring and was extremely low after June. This observation suggests the possibility of sex-specific movement, but other workers have not reported this phenomenon.

## Interspecific Interactions

Redside Dace usually lives in mixed-species groups, often schooling with Creek Chub, Eastern Blacknose Dace (*Rhinichthys atratulus*), White Sucker, Bluntnose Minnow, and Common Shiner (Koster 1932; Poos and Jackson 2012; Drake pers. comm. 2016). This behaviour has been hypothesized to reduce predation risk (Poos and Jackson 2012) and extends to spawning behaviour as well. Redside Dace has been observed to deposit eggs in redds constructed by other species, specifically Creek Chub and Common Shiner. Hybridization has been documented among these species, probably facilitated by their associations on the spawning grounds (Koster 1939). Redside Dace is a small-bodied fish that is subject to predation by a variety of larger fishes and other animals. The nature of interactions between native Brook Trout (*Salvelinus fontinalis*) and Redside Dace is not known, but the two species naturally co-occur in some watersheds (e.g., Duffins Creek). Introduced predatory species are considered to have contributed to the decline of the species in some catchments (see Threats section).

## POPULATION SIZES AND TRENDS

### Sampling Effort and Methods

Most survey work was done using seine nets and/or backpack electrofishers. Some records are based on visual observations rather than physical captures. Very recently, underwater video cameras have been deployed to record occurrences (Davis *et al.* 2015; Castaneda pers. comm. 2016; Lawrie pers. comm. 2017). Another recently developed method for detecting Redside Dace, and other species, is analysis of water samples for DNA using quantitative polymerase chain reaction (qPCR). When a species is present in a stream, DNA deposited into the water column (environmental DNA or eDNA) due to sloughing of skin and gut cells can be detectable using sensitive laboratory methods (Darling and Mahon 2011; Serrao 2016).

### Abundance

The lack of consistent population sampling through time prevents quantitative estimates of abundance in most systems (Heaton pers. comm. 2016). Qualitative indications of abundance rely on presence/absence information determined through time from the various survey efforts outlined above. Systematic sampling in five Toronto area catchments has permitted quantitative estimates of abundance (Poos *et al.* 2012; details below). Because these estimates represent a snapshot in time, they are not informative regarding trends in abundance.

COSEWIC (2007) used 1 km x 1 km grids to measure area of occupancy. Although it is no longer acceptable to measure the index of area of occupancy at this scale, measuring area of occupancy at this scale represents an index of abundance appropriate to the taxon. It is appropriate because the species occurs in habitat patches in streams typically less than 10 m wide. COSEWIC (2007) reported area of occupancy to be 441 km<sup>2</sup>. Using the same grid scale on 2007-2016 data, the area of occupancy is 83 km<sup>2</sup> and, as an index of abundance, represents a decline of >81%.

### Fluctuations and Trends

Redside Dace has been historically recorded from 62 Ontario streams (Redside Dace Recovery Team 2010) within 26 watersheds (Table 2). In general, there has been a lack of repeated sampling of the same sites using the same gear type; therefore, there is little information regarding population trends. Few of the original Ontario Department of Planning and Development (ODPD) sites, sampled in the 1950s, are included among sites sampled on a regular basis by several Conservation Authorities. Almost all ODPD sites included in ongoing sampling rotations have yielded no Redside Dace since regular rotations began. Similarly, catch records at other sites in the rotations (i.e., those not sampled by ODPD) are not informative. Redside Dace have never been recorded at most of these sites. The species has been recorded at a few other sites consistently (e.g., sites on the Leslie and Berczy tributaries of Rouge River and Mitchell's Creek tributary of Duffins Creek) while other sites have yielded records on single occasions.

**Table 2. Recent trends in Redside Dace populations in Ontario watersheds.**

<b>Watershed</b>	<b>Stable</b>	<b>Decline</b>	<b>Extirpated</b>	<b>Comment</b>
Pringle Creek			X	Last record in 1959
Lynde Creek		X		20 sites sampled in 2015, 2016; none collected
Carruthers Creek	X?			Recent surveys
Duffins Creek		X?		Extensive recent surveys
Petticoat Creek			X	Last record in 1954
Highland Creek			X	Last record in 1952
Rouge River		X?		Few records from Morningside Creek
Don River			X?	Last record in 2013; recent surveys
Humber River	X?			Largest known Ontario population
Mimico Creek			X	Last record in 1949
Etobicoke Creek			X?	Last record in 1940
Clarkson Creek			X	Last record in 1927
Credit River		X		Regular sampling over last decade; few records
Morrison Creek			X?	eDNA detection in 2015
Sixteen Mile Creek		X		Few recent records
Fourteen Mile Creek	X?			Many recent records but from increased effort
Bronte Creek		X?	X?	Last record in 1998; extensive surveys recently
Spencer Creek		X		Last record from 1998
Niagara Peninsula			X	Last record from 1960
Kettleby Creek		X?		eDNA detection in 2014
Sharon Creek			X?	Single record from 1994; surveyed repeatedly
Grand River (Irvine Creek)		X?	X?	Last record in 2003; recent surveys
Gully Creek	X			Appears stable
South Gully Creek	X			Appears stable
Saugeen River		X		Last record in Meux Creek in 2004; limited recent surveys
Two Tree River	X			Appears stable

Population trends across watersheds, based on presence/absence data, are indicated in Table 2. There is strong evidence indicating the species has been extirpated from eight watersheds (Pringle Creek, Petticoat Creek, Highland Creek, Don River, Mimico Creek, Etobicoke Creek, Clarkson Creek, Sharon Creek). Two records from an unidentified creek on Niagara Peninsula are unconfirmed. If Redside Dace did occur there historically, the species has almost certainly been extirpated from that catchment as well. Redside Dace may have been extirpated from three additional watersheds (Morrison Creek, Bronte Creek, Grand River (Irvine Creek, Snow Drain)). Surveys suggest continuing decline in population sizes in several systems including Lynde Creek, Duffins Creek, Rouge River (east branch, Morningside Tributary), Credit River, Sixteen Mile Creek, and possibly Spencer Creek, Kettleby Creek, and Saugeen River (main branch, Meux Creek). At present, the largest populations are believed to occur in Rouge River and Humber River (Poos *et al.* 2012). Stable populations appear to be present in three small Lake Huron watersheds (Two Tree River, Gully Creek, and South Gully Creek). Populations in Carruther's Creek, Humber River, and Fourteen Mile Creek may be stable.

### Pringle Creek

The most recent record is from 1959. The Central Lake Ontario Conservation Authority has sporadically surveyed 13 sites (electrofishing and seining) over the period 2008 – 2016. Redside Dace is likely extirpated from Pringle Creek (Andersen 2002; Kelsey pers. comm. 2017).

### Lynde Creek

Many sites in Lynde Creek have been sampled since the last COSEWIC assessment (COSEWIC 2007); all live specimens recorded over that period have come from the west branch, in and near Heber Down Conservation Area. Seven specimens were collected in a small area south of Lyndebrook Road in 2009. The presence of Redside Dace in the same area was confirmed in at least two sampling events in 2010 (number of individuals not recorded). In 2012, eDNA was detected at a nearby site. Two specimens were collected in 2009 at a site in the northern portion of Heber Down Conservation Area and Redside Dace were observed (number not recorded) in 2010 at another site just upstream. A site just downstream of Highway 7 yielded a single specimen in 2009 and 3 specimens in 2014. An unknown number was observed at this site in 2010. A single specimen was captured just north of Highway 7 in 2014. The few specimens captured and eDNA detections noted above were the result of considerable effort. OMNRF and Central Lake Ontario Conservation Authority sampled 75 sites throughout the watershed using backpack electrofishing in 2009 and 2014 (Moore 2017).

A major agricultural spill occurred in the west branch of Lynde Creek just upstream of Watson's Glen Golf Course in July 2014. A mixture of manure and acidic material caused severe reduction of dissolved oxygen and pH along approximately 21 km of stream, including much of the Heber Down Conservation Area (Moore 2017). Much of the affected area was surveyed on foot and dead fishes were noted. Although Redside Dace was not observed among the dead fish, it was determined that the spill eliminated almost all fishes in the affected area. Following the spill, 20 sites were electrofished in 2014, 2016, and 2017 by OMNRF (Reid 2016), but Redside Dace was not found. The extent of the fish kill is indicated by severely reduced species diversity and density downstream of the spill site determined in the 2014 sampling. Prior to the spill, densities at surveyed sites averaged 1.65/m<sup>2</sup> versus 0.02/m<sup>2</sup> after the spill (Moore 2017). Finally, a major effort to detect eDNA was completed in 2013 and 2014 by OMNRF (Reid *et al.* 2017). Water samples from 72 sites resulted in eDNA detections at four sites, three on west branch and one site on the east branch. These recent survey results indicate that Redside Dace is present in very low numbers in both branches of Lynde Creek.

### Carruthers Creek

No records from the lower reaches of Carruthers Creek are known since 1978 (Natural Heritage Information Centre). All subsequent records are from Highway 407 southward to Deer Creek Golf Course, including 90 individuals captured in 2001 (Ruthven pers. comm. 2001). Since the previous COSEWIC assessment (COSEWIC 2007), specimens were reported from eight sites in this area in 2009 (two specimens), 2011 (two specimens), 2013 (two live specimens and eDNA), 2014 (56 specimens), and 2015 (47 specimens). Serrao (2016) collected 50 specimens just north of Deer Creek Golf Course in 2012/2013. In 2016, seven specimens were captured in a 30 m stream corridor upstream of Highway 7 that was re-aligned in 2005 (Villard and Heaton 2016).

### Duffins Creek

Redside Dace was known to be present in three areas of Duffins Creek at the time of the previous COSEWIC status report (COSEWIC 2007), including the east branch headwater tributary Mitchell Creek, downstream tributaries of East Duffins Creek, and Ganatsekiagon Creek. Specimens have been captured at sites in all of these areas since 2007. In Mitchell Creek, three sites yielded specimens or eDNA detections. Redside Dace were recorded in 2009 (specimens from two sites), 2012 (specimens at one site, eDNA detected at one site), 2014 (specimens at one site), and 2015 (specimens at one site). Two sites farther downstream on the east branch produced records; one specimen in Brougham Creek in 2009 and one eDNA detection in the east branch in 2012. In Ganatsekiagon Creek, Redside Dace was reported from nine sites including two sites in 2009 (eight live specimens), one site in 2010 (two specimens), one site in 2012 (one specimen and eDNA detection), one site in 2013 (eDNA detection), and six sites in 2015 (46 specimens).

Intensive sampling of 2105 m of stream length (including 10 pools) in 2008 resulted in an estimated basin-wide population size of 1207-2398 individuals (Poos *et al.* 2012).

### Petticoat Creek

Redside Dace was likely extirpated from Petticoat Creek prior to the most recent status update (COSEWIC 2007). No specimens have been reported since 1954 despite regular surveys (Lawrie pers. comm. 2017).

### Rouge River

Although the Rouge River populations were considered to be among the healthiest in Ontario in 2007, with specimens captured at many sampling sites, significant declines were noted in preceding years, particularly in Morningside Creek (COSEWIC 2007). All recent records are from tributaries of the west branch and were reported by MNRF and University of Toronto personnel. Extensive sampling in Berczy Creek and the Leslie tributary in 2008 yielded 2141 specimens (Poos and Jackson 2012). A quantitative estimate of population size for the Rouge River was 4499-9180 individuals (Poos *et al.* 2012). A single individual from Morningside Creek was reported in 2009. Another single individual was captured in Bruce Creek in 2012. In Berczy Creek, additional specimens were captured in 2009 (three sites), 2012 (three sites), 2013 (one site), 2014 (two sites), and 2015 (two sites). Additional specimens from Leslie tributary were reported from 2009 (five sites), 2010 (one site), 2012 (two sites), 2014 (one site), and 2015 (one site). The Robinson Creek tributary, which enters the west branch of the Rouge River at Milne Dam Conservation Park is believed to support Redside Dace, although specimens have not been reported since the previous COSEWIC assessment. The lack of recent records from the east branch (Little Rouge) suggests the possibility the species has been extirpated from that part of the watershed.

### Highland Creek

Redside Dace was considered likely extirpated from Highland Creek by COSEWIC (2007) because no specimens had been reported since 1952. Highland Creek is surveyed regularly as part of the Toronto Region Conservation Authority monitoring program.

### Don River

Considerable effort has been expended searching for Redside Dace in the Don River over the last 30 years. The decline of Redside Dace from both east and west branches of the Don River is documented by COSEWIC (2007). The species was widespread into the 1980s and 1990s. There are no recent records for the west branch and the species may now be extirpated there (Lawrie pers. comm. 2017). Only four recent records exist for the east branch; all from a small area in Richmond Hill. In 2011, a single individual was captured in Little Don Park. In 2013, the species was captured on video at two sites, both upstream from the 2011 record. One site was near the Bathurst/Major MacKenzie intersection; the second was approximately one kilometre upstream, just below Mill St. eDNA was also detected in 2013 at one site (Serrao 2016). Intensive sampling in the east branch in 2008 revealed Redside Dace in only two of 27 pools (Poos *et al.* 2012; Lawrie pers. comm. 2017). However, high densities were observed in those two pools (99.2 individuals/pool). The basin-wide population estimate was 402-1607 individuals (Poos *et al.*

2012). Substantial seine and video sampling of the two pools in 2016 and 2017 failed to detect any Redside Dace (Lawrie pers. comm. 2017). It is likely that the species is now extirpated in the Don River.

### Humber River

The Humber River appears to contain one of the healthier populations of Redside Dace in Canada. It is unusual among Canadian watersheds regarding historical patterns of Redside Dace occurrence. As described in COSEWIC (2007), extensive survey effort during the 1940s across the system revealed the species to be present only in a limited portion of the east branch and a single site in Black Creek. Subsequent sampling revealed the species to be present in the main branch (near Bolton) in 1959. Surveys conducted during the 1970s, 1980s, 1990s, and early 2000s found Redside Dace in the east, west, and central Humber branches. Fieldwork since 2007 has found Redside Dace only in the tributaries of the west Humber and the east Humber upstream of the Kortright Centre for Conservation. In the east Humber, Toronto Region Conservation Authority (TRCA) personnel found a single specimen at the mouth of Marigold Creek in 2009 and MNRF reported another specimen upstream in the same year. Three sites on Purpleville Creek (east Humber) yielded specimens in 2011 and 2014 while two sites near Hwy 11 (between Hwy. 400 and Hwy. 27) yielded a total of 5 specimens in 2010 and 2014.

On the west Humber, MNRF reported Redside Dace in Kilmanagh Creek at one site in 2009, two sites in 2010, one site in 2011, one site in 2013, and two sites in 2015. Redside Dace was also captured in a west Humber tributary below Healy Bridge in 2011 (two specimens) and at a site approximately 2km upstream in 2013 (four specimens).

The largest population estimates determined by Poos *et al.* (2012) are in the Humber River (21530-38582 individuals).

### Mimico Creek and Etobicoke Creek

Despite some survey effort over the past 30 years, including recent sampling as part of the TRCA monitoring program, Redside Dace has not been reported from these systems since the 1940s. The species is likely extirpated from these systems, although there is a small possibility the species persists in the headwaters of Etobicoke Creek, which flow through unsurveyed privately owned land (Lawrie pers. comm. 2017).

## Credit River

Redside Dace persist in localized areas of the Credit River. Over the past decade, the Credit Valley Conservation Authority has established approximately 100 sampling sites throughout the watershed, approximately 50 of which are surveyed annually (Morris pers. comm. 2016). Recent records exist from Fletcher's Creek (two sites in 2010, two sites in 2011, two sites in 2014), Huttonville Creek (one site in 2008), Silver Creek (two sites in 2014, one site in 2016), Springbrook Creek (one site in 2011), and an unspecified tributary near Eldorado Park. Sites that have yielded Redside Dace historically, but not recently, include Rogers Creek, Levi's Creek, and Caledon Creek.

## Morrison Creek

The most recently caught specimens of Redside Dace in Morrison Creek were electrofished in 2000 in a 1.7 km section of stream. COSEWIC (2007) considered the species to be extirpated or nearly extirpated from this system; however, an eDNA detection was made in 2015 at one of nine sites sampled. An extensive search in 2016 by MNRF staff did not locate live specimens (Dunn pers. comm. 2016).

## Sixteen Mile Creek

Catch records suggest a contraction in Sixteen Mile Creek prior to 2007, particularly in the most upstream reaches, although the species appears to persist throughout much of the system. McKee and Parker (1982) were unable to find the species despite "intensive effort" in 1979 and 1980. Recent MNRF records include two sites on the west branch from 2008, and one nearby site from 2009 (all three sites approximately 700 m upstream of Highway 401 near Kelso Conservation Centre), two sites from 2010 on the middle east branch (upstream of #5 Sideroad east of 5<sup>th</sup> Line), one site from 2011 on the middle east branch (approximately 2 km upstream of 2010 sites), one site from 2013 on the middle east branch (one of the sites from 2010), and two sites from 2015 (both on middle east branch near #5 Sideroad and 5<sup>th</sup> Line). Targeted sampling by University of Toronto personnel at five sites in 2016 (west branch downstream of Kelso Conservation Centre) did not capture Redside Dace (Castaneda pers. comm. 2016).

## Fourteen Mile Creek

Survey work from 1998-2003 returned significant numbers of Redside Dace and indicated that the population in Fourteen Mile Creek was reasonably healthy. Recent sampling (2010, 2012, 2013, 2015, and 2016) has continued to locate significant numbers of fish. This sampling has been concentrated around the upper Fourteen Mile Creek Lands and just upstream of Upper Middle Road, but also included sites farther upstream and downstream, on both east and west branches. One site on the east branch near Dundas St. West yielded 148 specimens on 20 September 2012.



Early surveys revealed Redside Dace to be widely distributed in Fourteen Mile Creek. Records from 1985 suggested that the species had disappeared from the lower portion of the system, i.e., downstream from the Queen Elizabeth Way highway (COSEWIC 2007). The capture of specimens in this area and a small tributary entering from the east in 2000 and 2016 (Castaneda pers. comm. 2016) suggests either an expansion from upstream reaches or that the species survived in very low numbers since the 1950s.

Fourteen Mile Creek is a relatively small waterway in which catches of Redside Dace appear to have increased in recent years. Whether this is due to population growth, or simply increased sampling effort, is not known (Dunn 2016).

### Bronte Creek

Surveys from the 1970s indicated that Redside Dace was common throughout Bronte Creek including downstream portions of the drainage. From 1970 to 1979, Redside Dace was observed at all 20 sites surveyed (COSEWIC 2007). After that time, the species seems to have largely disappeared from the system. Between 1995 and 2004, three specimens were collected in 1998 at three sites, all a short distance south of the intersection of Highway 6 and Concession Road 10E. The species has not been reported since then in Bronte Creek despite intensive sampling since 2008 (60 sites; Dunn pers. comm. 2016).

### Spencer Creek

A rapid decline in Redside Dace abundance was noted during the 1990s. Sampling during the 1970s indicated that the species was widely distributed in the upper main branch of Spencer Creek and in a tributary, Flamborough Creek. Staton *et al.* (1993) and Thompson *et al.* (1995) found specimens only in a 1-2 km portion of habitat (downstream of Safari Road and east of Westover Road) where the species was noted in the 1970s. The most recent record is a single specimen captured in this area in 1998 (Redside Dace Recovery Team; RSD database). Unsuccessful searches at three sites previously occupied by Redside Dace were made in 1998, 2001, and 2004. Water samples collected in 2015 from 11 sites were negative for eDNA (Reid *et al.* (2017). Current population trends are unknown due to insufficient sampling.

### Niagara Peninsula

There are no records from the Niagara Peninsula since 1960. As noted previously, if historical records of Redside Dace on Niagara Peninsula are reliable, the species has probably been extirpated from this area.

## Grand River

The decline in the Grand River described in COSEWIC (2007) appears to have continued. Sampling in 1997-2005 revealed apparent disappearance from several historically occupied sites on Irvine Creek and Snow Drain and strong declines at other sites more recently found to support Redside Dace. The last specimen was collected at Irvine Creek by DFO personnel in 2003. There has been no sampling from 2005 through 2015 (Barnucz pers. comm. 2016). In 2016, University of Toronto personnel surveyed 8 headwater sites on Irvine Creek and Snow Drain specifically for Redside Dace, but found none (Castaneda pers. comm. 2016). All of these sites had either yielded Redside Dace in previous sampling events, or are situated very near to sites that historically supported the species. The species may be extirpated from the Grand River; however, additional sampling is needed for confirmation.

## Saugeen River

Little sampling effort has been expended in the Saugeen watershed since the previous COSEWIC status update (Scheifley pers. comm. 2016). In 1953/1954, five sites along a 13 km stretch of Meux Creek (approximately between Neustadt and Alsfeldt) yielded Redside Dace. In 2001, Redside Dace were found at two additional sites in the headwaters of Meux Creek. Sampling in 2004 found only a single specimen in the original five sites (COSEWIC 2007). In 2016, Redside Dace was not found at five sites spanning the combined length of stream sampled in 1953/1954 and 2001 (Castaneda pers. comm. 2016), suggesting that Meux Creek may no longer support Redside Dace.

In the South Saugeen River, one site yielded Redside Dace in 1953. There are no more recent records and no reported search effort since the previous COSEWIC status assessment.

The only part of the Saugeen system to have recent records of Redside Dace is the headwater area near Flesherton. In 1953/1954, 20 sites along a 40 km segment of river yielded Redside Dace. Subsequent sampling of subsets of these sites occurred in 1985 (10 sites), 2000 (nine sites), 2001 (two sites), 2004 (10 sites; COSEWIC 2007), 2005 (six sites), 2013 (one site; Serrao 2016) and 2016 (five sites; Castaneda pers. comm. 2016). Redside Dace were found in 2000 (three sites), 2005 (six sites), 2013 (1site) and 2016 (three sites; targeted sampling). All sites yielding Redside Dace are just downstream of the Osprey Wetland Conservation Lands. The species appears to have been eliminated from most of its historical distribution in the Saugeen River.

## Gully Creeks

Gully Creek, a small stream entering Lake Huron approximately 15 km south of Goderich, was found to contain Redside Dace in 1980 when eight individuals were captured at two sites. The species was subsequently reported in 1999 from one site (one individual), 2001 from one site (six individuals), 2003 from one site (four individuals). One site yielded 282 individuals from five seine hauls in 2007. Fish may have been

concentrated at this site due to low water levels during the summer of 2007 (Drake pers. comm. 2017). In 2009, four sites yielded Redside Dace (at least 24 individuals) and, in 2010, an unknown number of individuals was observed at one site. A single site yielded 36 specimens in 2013 (Serrao 2016) and four sites yielded 17 individuals in 2016 (targeted sampling; Castaneda pers. comm. 2016). A quantitative population size estimate of 462-741 individuals was reported by Poos *et al.* (2012). Unlike the distribution of fish in the Don River, which were found to be concentrated in just two pools, the Gully Creek population was found to be scattered at low density throughout the system, except for the large catch from one site in 2007.

A second small stream, South Gully Creek, located approximately 20 km south of Gully Creek, contains a population of Redside Dace. Sampling in 2008 and 2011 was conducted by MNRF and Ausable Bayfield Conservation Authority. A single fish was captured in June 2008 at one site; the same site yielded four fish in August of 2008. Forty-two individuals were captured at four sites in 2011. In 2016, 60 individuals were sampled at one site (targeted sampling; Castaneda pers. comm. 2016).

### Holland River System

Redside Dace was first detected in Kettleby Creek, a tributary of the Holland River, in 1976 when an unspecified number of fish were observed at one site. In 1980, two sites were sampled, resulting in two individuals recorded at one site and an unspecified number at the other site. Redside Dace was recorded on subsequent sampling attempts at single sites in 1987 (two individuals), 1988 (five individuals), 2003 (one individual), 2005 (one individual), and 2006 (10 individuals). Serrao (2016) collected 35 specimens in 2012-2013 as part of a study of genetic variation in Redside Dace. eDNA was not detected in any of 11 sampling stations in Kettleby Creek in 2014 (Reid *et al.* 2017). Although regular sampling in Kettleby Creek is conducted by Lake Simcoe Conservation Authority, Redside Dace is not specifically targeted (Wilson pers. comm. 2017).

One individual was caught in 1991 in a different tributary of Holland River at the intersection of Hwy 400 and Hwy 9. Subsequent sampling at this site has not been reported. The species was also found in Sharon Creek (one site, four individuals) in 1994. Since that date, repeated recent sampling has not yielded Redside Dace in Sharon Creek (Wilson pers. comm. 2017). Water samples from nine stations in 2014/2015 did not reveal eDNA for Redside Dace (Reid *et al.* 2017).

Redside Dace appears to persist in the Holland River drainage but likely at low abundance. Population trends are unclear from catch records.

## Two Tree River

Two Tree River is a small waterway on St. Joseph Island near Sault Ste. Marie, Ontario. Redside Dace was first reported in 1997 at the culvert of A Line Road (one specimen). Four specimens were reported from the same site in 2002. Between 2009 and 2011, specimens were reported from 20 sites, with numbers of fish per site ranging from one to 63. Serrao (2016) collected 40 specimens in 2013 and a single individual was captured in a small tributary of Two Tree River in 2015. Redside Dace appear to be widely distributed throughout the system.

## **Rescue Effect**

There is virtually no prospect for rescue effect. Redside Dace is a poor disperser based on dispersal models constructed from tagging data from Rouge River (Poos and Jackson 2012; Drake pers. comm. 2017) and the very low levels of gene flow among watersheds (Serrao 2016; Serrao *et al.* 2017). The species is a habitat specialist now generally limited to headwater areas. Rescue from American populations would require dispersal through vast areas of inhospitable habitat including the lower reaches of American and Canadian tributaries to the Great Lakes, many of which have barriers, and the Great Lakes proper and/or major connecting waterbodies such as the Detroit River.

## **THREATS AND LIMITING FACTORS**

To identify the nature and magnitude of threats to the Redside Dace, a threats calculator was completed based on the IUCN-CMP (World Conservation Union-Conservation Measures Partnership) unified threats classification system (IUCN and CMP 2006; Salafsky *et al.* 2008). Based on the threats calculator, the overall threat impact is very high, which indicates a potential population decline of 50-1-00% over the next 10 years (Appendix 2).

## **Physical Habitat Alteration**

Natural system alterations is ranked very high threat impact and is the greatest threat to Redside Dace (Appendix 2). Some of these threats, which operate in both urban and rural settings, result in altered water flow regimes. Many streams are highly modified. Frequently, channels have been widened, resulting in reduction of preferred pool habitat. Prior to enactment of the Ontario *Endangered Species Act* in 2007, the biological needs of Redside Dace, or any other fish species, were not generally considered when stream beds were moved or otherwise altered. A common feature in urban settings is general surface hardening of watersheds caused by road paving and construction of housing and other buildings (Redside Dace Recovery Team 2010). This increases surface imperviousness and, when combined with destruction of headwater features that affect groundwater discharge, can alter base flow and/or dramatically change stream discharge during extreme weather events, especially if combined with poor storm-water management. Poos *et al.* (2012) conducted extensive sampling in five Toronto area watersheds to develop

quantitative estimates of Redside Dace population sizes. They reported a highly significant negative relationship between population size and impervious land-use at pool and sub-catchment scales.

Water flow regimes have also been affected by stream bed alterations associated with reservoir development and establishment of barriers to fish movement. For example, reservoirs installed in the headwaters of Mountsberg Creek (Bronte Creek tributary) and Spencer Creek have altered flow regimes and increased water temperatures (Featherstone 2000). The tributary of the Two Tree River noted above has largely been diverted into a drain that flows beside L Line Road in St. Joseph Island. Stream flow is also disrupted by extraction of surface/subsurface water, although the magnitude of this threat cannot be quantified. Many watersheds occupied by Redside Dace flow through agricultural areas and near golf courses. Water extraction for irrigation reduces flow volumes, potentially to levels insufficient to support Redside Dace and other species. Agricultural drain maintenance also affects fish populations. Snow Drain is a tributary of Irvine Creek (Grand River watershed) that has historically contained Redside Dace. The apparent disappearance of Redside Dace from Irvine Creek in recent years may be associated with clean-out of the drain (Staton pers. comm. 2017).

Redside Dace is also affected by habitat alterations that are not directly connected to stream flow. Removal of riparian vegetation, particularly grasses, forbs, and shrubs, has a negative impact on terrestrial insects which constitute a large fraction of the species' diet. The practice also reduces cover and, along with some physical stream bed alterations such as channelization, results in elevated water temperatures due to reduced shading. The widespread use of broad-spectrum insecticides may also reduce insect forage available to Redside Dace.

## **Invasive Species**

Invasive species is ranked as a very high-medium threat impact (Appendix 2). Introduced predatory species also threaten Redside Dace, although study is required to better characterize the nature of this threat. Northern Pike (*Esox lucius*), Largemouth Bass (*Micropterus salmoides*), and Black Crappie (*Pomoxis nigromaculatus*) are now present in Bronte Creek (COSEWIC 2007; Redside Dace Recovery Team 2010), a system in which Redside Dace has not been observed for more than a decade. The marked reduction in Redside Dace abundance in Spencer Creek may also be associated with predatory species. Salmonids are another potential problem. Redside Dace has disappeared from several streams in Wisconsin, including Deer Creek and Fries Feeder Creek, wherein the distribution of piscivorous Brown Trout (*Salmo trutta*) has expanded (Lyons *et al.* 2000). Brown Trout and Rainbow Trout (*Oncorhynchus mykiss*) are present in some Toronto-area streams and are stocked in the Credit River (Silver Creek; Morris pers. comm. 2016). Brown Trout, in particular, may be a serious threat. Examination of the stomach contents of one individual revealed that it had consumed a large number of Redside Dace (Drake pers. comm. 2017). The impact of Rainbow Trout is more uncertain; an experimental study on Rosyside Dace, the congener of Redside Dace, revealed little interaction with Rainbow Trout when the species were held together in an artificial stream (Rincon and Grossman 1998).

## **Pollution**

Pollution is ranked a high threat impact (Appendix 2). Inputs of toxic materials from numerous sources also threaten Redside Dace. Agricultural activities, particularly cultivation, can accelerate sedimentation and raise turbidity in otherwise clear-water streams. Chronic nutrient inputs, especially nitrogen and phosphorus, are often associated with use of tile beds to rapidly drain farm fields. Redside Dace are also affected by acute episodes of nutrient pollution. For example, a manure spill in Lynde Creek in 2014 resulted in a large fish-kill (Moore pers. comm. 2017). Other sources of pollution include leachate from landfill sites, storm-water inputs, and chloride from roadway salting.

## **Low Level/Potential Threats**

The harvest and sale of bait fishes is a significant component of the Ontario recreational fishery; some 100 million fish are collected annually (OMNR and BAO 2006), mostly from lower reaches of Great Lakes tributaries and nearshore areas of lakes (Drake, pers. comm. 2017). In addition, bait fishes collected by anglers for their own use is a potential source of mortality (Drake pers. comm. 2017). Although Redside Dace is not targeted and collection is illegal, there is some risk of capture through bycatch because the species is susceptible to capture by seining (Reid *et al.* 2008; Drake and Mandrak 2014a). Bait fishers have been observed capturing Redside Dace while seining for other species in Spencer Creek and, in some instances, may be responsible for transfer of fishes (and potentially other organisms) among watersheds (Staton pers. comm. 2017). A study of species composition in live bait fish sales did not report Redside Dace (Drake and Mandrak 2014b), suggesting that the probability of incidental catch in the bait fishery is low, but greater than zero. Drake and Mandrak (2014a) estimated the probability of incidental capture of Redside Dace based on a generic harvest model. Results suggest an average of 358 harvest events would lead to a 95% chance of capturing Redside Dace during harvest operations, but this value could be lower (156) or higher (failure to capture entirely) based on uncertainty in harvest site selection and detection. Licence stipulations for bait harvesting in waters containing Redside Dace typically prohibit collection of bait animals during 1 May and 30 June as a means of protecting spawning fish (Gibson pers. comm. 2017). Currently, the bait fishery is not viewed as a serious threat to Redside Dace.

Scientific monitoring may have some negative impact. Although lethal sampling in Ontario is generally no longer permitted, there may be delayed or unobserved negative effects resulting from capture for population monitoring (e.g., Bohl *et al.* 2009). These potential effects have not been examined specifically in Redside Dace.

## **Climate Change**

Climate change looms as a significant future threat. Although the timeframe of full impact is not immediate (i.e., it is longer than 10 years or three generations), some effects of climate change are currently evident. The impact on specific Redside Dace populations cannot be predicted with confidence. Two important determinants of stream water temperature, air temperature and groundwater discharge (Power *et al.* 1999; Poole and

Berman 2001), are both expected to be affected by climate change. As average air temperature increases in coming years, stream water temperatures will likely increase. Redside Dace, a cool-water species, will likely be negatively affected by higher average temperatures. In addition to contributing to warmer stream temperatures, reduced groundwater discharge is expected to contribute to higher variation in stream flows resulting from more frequent extreme weather events (Redside Dace Recovery Team 2010). The degree of stream warming as a result of climate change is expected to vary in southern Ontario watersheds due to variation in groundwater discharge. Chu *et al.* (2008) reported that watersheds in the Nottawasaga region and eastern Lake Ontario basin will probably experience relatively small impacts from climate change due to high rates of groundwater discharge. Watersheds containing Redside Dace are situated outside these areas, hence are expected to be impacted more significantly. Although Chu *et al.* (2008) were unable to predict the impact of climate change on cool-water fish distributions in southern Ontario, their models suggested that most watersheds currently containing Redside Dace have a mid-to-high probability of retaining cold-water fishes. Impacts on cool-water species inhabiting these systems will presumably be lower.

## **Limiting Factors**

Several factors limit the potential for recovery of Redside Dace. Low dispersal ability has been shown by direct observation (Poos and Jackson 2012) and indirectly by modelling (Drake pers. comm. 2017) and by the observation of genetic uniqueness of each population (Serrao 2016). The retraction of the species to headwater areas also limits inter-watershed dispersal. The preference for clear, cool water limits the species' ability to expand out of headwater streams. Redside Dace are also known to spawn in the nests of other cyprinid species, specifically Creek Chub and Common Shiner (Koster 1939). The degree to which this behaviour is obligatory is not known; therefore, the degree of dependence on these species remains to be determined. Furthermore, the observation of Redside Dace movement into reaches of Rouge River with high catch per unit effort of other cyprinids and White Sucker suggests the possibility of some uncharacterized ecological association among these species that could be undermined if their populations are reduced. Finally, an additional limiting factor affecting Redside Dace is suggested by modelling data indicating that population abundance is quite sensitive to juvenile mortality (Velez-Espino and Koops 2008).

## **Number of Locations**

Accurately quantifying the number of locations is difficult owing to uncertainty about the number of watersheds, and tributaries within watersheds, that still support Redside Dace. Redside Dace is known to have been present in 26 watersheds in Ontario (Table 2). The historical distribution in those watersheds was likely continuous, and the subsequent threats largely watershed-wide, which would suggest a maximum of 26 locations. Of these 26 locations, Redside Dace is thought to still occur in 15. However, fragmentation of those watersheds by threats gives the appearance of more locations. Conversely, the system alteration threat related to urbanization is the single most plausible threat for those populations in the 18 watersheds in the Golden Horseshoe (including 10 watersheds in the

Greater Toronto Area) – this would suggest a maximum of nine locations, of which three have been lost, leaving six extant locations. Therefore, depending on how they are defined, there are six to 15 extant locations.

## PROTECTION, STATUS AND RANKS

### Non-Legal Status and Ranks

Redside Dace was assessed as Endangered by COSEWIC in 2007, and was listed under the federal *Species at Risk Act* in May 2017. It is also classified as Endangered under the Ontario *Endangered Species Act*. Conservation status ranks are provided in Table 3 (NatureServe 2015).

**Table 3. NatureServe ranks for Redside Dace.**

Level	Jurisdiction	Rank
Global		G3
National	Canada	N2
	United States	N3N4
Subnational	Indiana	S1
	Michigan, West Virginia	S1S2
	Ontario	S2
	New York	S3
	Wisconsin	S3S4
	Kentucky, Ohio	S4
	Pennsylvania	S5
	Iowa, Maryland	SX
	Minnesota	SNR

**Table 4. Population status of Redside Dace based on 2007 DFO recovery potential assessment workshop (DFO 2009; Mandrak pers. comm. 2017). Current Occurrence: Limited (<50 km); Wide (>50 km). Size: Small (<100 individuals); Medium (100-1000); Large (>1000); Trajectory: Stable; Declining; Increasing; Unknown; Status: Extirpated; Critical; Cautious; Healthy. Numbers represent certainty ranks: 1=best guess; 2=CPUE or standardized sampling; 3=quantitative analysis. n/a – not applicable. na – not assessed.**

Population	Current Occurrence	Size	Trajectory
Pringle Creek	Limited, 2	Small, 2	Declining, 1
Lynde Creek	Limited, 2	Small, 2	Declining, 2
Carruthers Creek	Limited, 2	Medium, 2	Unknown
Don River	Limited, 1	Small, 1	Declining, 2
Humber River	Wide, 2	Large, 2	Declining, 2



Population	Current Occurrence	Size	Trajectory
Mimico Creek	Extirpated	n/a	n/a
Etobicoke Creek	Extirpated	n/a	n/a
Clarkson Creek	Extirpated	n/a	n/a
Credit River	Wide, 2	Small, 2	Declining, 2
Morrison Creek	Extirpated	n/a	n/a
Sixteen Mile Creek	Wide, 2	Medium, 2	Declining, 2
Fourteen Mile Creek	Limited, 2	Medium, 2	Declining, 2
Bronte Creek	Limited, 2	Small, 2	Declining, 2
Spencer Creek	Limited, 2	Small, 2	Declining, 2
Niagara-area stream	Extirpated	n/a	n/a
Holland River	Limited, 2	Small, 2	Declining, 2
Gully Creek	Limited, 2	Large, 2	Stable, 2
Saugeen River	Limited, 2	Small, 2	Declining, 2
Two Tree River	Limited, 1	Small, 2	Stable, 2
Duffins Creek	na	na	na
Petticoat Creek	na	na	na
Highland Creek	na	na	na
Rouge River	na	na	na
Irvine Creek	Limited, 2	Small, 2	Declining, 2

## Habitat Protection and Ownership

Redside Dace habitat receives protection under the harm provisions of the *Species at Risk Act* and will receive additional protection once critical habitat is identified. Redside Dace habitat receives some protection by provisions of the federal *Fisheries Act*. Ontario statutes also protect habitat, including the *Endangered Species Act* and the *Planning Act*. A habitat regulation under the *Endangered Species Act* provides protection to identified occupied and recovery habitat (previously occupied habitat) as well as supporting habitat such as riparian zone, meander belt, wetlands, and groundwater supply. The *Planning Act* is implemented by local Conservation Authorities which control flood plain development.

The Crown owns the beds of navigable rivers. Most land, urban and rural, adjacent to waterways is privately owned. These lands are usually surrendered to the municipality in housing developments (Redside Dace Recovery Strategy 2010).

The Rouge National Urban Park, established in 2015, encompasses much of the east branch of the Rouge River. Policy directions for this new class of park regarding future development are presently unclear. The Park's impact on the species remains to be determined.

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## INFORMATION SOURCES

- Andersen, J.J. 2002. Studies of redbside dace, *Clinostomus elongatus*, in the Lynde and Pringle Creek watersheds of Lake Ontario. Canadian Field-Naturalist 116:76-81.
- Andersen, J.J. 2006. A report on a 2006 effort to find redbside dace (*Clinostomus elongatus*) in the West Holland River watershed. Lake Simcoe Region Conservation Authority. Newmarket, Ontario. Unpublished report.
- Barnucz, J., pers. comm. 2016. *Telephone conversation*. 13 October. Fisheries and Oceans Canada, Burlington, Ontario.
- Becker, G.C. 1983. Fishes of Wisconsin. University of Wisconsin Press, Madison, Wisconsin. 1052 pp.
- Bohl, R.J., T.B. Henry, R.J. Strange, and P.L. Rakes. 2009. Effects of electroshock on cyprinid embryos: implications for threatened and endangered fishes. Transactions of the American Fisheries Society 138:768-776.
- Bouvier, L., pers. comm. 2016. *Email communication* 7 October. Fisheries and Oceans Canada, Burlington, Ontario.
- Castaneda, R., pers. comm. 2016. *Telephone conversation* 31 August and *Email communication* 17 October. University of Toronto, Toronto, Ontario.
- Castaneda, R., pers. comm. 2017. *In-person conversation* 18 December. University of Toronto, Toronto, Ontario.

- Chu, C., N.E. Jones, N.E. Mandrak, A.R. Piggott, and C.K. Minns. 2008. The influence of air temperature, groundwater discharge, and climate change on the thermal diversity of stream fishes in southern Ontario watersheds. *Canadian Journal of Fisheries and Aquatic Sciences* 65:297-308.
- Coon, T.G. 1993. Projected impact of wastewater discharge on redbide dace, *Clinostomus elongatus*, in Seeley Drain, Michigan. Department of Fisheries and Wildlife, Michigan State University, East Lansing, Michigan. Unpublished manuscript. 34 pp.
- Cooper, E.L. 1983. Fishes of Pennsylvania and the northeastern United States. Pennsylvania State University Press, University Park and London. 252 pp.
- COSEWIC. 2007. COSEWIC assessment and update status report on the Redside Dace *Clinostomus elongatus* in Canada. Committee on the Status of Endangered Wildlife in Canada. vii + 59 pp.
- COSEWIC. 2016. Guidelines for recognizing designatable units. [http://www.cosewic.gc.ca/eng/sct2/sct2\\_5\\_e.cfm](http://www.cosewic.gc.ca/eng/sct2/sct2_5_e.cfm) [accessed 24 October 2016].
- Daniels, R.A., and S.J. Wisniewski. 1994. Feeding ecology of redbide dace, *Clinostomus elongatus*. *Ecology of Freshwater Fish* 3:176-183.
- Darling, J.A., and A.R. Mahon. 2011. From molecules to management: adopting DNA-based methods for monitoring biological invasions in aquatic environments. *Environmental Research* 111:978-988.
- Davis, L, J. Cockburn, and P. Villard. 2015. Integrating overwinter habitat into stream restoration projects employing natural channel design. Unpublished poster.
- DFO (Fisheries and Oceans Canada). 2009. Proceedings of the Central and Arctic regional science advisory process on the recovery potential assessment of Redside Dace, 14 December 2007. DFO Canadian Science Advisory Secretariat Proceedings Series 2009/003. 20 pp.
- Drake, D.A.R., pers. comm. 2016. *Email communication*. 24 October. Fisheries and Oceans Canada, Burlington, Ontario.
- Drake, D.A.R., and N.E. Mandrak. 2014a. Harvest models and stock co-occurrence: probabilistic methods for estimating bycatch. *Fish and Fisheries* 15:23-42.
- Drake, D.A.R., and N.E. Mandrak. 2014b. Ecological risk of live bait fisheries: a new angle on selective fishing. *Fisheries* 39:201-211.
- Dunn, A. pers. comm. 2016. *Email communication*. 26 October. Ecologist. Conservation Halton, Burlington, Ontario.
- Featherstone, D., pers. comm. 2000. *Conversation with Erling Holm*. Formerly with Conservation Halton, Burlington, Ontario. Cited in COSEWIC (2007).
- Fuller, P. 2016. *Clinostomus elongatus*. USGS Nonindigenous Aquatic Species Database, Gainesville, FL. <https://nas.er.usgs.gov/queries/FactSheet.aspx?speciesID=510> Revision Date: 12/22/2000. [accessed 11 October 2016].

- Gibson, S., pers. comm. 2017. *Telephone communication*. 3 April. Ministry of Natural Resources and Forestry, Peterborough, Ontario.
- Gilbert, C.R. 1980. *Clinostomus elongatus* (Kirtland). Redside dace. p. 148, in D.S. Lee *et al.* Atlas of North American Freshwater Fishes. North Carolina Biological Survey. N.C. State Museum of Natural History Publication, Raleigh, North Carolina. 854 pp.
- Heaton, M., pers. comm. 2016. *Email communication*. 13 October. Ontario Ministry of Natural Resources and Forestry, Aurora, Ontario.
- Holm, E., pers. comm. 2016. *Email communication*. 12 October. Royal Ontario Museum, Toronto, Ontario.
- Houston, D.D., D.K. Shiozawa, and B.R. Riddle. 2010. Phylogenetic relationships of the western North American cyprinid genus *Richardsonius*, with an overview of phylogeographic structure. *Molecular Phylogenetics and Evolution* 55:259-273.
- Iowa Fish Atlas. 2004-2006. <http://maps.gis.iastate.edu/iris/fishatlas/IA163373.html>. [accessed 11 October 2016].
- International Union for Conservation of Nature and Conservation Measures Partnership (IUCN and CMP). 2006. IUCN – CMP unified classification of direct threats, ver. 1.0 – June 2006. Gland, Switzerland. 17 pp. [accessed 21 December 2017].
- Kelsey, I., pers. comm. 2017. *Telephone communication*. 31 March. Biologist, Central Lake Ontario Conservation Authority, Oshawa, Ontario.
- Koster, W.J. 1939. Some phases of the life history and relationships of the cyprinid, *Clinostomus elongatus* (Kirtland). *Copeia* 1939 (4):201-208.
- Lawrie, D., pers. comm. 2017. *Email correspondence*. 30 March. 1 November. Aquatic Biologist, Toronto Regional Conservation Authority, Toronto, Ontario.
- Lyons, J., P.A. Cochran, and D. Fago. 2000. Wisconsin fishes 2000: status and distribution. Wisconsin Sea Grant Institute. Madison, Wisconsin.
- Mandrak, N.E., pers. comm. 2003. *Email correspondence to Erling Holm including a database on the distribution of redside dace in Ohio*. Research Scientist, Fisheries and Oceans Canada, Burlington, Ontario. Cited in COSEWIC (2007).
- Mandrak, N.E., pers. comm. 2016. *Email communication*. 9 August. University of Toronto, Toronto, Ontario.
- Mandrak, N.E., pers. comm. 2017. *In-person communication*. 25 November. University of Toronto, Toronto, Ontario.
- McKee, P.M., and B.J. Parker. 1982. The distribution, biology, and status of the fishes *Compostoma anomalum*, *Clinostomus elongatus*, *Notropis photogenis* (Cyprinidae), and *Fundulus notatus* (Cyprinodontidae) in Canada. *Canadian Journal of Zoology* 60:1347-1358.

- MDNR (Michigan Department of Natural Resources) 2004. Michigan fish atlas maps. University of Michigan Museum of Zoology. Center for Great Lakes and Aquatic Science at the University of Michigan (CGLAS/UM).  
[http://www.dnr.state.mi.us/spatialdatalibrary/pdf\\_maps/fish\\_atlas/maps/clielo.pdf](http://www.dnr.state.mi.us/spatialdatalibrary/pdf_maps/fish_atlas/maps/clielo.pdf)  
 [accessed 21 December 2017].
- Meade, L., D.L. McNeely, L. Kornman, and A. Surmont. 1986. New records of the reidside dace, *Clinostomus elongatus*, with comments on its habitat requirements. Transactions of the Kentucky Academy of Sciences 47:121-125.
- Moore, D., pers. comm. 2017. *Email communication*. 10 July. Central Lake Ontario Conservation Authority, Oshawa, Ontario.
- Morris, R., pers. comm. 2016. *Telephone conversation*. 18 October. Credit Valley Conservation Authority, Mississauga, Ontario.
- NatureServe. 2015. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. Available <http://explorer.natureserve.org> [accessed October 22, 2016].
- Novinger, D.C. and T.G. Coon. 2000. Behaviour and physiology of the reidside dace, *Clinostomus elongatus*, a threatened species in Michigan. Environmental Biology of Fishes 57:315-326.
- NYDEC (New York Department of Environmental Conservation). 2004. *Databases (Historic.mdb Recent (after 1987).mdb)* obtained from Douglas Carlson. Cited in COSEWIC (2007).
- OMNR (Ontario Ministry of Natural Resources) and BAO (Bait Association of Ontario) 2006. The commercial bait industry in Ontario: statistical report, 2005. Ontario Ministry of Natural Resources, Peterborough, Ontario.
- Ontario Ministry of Finance. 2017. Ontario Population Projections Update, 2016–2041. <http://www.fin.gov.on.ca/en/economy/demographics/projections/>. [accessed 3 August 2017].
- Page, L.M., and B.M. Burr. 2011. A field guide to freshwater fishes of North America and Mexico. Second edition. Houghton Mifflin, Boston, Massachusetts. 663 pp.
- Page, L.M., H. Espinosa-Pérez, L.T. Findley, C.R. Gilbert, R.N. Lea, N.E. Mandrak, R.L. Mayden, and J.S. Nelson. 2013. Common and Scientific Names of Fishes from the United States, Canada, and Mexico. 7<sup>th</sup> Edition, American Fisheries Society, Special Publication 34.
- Parish, J. 2004. Redside Dace Recovery strategy fluvial geomorphology study. Parish Geomorphic. Mississauga, Ontario. Report prepared for the Redside Dace Recovery Team. 22 pp. Cited in COSEWIC (2007).
- Poole, G.C., and C.H. Berman. 2001. An ecological perspective on in-stream temperature: natural heat dynamics and mechanisms of human-caused thermal degradation. Environmental Management 27:787-802.

- Power, G., R.S. Brown, and J.G. Imhof. 1999. Groundwater and fish – insights from northern North America. *Hydrological Processes* 13:401-422.
- Poos, M.S., and D.A. Jackson. 2012. Impact of species-specific dispersal and regional stochasticity on estimates of population viability in stream metapopulations. *Landscape Ecology* 27:405-416.
- Poos, M.S., D. Lawrie, C. Tu, D.A. Jackson, and N.E. Mandrak. 2012. Estimating local and regional population sizes for an endangered minnow, redbside dace (*Clinostomus elongatus*), in Canada. *Aquatic Conservation: Marine and Freshwater Ecosystems* 22:47-57.
- Redside Dace Recovery Team. 2010. Recovery Strategy for Redside Dace (*Clinostomus elongatus*) in Ontario. Ontario Recovery Strategy Series. Prepared for the Ministry of Natural Resources, Peterborough, Ontario. vi + 29 pp.
- Reid, S.M., pers. comm. 2016. *Email communication*. 11 October. Ministry of Natural Resources and Forestry.
- Reid, S.M., and S. Parna. 2017. Urbanization, long-term stream flow variability, and Redside Dace status in Greater Toronto Area streams. Canadian Manuscript Report of Fisheries and Aquatic Sciences 3210: iv + 20 pp.
- Reid, S.M., V. Kopf, and M. Boothroyd. 2017. An environmental DNA-based survey for Redside Dace (*Clinostomus elongatus*) in Greater Toronto Area watersheds. Canadian Manuscript Report of Fisheries and Aquatic Sciences 3210: iv + 10 pp.
- Reid, S.M., N.E. Jones, and G. Yunker. 2008. Evaluation of single-pass electrofishing and rapid habitat assessment for monitoring Redside Dace. *North American Journal of Fisheries Management* 28:50-56.
- Rincon, P.A., and G.D. Grossman. 1998. The effects of rainbow trout (*Oncorhynchus mykiss*) on the use of spatial resources and behavior of rosyside dace (*Clinostomus funduloides*). *Archiv für Hydrobiologie* 141:333-352.
- Ruthven, M., pers. comm. 2001. *Field notes communicated to E. Holm*. Consulting Biologist. AMEC Earth and Environmental Mississauga, Ontario. Cited in COSEWIC (2007).
- Salafsky, N., D. Salzer, A.J. Stattersfield, C. Hilton-Taylor, R. Neugarten, S.H.M. Butchart, B. Collen, N. Cox, L.L. Master, S. O'Connor, and D. Wilkie. 2008. A standard lexicon for biodiversity conservation: unified classifications of threats and actions. *Conservation Biology* 22:897–911.
- Scheifley, J., pers. comm. 2016. *Telephone communication*. 17 October. Ministry of Natural Resources and Forestry.
- Schwartz, F.J., and J. Norvell. 1958. Food, growth and sexual dimorphism of the redbside dace *Clinostomus elongatus* (Kirtland) in Linesville Creek, Crawford Creek, Pennsylvania. *Ohio Journal of Science* 58:311-316.
- Scott, W.B., and E.J Crossman. 1973. Freshwater Fishes of Canada. Fisheries Research Board of Canada Bulletin 181. 966 pp.

- Serrao, N.R. 2016. Conservation genetics of Redside Dace (*Clinostomus elongatus*): insights from environmental DNA and phylogeography. M.Sc. Thesis. Trent University. xvi + 175 pp.
- Serrao, N.R., S.M. Reid, and C.C. Wilson. 2017. Conservation genetics of Redside Dace (*Clinostomus elongatus*): phylogeography and contemporary spatial structure. Conservation Genetics. DOI 10.1007/s10592-017-1012-0.
- Staton, S. pers. comm. 2017. *Email communications*. 31 March. Fisheries and Oceans Canada, Burlington, Ontario.
- Staton, S., K. Smith, and B. Duncan. 1993. Spencer Creek fisheries habitat study. Report prepared for the Hamilton Region Conservation Authority, Hamilton, Ontario.
- Trautman, M.B. 1981. The fishes of Ohio. Ohio State University Press, Columbus, Ohio. 782 pp.
- TRCA. 2016. Toronto and Region Conservation Authority. Monitoring sensitive fish species on Seaton development lands. <https://trca.ca/news/monitoring-sensitive-fish-species-on-seaton-development-lands>. [accessed 21 December 2017].
- Wilson, R., pers. comm. 2017. *Telephone communication*. 31 March. Lake Simcoe Region Conservation Authority, Newmarket, Ontario.
- Vélez-Espino, L.A., and M.A. Koops. 2008. Recovery potential modelling of Redside Dace (*Clinostomus elongatus*) in Canada. Canadian Science Advisory Secretariat Research Document 2008/005. 23 pp.
- Villard, P., and M. Heaton. 2016. Review of Redside Dace habitat corridor realignments: morphology, sedimentology and habitat suitability within aged natural corridor designs. Presentation to 5<sup>th</sup> International Conference on Natural Channel Systems, September 26-27, Niagara Falls, Ontario.
- Zimmerman, B. 2009. Microhabitat use by the Redside Dace (*Clinostomus elongatus*) in Ohio. M.Sc. thesis. Bowling Green State University. 34 pp.

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Tim Birt is an adjunct professor at Queen's University. His research activities have focused mainly on population genetics and evolution of seabirds and fishes. He has authored or co-authored five COSEWIC status reports.

## COLLECTIONS EXAMINED

None

## Appendix 1. Results of early and recent sampling in Canadian watersheds (Tables 1 - 26).

The information presented in the following 26 tables is summarized from data in the Redside Dace database (Holm and Andersen 2005) (cited in COSEWIC 2007) annotated with more recent records from various sources. It consists of a table for each watershed in Canada where there is information on success of capture of Redside Dace at both historical and more recent sampling sites. Where known, the following information is summarized: gear (S=seine, E=electrofisher), number of sampling attempts, electrofisher seconds (Total e-secs), length of stream sampled (Total Run Length), and number of seine hauls (Total # hauls). In many cases, there is no information on the number of Redside Dace captured in a sampling event. In these cases, the number of individuals given is preceded by  $\geq$ . For example, if 29 sites were sampled, but there is no information on the number captured at any of the sites, the number of individuals is given as  $\geq 29$ . In many cases, an historical site was visited more than once at different times, often by different individuals. Thus, if the number of sites sampled is 13 and the number of sampling events is 22, some of the sites were visited more than once.

**Table 1. Results of sampling in Pringle Creek at 1959 Ontario Department of Planning and Development sites.**

Results					Effort						Comments
Time Period	No. of Sites Sampled	No. of Sites with Redside Dace	% of Sites with Redside Dace	Number of Specimens	Gear*	No. of Sampling Events	Total E-secs	Total Run Length	Total # Hauls	Total Area Seined	
1959	1	1	100	$\geq 1$	S?	1			n/a		
1985	1	0	0	0	S/E	4	100		3	44	
1999	1	0	0	0	E	1		n/a			SAPO† protocol
2010	1	0	0	0	E	1		n/a			
2015	1	0	0	0	E	1		n/a			

\*Gear S=seine, E=electrofisher

n/a not available

†SAPO Stream Assessment Protocol of Ontario

Redside Dace was not found at any additional sites in Pringle Creek since the 1959 survey.

**Table 2a. Results of sampling in Lynde Creek at 1959 Ontario Department of Planning and Development sites.**

Results					Effort						Comments
Time Period	No. of Sites Sampled	No. of Sites with Redside Dace	% of Sites with Redside Dace	Number of Specimens	Gear*	No. of Sampling Events	Total E-secs	Total Run Length	Total # Hauls	Total Area Seined	
1959	5	5	100	$\geq 5$	S ?	5			n/a		
1985	2	0	0	0	S/E	2	189		4	>17	
2000	5	1	20	1	E	5					SAPO† protocol
2009	2	0	0	0	E	1	n/a				
2014	2	0	0	0	E	1	n/a				

\*Gear S=seine, E=electrofisher

†SAPO Stream Assessment Protocol of Ontario



**Table 2b. Number of additional sites where Redside Dace were found in Lynde Creek since 1959 surveys.**

Time Period	Number of New Sites	Number of Specimens	Sources
1983	10	≥10	Tumey 1984, ROM 44166
1997-2001	10	73	Central Lake Ontario Conservation Authority (2001), Ecotec (1999), Andersen 2002, ROM 71031, 72455
2009	3	10**	Reid <i>et al.</i> (2017); Central Lake Ontario Conservation Authority (Moore 2017)
2010	4	Not specified**	Central Lake Ontario Conservation Authority (Moore 2017)
2011	1	1**	Central Lake Ontario Conservation Authority (Moore 2017)
2013/2014	4	Not determined*	Reid <i>et al.</i> (2017)
2014	2	4**	MNRF (Reid 2016); Central Lake Ontario Conservation Authority (Moore 2017)

\*eDNA positive detections

\*\*electrofishing

Sources for Table 1a and 2a

1959 Ontario Department of Planning and Development surveys

1985 ROM Accession 4910

2000 Andersen 2002

**Table 3. Results of sampling in Carruthers Creek since 2003.**

Time Period	Number of Sites	Number of Specimens	Sources
2003	3	0	Toronto Region Conservation Authority (Lawrie 2017)
2006	3	0	Toronto Region Conservation Authority (Lawrie 2017)
2009	5	2	Toronto Region Conservation Authority (Lawrie 2017); RSD database
2011	1	2	Redside Dace Recovery Team (RSD database)
2012/13	5	52*	Serrao 2016; Toronto Region Conservation Authority (Lawrie 2017)
2014	1	56	RSD database
2015	6	47	Toronto Region Conservation Authority (Lawrie 2017)
2016	1	7	GeoMorphix (Villard and Heaton 2016)

\*also positive eDNA detection at one site (Serrao 2016)

**Table 4a. Results of sampling in Duffins Creek watershed at 1954 Ontario Department of Planning and Development sites.**

Results					Effort			
Time Period	No. of Sites Sampled	No. of Sites with Redside Dace	% of Sites with Redside dace	Number of Specimens	Gear*	No. of Sampling Events	Total E-secs	Total # Hauls
1954	8	8	100	≥8	S ?	8	n/a	
1978-1979	4	2	50	28	n/a	5	n/a	
1985	8	4	50	99	S/E	9	1528	≥18
1999-2003	3	1	33	≥1	E	3	>4210	0
2009	1	0	0	0	E	n/a	n/a	0

\*Gear S=seine, E=electrofisher; n/a not available

Sources for Table 4a

1954 Ontario Department of Planning and Development surveys

1978 ROM Accession 3752 (Ministry of Natural Resources stream surveys)

1979 CMN79-1077, 79-1079 (Parker and McKee 1980)

1985 ROM Accession 4910 (Holm and Crossman 1986), ROM Accession 5267 (R. Steedman)

1999 ROM Accession 6771 (Ecotec)

2003 Forder 2003, Toronto Region Conservation Authority database (2003)

Table 4b. Number of additional sites where Redside Dace were found in Duffins Creek since 1954 surveys.			
Time Period	Number of New Sites	Number of Specimens	Sources
1973-1979	5	≥51	ROM Accession 2314 and 3751, 3752; CMN 79-1080, CMN 79-1194, CMN 79-1196
1984-1985	2	≥18	ROM Accession 5267 (R. Steedman)
1996-2004	3	≥10	ROM Accessions 6750, 7100, 7217; Ministry of Natural Resources, Salmonid Unit
2009	5	15	Redside Dace Recovery Team (RSD database); TRCA (Lawrie 2017)
2010	1	2	Redside Dace Recovery Team (RSD database); TRCA (Lawrie 2017)
2012	4	42*	Redside Dace Recovery Team (RSD database); TRCA (Lawrie 2017); Serrao (2016)
2013	1	eDNA	Serrao (2016)
2014	1	2	Redside Dace Recovery Team (RSD database); TRCA (Lawrie 2017)
2015	7	61	Redside Dace Recovery Team (RSD database); TRCA (Lawrie 2017)

\* live specimens collected at three sites; eDNA detected at 3 sites

Table 5. Results of sampling in Highland Creek at site where Redside Dace were captured in 1928.								
Results					Effort			
Time Period	No. of Sites Sampled	No. of Sites with Redside Dace	% of Sites with Redside Dace	Number of Specimens	Gear	No. of Sampling Events	Total E-secs	Total # Hauls
1928-1952	1	1	100	2	S	2	n/a	≥2
1976-1985	1	0	0	0	E/S?	4	>1004	?

#### Sources for Table 5

1928 UMMZ 85643  
1952 ROM 15637  
1976 ROM Accession 3074 (Ministry of Natural Resources)  
1981 ROM Accession 4415 (Metro Toronto Region Conservation Authority)  
1984-1985 ROM Accession 5267 (R. Steedman)

There are no additional sites where Redside Dace were found since the 1952 survey.

Table 6a. Results of sampling in Rouge River watershed at 1954 Ontario Department of Planning and Development sites.								
Results					Effort			
Time Period	No. of Sites Sampled	No. of Sites with Redside Dace	% of Sites with Redside Dace	Number of Specimens	No. of Sampling Events	Total E-secs	Total Run Length	Total # Hauls
1954	30	29	97	≥ 29	29	n/a		
1982-1987	11	9	82	≥ 120	15	n/a		
1992-1994	5	3	60	38	5	>1567	n/a	≥4 ?
1999-2003	13	4	31	≥ 138	22	>3687	>443.6	≥1
2005	1	0	0	0	1		50	
2008	1	0	0	0	1	n/a	n/a	n/a
2009	3	1	33	13	4	n/a	n/a	n/a
2012	2	1	50	1	2	n/a	n/a	n/a
2014	1	1	100	24	2	n/a	n/a	n/a

#### Sources for Table 6a

1954 Ontario Department of Planning and Development surveys  
1982 ROM Accession 4556  
1984-1985 ROM Accession 5267 (R. Steedman), ROM Accession 4830, ROM Accession 4749  
1987 Ministry of Natural Resources, Aurora, files (Rouge.171)  
1992 ROM Accession 6386 (G. Wichert)  
1994 Ministry of Natural Resources, Aurora files (Rouge. 80)  
1999 ROM Accession 6750 (Sir Sanford Fleming Student)  
2000 ROM Accession 6797, 6807 (Holm *et al.*), Toronto Region Conservation Authority database (2003)  
2001 J. Andersen (pers. comm.). W. King (pers. comm.)  
2002 Andersen *et al.* 2002 (Aurora MNR files), M. Cece and R. Roth (Marshall Macklin Monaghan), OMNR Aurora files  
2003 Toronto Region Conservation Authority database (2003), W. King (pers. comm.)  
2005 Comments from a reviewer (Andersen?) of the Redside Dace status update 2006

Table 6b. Number of additional sites in Rouge River watershed where Redside Dace were found since 1954 surveys.			
Time Period	Number of New Sites	Number of Specimens	Sources
1972-1987	13	≥ 123	ROM Accessions 2163 (Ministry of Natural Resources), 4830, 4685, 5267 (R. Steedman), CMN79-1199, Ministry of Natural Resources, Aurora files
1991-1998	2	54	ROM 58162; ROM Accessions 6386, and 6767; Ecotec, Ministry of Natural Resources Stream Assessment Protocol of Ontario database
2000-2004	7	73	Toronto Region Conservation Authority database (2003), W. King (pers. comm.); J. Andersen (pers. comm.); Forder (2003)
2009	6	11	Redside Dace Recovery Team (RSD database); TRCA (Lawrie 2017)
2010	2	7	Redside Dace Recovery Team (RSD database); TRCA (Lawrie 2017)
2012	5	13	Redside Dace Recovery Team (RSD database); TRCA (Lawrie 2017)
2013	1	1	Redside Dace Recovery Team (RSD database); TRCA (Lawrie 2017)
2014	3	5*	Redside Dace Recovery Team (RSD database); TRCA (Lawrie 2017)
2015	3	6	Redside Dace Recovery Team (RSD database); TRCA (Lawrie 2017)

\*specimens not counted at one site

Table 7a. Results of sampling in East Branch Don River at 1949 Ontario Department of Planning and Development sites.									
Time period	Results				Effort				
	No. of Sites Sampled	No. of Sites with Redside Dace	% of Sites with Redside Dace	Number of Specimens	Gear*	No. of Sampling Events	Total E-secs	Total Run Length	Total # Hauls
1949	14	13	93	≥13	S ?	14	-	n/a	≥14
1970s	2	1	50	≥1	n/a	2		n/a	
1984-1985	12	6	50	48	E/S	26	>6425	>430	≥5
1992	6	2	33	32	E/S	6	3350	n/a	≥6
1995-2003	8	5	63	13	E	10	>15141	>333.5	0

\*Gear S=seine, E=electrofisher, n/a=not available

#### Sources for Table 7a

1949 Ontario Department of Planning and Development surveys  
1970s ROM Accession 2094, Martin (1986)  
1995-2003 TRCA database (2003); Ministry of Natural Resources, Aurora, files (Dillon Consulting); ROM Accessions 6542, 6768, 6783, 6876, 7268,  
1981-1985 Martin 1986, ROM Accessions 4497 (Martin/Whillans) and 5267 (R. Steedman)  
1991-1992 ROM Accession 6386 (G. Wichert), 6768

Table 7b. Number of additional sites in East Don where Redside Dace were found since 1949 surveys.			
Time Period	Number of New Sites	Number of Specimens	Sources
1966	1	1	ROM Accession 1222 (Ontario Water Resources Commission)
1991	1	4	ROM Accession 5864, 6876 (J. Lane)
2008	2	Approx. 200	Poos <i>et al</i> 2012
2011	1	1	Redside Dace Recovery Team (RSD database); TRCA (Lawrie 2017)
2013	2	Unspecified*	Redside Dace Recovery Team (RSD database); TRCA (Lawrie 2017)

\*eDNA detected at one site; video detection at other site

Table 8a. Results of sampling in West Branch Don River at 1949 Ontario Department of Planning and Development sites.									
Results					Effort				
Time period	No. of Sites Sampled	No. of Sites with Redside Dace	% of Sites with Redside Dace	Number of Specimens	Gear*	No. of Sampling Events	Total E-secs	Total Run Length	Total # Hauls
1949	10	10	100	≥10	S ?	10	-	n/a	≥10
1970s	1	1	100	≥1	n/a	1		n/a	
1981-1985	8	1	13	3	E/S	14	>3940	n/a	≥1
1991	3	1	33	6	E/S	3	3163	n/a	≥2
2002	3	0	0	0	E	3	>1279	>42.5	n/a
2008, 2011, 2014	1	0	0	0	E	3	n/a	n/a	n/a

\*Gear S=seine, E=electrofisher, n/a=not available

#### Sources for Table 8a

1949 Ontario Department of Planning and Development surveys  
1970s ROM Accession 2094, Martin (1986)  
1995-2003 TRCA database (2003); Ministry of Natural Resources, Aurora, files (Dillon Consulting); ROM Accessions 6542, 6768, 6783, 6876, 7268,  
1981-1985 Martin 1986, ROM Accessions 4497 (Martin/Whillans) and 5267 (R. Steedman)  
1991-1992 ROM Accession 6386 (G. Wichert), 6768

Table 8b. Number of additional sites in West Don River where Redside Dace were found since 1949 surveys.			
Time Period	Number of New Sites	Number of Specimens	Sources
1991-1998	1	3	ROM Accessions 5864 and 6768

Table 9a. Results of sampling in East Humber River watershed at 1946 Ontario Department of Planning and Development sites.								
Results					Effort			
Time Period	No. of Sites Sampled	No. of Sites with Redside Dace	% of Sites with Redside Dace	Number of Specimens	No. of Sampling Events			
					8	Total E-secs	Total # Hauls	Total Area Seined
1946	8	8	100	≥77	20		n/a	
1972-1994	8	7	87.5	≥116	4	>3571	≥8	n/a
1996-1999	3	3	100	3				

#### Sources for Table 9a

1946 Ontario Department of Planning and Development surveys  
1972 Toronto Region Conservation Authority database  
1979 CMN79-1015, 79-1016, 79-1020, 79-1021  
1981 ROM Accession 4415  
1984-1985 ROM Accession 5267 (R. Steedman)  
1987 Toronto Region Conservation Authority database  
1992 ROM Accession 6386 (G. Wichert)  
1996 ROM Accession 6767 (OMNR), ROM Accession 6709 (TRCA)

Table 9b. Number of additional sites in East Humber watershed where Redside Dace were found since 1946 surveys.			
Time Period	Number of New Sites	Number of Specimens	Sources
1952-1959	3	6	ROM 15972, 17316; Wainio and Hester 1973
1972-1983	28	≥112	ROM records, Toronto Region Conservation Authority records. Canadian Museum of Nature records, Wilfrid Laurier University records
1984-1994	20	≥181	ROM records (mostly R. Steedman), Toronto Region Conservation Authority records.
1995-2003	10	189	ROM Accessions 6709, 6767, 6774, 6959, records, Toronto Region Conservation Authority records; Forder (2003); Holm (pers. observations)
2009	2	2	Redside Dace Recovery Team (RSD database); TRCA (Lawrie 2017)
2010	1	4	Redside Dace Recovery Team (RSD database); TRCA (Lawrie 2017)
2011	2	6	Redside Dace Recovery Team (RSD database); TRCA (Lawrie 2017)
2013	2	Unspecified*	Serrao 2016
2014	3	11	Redside Dace Recovery Team (RSD database); TRCA (Lawrie 2017)

\*eDNA detections

Table 10. Number of sites in West Humber watershed where Redside Dace were found since 2007.			
Time Period	Number of New Sites	Number of Specimens	Sources
2009	1	24	Redside Dace Recovery Team (RSD database); TRCA (Lawrie 2017)
2010	2	17	Redside Dace Recovery Team (RSD database); TRCA (Lawrie 2017)
2011	2	12	Redside Dace Recovery Team (RSD database); TRCA (Lawrie 2017)
2013	3	12	Redside Dace Recovery Team (RSD database); TRCA (Lawrie 2017)
2015	2	32	Redside Dace Recovery Team (RSD database); TRCA (Lawrie 2017)

Table 11. Results of sampling in Mimico Creek at sites where Redside Dace were captured prior to 1950.								
Time Period	Results				Effort			
	No. of Sites Sampled	No. of Sites with Redside Dace	% of Sites with Redside Dace	Number of Specimens	Gear*	No. of Sampling Events	Total E-secs	Total # Hauls
1935-1949	4	4	100	≥4	S	4	n/a	
1984-1985	4	0	0	0	S/E	7	≥2556	≥21
1992-2002	3	0	0	0	S/E	3	7986	≥1

\*S=seine, E=backpack electrofisher

#### Sources for Table 11

1935 ROM 11712 (1 site)

1949 Ontario Department of Planning and Development surveys (3 sites)

1984-1985 ROM Accessions 49?? (4 sites), 5267 (R. Steedman 3 sites)

1992-2002 Toronto Region Conservation Authority database (2 sites), ROM Accession 6386 (G. Wichert, 1 site)

There are no additional sites in Mimico Creek where Redside Dace were found since the 1949 survey.

**Table 12a. Results of sampling in Etobicoke Creek at two sites.**

Time Period	Results				Effort		
	No. of Sites Sampled	No. of Sites with Redside Dace	% of Sites with Redside Dace	Number of Specimens	No. of Sampling Events	Total E-secs	Total # Seine Hauls
1928-1935	2	2	100	15	3	-	≥3
1984-1985	2	0	0	0	3	-	≥7
1995-2004	1	0	0	0	3	21301	-

**Sources for Table 12a**

1928-1935 ROM and UMMZ records

1984-1985 ROM Accession 4923

1995-2004 ROM Accession 6645 and TRCA Watershed Monitoring database, 2003 and 2005

**Table 12b. Number of additional sites in Etobicoke Creek where Redside Dace were found since 1928-1935 surveys.**

Time Period	Number of New Sites	Number of Specimens	Sources
1940s	3	≥3	Ontario Department of Planning and Development surveys

**Table 13a. Results of sampling in Credit River watershed at 1954 Ontario Department of Planning and Development sites.**

Time Period	Results				Effort				
	No. of Sites Sampled	No. of Sites with Redside Dace	% of Sites with Redside Dace	Number of Specimens	Gear*	No. of Sampling Events	Total E-secs	Total Run Length	Total # Hauls
1954	13	12	92	≥ 12	S ?	12			≥ 13 ?
1965	13	6	46	≥ 6	?	13		n/a	
1982-1985	11	3	27	≥ 20	E	22	> 4270	> 340	
1992-1999	7	3	43	7	E/?	9	> 3592		
2000-2003	5	1	20	1	E	5	> 4765	> 140	
2011	1	1	100	1	n/a	n/a	n/a	n/a	n/a
2014	1	1	100	unspecified	n/a	n/a	n/a	n/a	n/a

\*Gear S=seine; E=electrofischer

**Sources for Table 13a**

1954 Ontario Department of Planning and Development surveys

1965 Reed 1968 in Martin 1984

1982-1985 Martin 1984, ROM Accession 5267 (Steedman surveys), M Ruthven (pers. comm. 2001)

1992-1999 Credit Valley Conservation records; ROM Accessions 6386 (G. Wichert), 6567, 6765, and 6769

2000-2003 Credit Valley Conservation; Ministry of Natural Resources, Aurora files; Forder 2003

**Table 13b. Number of additional sites in Credit River watershed where Redside Dace were found since 1954 surveys.**

Time Period	Number of New Sites	Number of Specimens	Sources
1966-1975	3	≥ 3	Ministry of Natural Resources surveys, ROM 58236
1976-1995	11	≥ 50	CMN 79-1094, 79-1096, 80-0876; Martin (198?), ROM Accessions 5267 (R. Steedman), 6765 (Credit Valley Conservation records)
1996-2005	4	≥ 5	ROM Accession 6428 (D. Featherstone), Ministry of Natural Resources, Aurora, (LGL Consulting), S. Copeland (pers. comm. 2002)
2008	1	1	Red Side Dace Recovery Team (RSD database)
2009	1	19	Red Side Dace Recovery Team (RSD database)
2010	2	Unspecified*	Red Side Dace Recovery Team (RSD database)
2011	2	18	Red Side Dace Recovery Team (RSD database)
2014	2	32	Red Side Dace Recovery Team (RSD database)
2016	1	1	Erling Holm (pers. comm. 2017)

\*visual observations; numbers of individuals not reported

**Table 14a. Results of sampling in Morrison Creek at 1957 Ontario Department of Planning and Development Sites.**

Time Period	Results				Effort				
	No. of Sites Sampled	No. of Sites with Redside Dace	% of Sites with Redside Dace	Number of Specimens	No. of Sampling Events	Total E-secs	Total Run Length	Total # Hauls	Total Area Seined
1957	6	6	100	≥6	6	n/a	n/a	n/a	n/a
1985	3	1	33	22	3	100	10	0	
2000-2003	5	0	0	0	11	>2682	>305		

Sources for Table 14a

1957 Ontario Department of Planning and Development surveys  
 1985 ROM Accession 4964 (Holm and Crossman 1986)  
 1991 A. Timmerman  
 1993, 1995 Ministry of Natural Resources, Aurora, files  
 2000 ROM Accession 6822 (Holm *et al.*)  
 2001 Conservation Halton  
 2002 Ministry of Natural Resources, Aurora, files  
 2003 Ministry of Natural Resources, Aurora, files (M. Heaton)

**Table 14b. Number of additional sites in Morrison Creek where Redside Dace were found since 1957 surveys.**

Time Period	Number of New Sites	Number of Specimens	Sources
1984	1	≥1	Proctor and Redfern
2000	1	2	ROM 72282
2015	1	Unspecified*	Reid <i>et al.</i> 2017

\*eDNA detection

**Table 15a. Results of sampling in Sixteen Mile Creek watershed at 1957 Ontario Department of Planning and Development sites.**

Time Period	Results				Effort				
	No. of Sites Sampled	No. of Sites with Redside Dace	% of Sites with Redside Dace	Number of Specimens	Gear*	No. of Sampling Events	Total E-secs	Total Run Length	Total # Hauls
1957	14	14	100	≥ 14	S ?	14	0	-	≥ 14
1972-1979	5	2	40	≥ 2	?	7	n/a		
1994-2003	4	3	75	≥ 43	E	6	≥ 4334	> 325	0
2010	1	1	100	10	n/a	n/a	n/a	n/a	n/a
2012	1	1	100	8	n/a	n/a	n/a	n/a	n/a
2013	1	1	100	95	n/a	n/a	n/a	n/a	n/a
2015	1	1	100	48	n/a	n/a	n/a	n/a	n/a

\*Gear E=electrofischer, S=seine

n/a not available

Sources for Table 15a

1957 Ontario Department of Planning and Development surveys  
 1972-1979 Halton Conservation, Ministry of Natural Resources, Parker & McKee 1980  
 1994-2003 Halton Conservation; Ministry of Natural Resources, Aurora; ROM Accessions 6621, 6960; Forder 2003  
 2010-2015 Redside Dace Recovery Team (RSD database); Halton Conservation (Dunn 2016)

**Table 15b. Number of additional sites in Sixteen Mile Creek watershed where Redside Dace were found since 1957 surveys.**

Time Period	Number of New Sites	Number of Specimens	Sources
1972-1975	5	≥ 17	McIlwrick 1996; Ministry of Natural Resources stream surveys; ROM 29999
1995-2003	4	≥ 9	ROM Accessions 6621 and 6960 (Halton Conservation surveys), 7143 (LGL Ltd)
2008	2	38	Redside Dace Recovery team (RSD database); Halton Conservation (Dunn 2016)
2009	1	1	Redside Dace Recovery team (RSD database); Halton Conservation (Dunn 2016)
2011	1	12	Redside Dace Recovery team (RSD database); Halton Conservation (Dunn 2016)
2012/2013	1	45	Serrao 2016
2013	1	55	Redside Dace Recovery team (RSD database); Halton Conservation (Dunn 2016)
2015	2	46	Redside Dace Recovery team (RSD database); Halton Conservation (Dunn 2016)

**Table 16a. Results of sampling in Fourteen Mile Creek at 1957 Ontario Department of Planning and Development sites.**

Time Period	Results				Effort				
	No. of Sites Sampled	No. of Sites with Redside Dace	% of Sites with Redside Dace	Number of Specimens	Gear*	No. of Sampling Events	Total E-secs	Total # Hauls	Total Area Seined
1957	3	3	100	≥ 3	S ?		n/a		
1985	3	1	33	8	S/E	3	351	4	>50
1990	1	1	100	≥6	?	2	n/a		
1998-2003	1	1	100	65	S/E	4	?	≥1	≥150
2010	1	1	100	2	n/a	n/a	n/a	n/a	n/a
2012	1	1	100	Unspecified**	n/a	n/a	n/a	n/a	n/a

\*Gear E=electrofisher, S=seine

\*\* visual observations; numbers of individuals not reported

n/a not available

Sources for Table 16a

1957	Ontario Department of Planning and Development surveys
1985	ROM Accession 4964 (Holm and Crossman 1986.)
1990	ROM 60209
1998	ROM 71696
2000	ROM Accession 6825
2001	ROM Accession 6956
2003	Ministry of Natural Resources (M. Heaton)
2010	Redside Dace Recovery Team (RSD database); Halton Conservation (Dunn 2016)
2012	Redside Dace Recovery Team (RSD database); Halton Conservation (Dunn 2016)



Table 16b. Number of additional sites in Fourteen Mile Creek where Redside Dace were found since 1957 surveys.			
Time Period	Number of New Sites	Number of Specimens	Sources
1960	1	2	CMN60-0533A
1990	1	≥ 1	Ministry of Natural Resources, Aurora, files
1998-2003	11	223	Ministry of Natural Resources, Aurora, files; G. Coker, pers. comm.; ROM Accessions 6825, 6832, 6853, 6956; R. Bilz (pers. comm.); P. Anderson (pers. comm.); M. Heaton, pers. comm.; Cam Portt & Associates (pers. comm.)
2010	2	>2*	Redside Dace Recovery Team (RSD database); Halton Conservation (Dunn 2016)
2012/2013	1	43	Serrao 2016
2012	14	582	Redside Dace Recovery Team (RSD database); Halton Conservation (Dunn 2016)
2013	2	2	Redside Dace Recovery Team (RSD database); Halton Conservation (Dunn 2016)
2015	2	27	Redside Dace Recovery Team (RSD database); Halton Conservation (Dunn 2016)

\*2 specimens from one site; visual observation only from the other site, number of individuals not reported

Table 17a. Results of sampling in Bronte Creek watershed at sites where Redside Dace were captured in 1972-1979.									
Time Period	Results				Effort				
	No. of Sites Sampled	No. of Sites with Redside Dace	% of Sites with Redside Dace	Number of Specimens	Gear	No. of Sampling Events	Total E-secs	Total Run Length	Total # Hauls
1972-1979	11	11	100	>100	S/E	22	n/a		
1995-2000	7	1	14	1	S/E	10	>3922	>420	≥2

Sources for Table 17a

1972, 1978 McIlwrick 1996, Halton Conservation watershed reports, B. Edmondson and A. Sorenson  
1974 Ministry of Natural Resources Stream surveys  
1979 Canadian Museum of Nature records, Paton and Sharp 1979  
1995 ROM Accession 6770 (A Timmerman, Ministry of Natural Resources); Conservation Halton  
1998 ROM Accession 6771 (Ecotec ); Conservation Halton  
2000 ROM Accession 6797 (ROM and Halton Conservation); Conservation Halton

Table 17b. Number of additional sites in Bronte Creek watershed where Redside Dace were found since 1979 surveys.			
Time Period	Number of New Sites	Number of Specimens	Sources
1998	1	1	ROM Accession 6771 (Ecotec)

Table 18a. Results of sampling in Spencer Creek watershed at 1970s sites.									
Time Period	Results				Gear*	Effort			
	No. of Sites Sampled	No. of Sites with Redside Dace	% of Sites with Redside Dace	Number of Specimens		No. of Sampling Events	Total E-secs	Total # Hauls	Total Area Seined
1970-1979	9	9	100	≥ 129		15			
1984	4	3	75	16		4			
1993	1	1	100	1					
1998-2004	3	0	0	0		12	> 1946	> 13	> 630

\*Gear E=electrofisher, S=seine

Sources for Table 18a

1970 Ministry of Natural Resources stream surveys, ROM records  
1972 ROM 28384, 28387, 28388  
1973 Ministry of Natural Resources stream surveys, ROM Accession 2448  
1979 CMN 79-1085, 79-1087  
1984 Holm 1986 (Fig 6, Table 17)  
1993 Staton *et al.* 1993  
1998 ROM Accession 6597, 6622  
2004 Hamilton Region Conservation Authority (S. Wiseman, email and attachment 25 April 2005)

Table 18b. Number of additional sites in Spencer Creek watershed where Redside Dace were found since 1970s surveys.			
Time Period	Number of New Sites	Number of Specimens	Sources
1993-1998	6	≥ 34	Staton <i>et al.</i> 1993, Thompson <i>et al.</i> 1995, ROM Accession 6622

Table 19. Results of sampling in Kettleby Creek at sites where Redside Dace were captured in 1976-1980.									
Time Period	Results				No. of Sampling Events	Effort			
	No. of Sites Sampled	No. of Sites with Redside Dace	% of Sites with Redside Dace	Number of Specimens		Total E-secs	Total Run Length	Total # Hauls	Total Area Seined
1976-1980	3	3	100	≥4	4	n/a			
1987-1991	2	1	50	12	4	n/a			
2000-2003	3	1	33	1	7	> 8000	> 526	≥ 1	≥ 60
2005	n/a	1	n/a	1	n/a	n/a	n/a	n/a	n/a
2006	n/a	1	n/a	10	n/a	n/a	n/a	n/a	n/a
2012-2013	1	1	100	35	n/a	n/a	n/a	n/a	n/a
2014	3	0	0	0	n/a	n/a	n/a	n/a	n/a

Sources for Table 19a

1976 Ministry of Natural Resources Stream survey  
1980 ROM 41411, ROM Accessions 4413, 4402  
1987-1988 ROM Accession 6988  
1991 Gamsby & Mannerow Limited, 1995  
2000 ROM Accession 6797 (Holm *et al.*)  
2002-2003 ROM Accession 7280 (J. Andersen)  
2005 Redside Dace Recovery Team (RSD database); ROM Accession 7377  
2006 Redside Dace Recovery Team (RSD database); Anderson 2006 (unpublished)  
2012-2013 Serrao 2016  
2014 eDNA survey; Reid *et al.* 2017  
There are no additional sites where redside dace were found since 1976-1980 surveys

Table 20. Results of Sampling in Sharon Creek at one site where Redside Dace was captured in 1994.									
Results					Effort				
Time Period	No. of Sites Sampled	No. of Sites with Redside Dace	% of Sites with Redside Dace	Number of Specimens	No. of Sampling Events	Total E-secs	Total Run Length	Total # Hauls	Total Area Seined
1994	1	1	100	4	4	n/a			
2003	1	0	0	0	1	2018	200		
2014-2015	1	0	0	0	n/a	n/a	n/a	n/a	n/a

Sources for Table 20

1994 Ministry of Natural Resources, Aurora, files (Holland River 155)

2003 ROM Accession 7280 (J. Andersen)

2014-2015 Reid *et al.* 2017

There are no additional sites where redside dace were found since 1994 survey.

Table 21a. Results of sampling in Irvine Creek at five 1970s sites.										
Results					Effort					
Time Period	No. of Sites Sampled	No. of Sites with Redside Dace	% of Sites with Redside Dace	Number of Specimens	No. of Sampling Events	Gear*	Total E-secs	Total Run Length	Total # Hauls	Total Area Seined
1974-1979	5	5	100	48	6	E/S	n/a			
1997-2003	5	2	40	8	15	E/S	>2832	n/a	8	n/a
2016	4	0	0	0	n/a	S	n/a	n/a	n/a	n/a

\*Gear: E=electrofischer, S=seine

n/a not available

Sources for Table 21a

1974 ROM Accession 2701 (Grand River Conservation Authority surveys)

1979 CMN79-1064

1997 ROM Accession 6534 (Holm & Boehm 1998)

1998 ROM Accession 6601 (Holm *et al.*)

2000 ROM Accession 6797 (Holm *et al.*)

2001 ROM Accession 6924 (Holm *et al.*)

2003 N. Mandrak, pers. comm.

2016 R. Castaneda 2016

Table 21b. Number of additional sites in Irvine Creek where Redside Dace were found since 1970s surveys.			
Time Period	Number of New Sites	Number of Specimens	Sources
2001-2003	3	31	ROM Accession 6797; N. Mandrak, pers. comm.

**Table 22a. Results of sampling in upper Saugeen River at 1951 Ontario Department of Planning and Development sites.**

Results					Effort				
Time Period	No. of Sites Sampled	No. of Sites with Redside Dace	% of Sites with Redside Dace	Number of Specimens	No. of Sampling Events	Total E-secs	Total Run Length	Total # Hauls	Total Area Seined
1951	24	24	100	n/a	24	n/a			
1985	10	0	0	0	10	3388		40	≥4033
2000	9	3	33	6	9	≥483		15	1603
2001	2	0	0	0	2	1850		-	-
2004	10	0	0	0	10	11362	800	≥2	n/a
2016	5	2	40	13	n/a	n/a	n/a	n/a	n/a

Sources for Table 22a

1951 Ontario Department of Planning and Development surveys  
 1985 Holm and Crossman 1986  
 2000 ROM records  
 2001 Gibson 2001  
 2004 Forder 2005  
 2016 Castaneda 2016

**Table 22b. Number of additional sites in upper Saugeen River where Redside Dace were found since 1951 surveys.**

Time Period	Number of New Sites	Number of Specimens	Sources
1972	1	3	Ministry of Natural Resources stream surveys
2000	1	1	Redside Dace Recovery Team (RSD database); ROM accession #6797
2005	5	9	Redside Dace Recovery Team (RSD database)
2012/2013	1	14	Serrao 2016

**Table 23a. Results of sampling in Meux Creek, Saugeen River, at 1953 Ontario Department of Planning and Development sites.**

Results					Effort						Comments
Time Period	No. of Sites Sampled	No. of Sites with Redside Dace	% of Sites with Redside Dace	Number of Redside Dace	No. of Sampling Events	Gear*	Total E-secs	Total Run Length	Total # Hauls	Total Area Seined	
1953	5	5	100	≥5	5	S?	n/a				
1985	4	4	100	≥100	4	E/S	1519	n/a	24	318	
1990	4	2	50	>41	4	S		120	≥2		50 m bag seine
1992	1	1	100	15	1		n/a				
1993	1	0	0	0	1		n/a				
2001	1	0	0	0	1	E	n/a	153	-	-	OSAP† Protocol
2004	5	1	20	1	5	E/S	6588	400	4	n/a	Redside Dace Protocol
2016	3	0	0	0	n/a	n/a	n/a	n/a	n/a	n/a	

\*Gear S= seine, E=backpack electrofisher  
 †OSAP Ontario Stream Assessment Protocol  
 n/a not available

Sources for Table 23a

1953 Ontario Department of Planning and Development surveys  
 1985 ROM Accession 4901  
 1990 C. Portt & Associates (ROM Accession 6873)  
 1992-1993 ROM Accession 7131 (BAR Environmental and Ministry of Natural Resources)  
 2001 S. Gibson, MSc thesis, University of Toronto  
 2004 ROM Accession 7236 (Forder 2005)  
 2016 Castaneda 2016

Table 23b. Number of additional sites in Meux Creek where Redside Dace were found since 1953 surveys.			
Results		Effort	
Time Period	Number of New Sites	Number of Specimens	Sources
2001-2004	3	≥10	Sageen Valley Conservation Authority Municipal Drain Classification Project (2001), Forder 2005

Table 24a. Results of sampling in Gully Creek at two 1980 sites.									
Results					Effort				
Time Period	No. of Sites Sampled	No. of Sites with Redside Dace	% of Sites with Redside Dace	Number of Specimens	Gear	No. of Sampling Events	Total E-secs	Total Run Length	Total # Hauls
1980	2	2	100	8	?	2			
1999-2001	2		50	7	S/E	3	>635		≥1
2009	2	2	100	>22	n/a	4	n/a		n/a
2016	1	1	100	1	n/a	1	n/a		n/a

Sources for Table 24

1980 Ministry of Natural Resources stream surveys  
1999 ROM Accession 6750 (Sir Sanford Fleming Student)  
2001 S. Gibson  
2009 Redside Dace Recovery Team (RSD database)  
2016 Castaneda 2016

Table 24b. Number of additional sites in Gully Creek where Redside Dace were found since 1980.			
Time Period	Number of New Sites	Number of Specimens	Sources
2010	1	>2	Redside Dace Recovery Team (RSD database)
2012/2013	1	36	Serrao 2016
2016	2	4	Castaneda 2016

Table 25. Number of sites in South Gully Creek where Redside Dace have been found.			
Time Period	Number of New Sites	Number of Specimens	Sources
2008	1	5	Redside Dace Recovery Team (RSD database)
2011	4	46	Redside Dace Recovery Team (RSD database)
2016	2	72	Castaneda 2016

Table 26. Number of sites in Two Tree River where Redside Dace have been found.			
Time Period	Number of New Sites	Number of Specimens	Sources
1997	1	1	Redside Dace Recovery Team (RSD database)
2002	1	1	Redside Dace Recovery Team (RSD database)
2009	4	131	Redside Dace Recovery Team (RSD database)
2010	12	46	Redside Dace Recovery Team (RSD database)
2011	4	14	Redside Dace Recovery Team (RSD database)
2012/2013	1	40	Serrao 2016

2015	1	1	Redside Dace Recovery Team (RSD database)
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## Appendix 2. IUCN Threats calculation for Redside Dace.

<b>Species or Ecosystem Scientific Name</b>	Redside Dace - <i>Clinostomus elongatus</i>		
<b>Element ID</b>		<b>Elcode</b>	
<b>Date (Ctrl + ";" for today's date):</b>	04/12/2016		
<b>Assessor(s):</b>	Dwayne Lepitzki (moderator and Mollusc SSC co-chair), Nick Mandrak (FWF SSC co-chair), Tim Birt (author), Tim Haxton, Mark Poesch and Jim Grant (SSC members), Rebecca Dolson (OMNR), Andrew Drake, Bill Glass, Shawn Staton and Lynn Bouvier (DFO), Angele Cyr (COSEWIC Secretariat).		
<b>References:</b>	draft calculator from writer, draft report		

<b>Overall Threat Impact Calculation Help:</b>		<b>Level 1 Threat Impact Counts</b>	
<b>Threat Impact</b>		<b>high range</b>	<b>low range</b>
A	Very High	2	1
B	High	1	1
C	Medium	0	1
D	Low	1	1
<b>Calculated Overall Threat Impact:</b>		Very High	Very High

<b>Assigned Overall Threat Impact:</b>	<b>A = Very High</b>
<b>Impact Adjustment Reasons:</b>	
<b>Overall Threat Comments</b>	Residential/commercial development impact was rated "high" because these threats affect at least 10 of 17 catchments supporting RSD, i.e. those catchments in the most urbanized settings. Generation time 2-3 years, therefore, score severity and timing for 10 years; 30 "subpopulations" / "locations" (creeks and rivers), but most in Rouge (< 20%) and Humber (~80%) rivers (have pop estimates). RPA in development by DFO that should be reviewed before COSEWIC reassessment (December 2017 update - RPA not completed before assessment). There may be a DU split (December 2017 update - assessed as one DU). Population decline outcome = 50 -100% over the next 10 years. Currently Endangered under B criteria. 50% decline over the next 10 years is not unrealistic.

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
1	Residential & commercial development		Not Calculated (outside assessment timeframe)	Small (1-10%)	Extreme (71-100%)	Low (Possibly in the long term, >10 yrs/3 gen)	
1.1	Housing & urban areas						Residential development is present across much of the range and is ongoing (e.g., Seaton community development). Activities associated with this threat, such as watershed hardening are accounted for under 7.3.

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
1.2	Commercial & industrial areas		Not Calculated (outside assessment timeframe)	Small (1-10%)	Extreme (71-100%)	Low (Possibly in the long term, >10 yrs/3 gen)	Commercial/industrial development expected to continue. Airport development expected in Pickering.
1.3	Tourism & recreation areas		Negligible	Negligible (<1%)	Slight (1-10%)	High (Continuing)	Rouge Park boat launch but minimal overlap with Dace habitat since Parks Canada development.
2	Agriculture & aquaculture						
2.1	Annual & perennial non-timber crops						Most catchments have farm land either upstream or adjacent to reaches supporting RSD. Production of both crops and livestock are apparent. Nutrient loading and siltation accounted for under pollution 9.3.
2.2	Wood & pulp plantations						not applicable
2.3	Livestock farming & ranching						Indirect impact to the species from cattle watering accounted for under 9.3
2.4	Marine & freshwater aquaculture						not applicable
3	Energy production & mining						
3.1	Oil & gas drilling						not applicable
3.2	Mining & quarrying						Gravel quarrying not directly in Dace habitat so accounted for under 7.3. Not known whether the mining is expected to expand in the future.
3.3	Renewable energy						not applicable
4	Transportation & service corridors						
4.1	Roads & railroads						Road salting or other pollution accounted for under 9.1. Road and bridge development expected, but no direct impact from a physical structure. Indirect only and accounted for under 7.3.
4.2	Utility & service lines						Fourteen-Mile Creek horizontal drilling, so no impact to habitat.
4.3	Shipping lanes						No shipping lanes.
4.4	Flight paths						not applicable
5	Biological resource use	D	Low	Large (31-70%)	Slight (1-10%)	High (Continuing)	
5.1	Hunting & collecting terrestrial animals						not applicable



Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
5.2	Gathering terrestrial plants						not applicable
5.3	Logging & wood harvesting						not applicable
5.4	Fishing & harvesting aquatic resources	D	Low	Large (31-70%)	Slight (1-10%)	High (Continuing)	Potentially targeted as aquarium fish. Incidental catch from bait fishery. By-catch estimates available with high probability of by-catch for this species.
6	Human intrusions & disturbance		Negligible	Small (1-10%)	Negligible (<1%)	High (Continuing)	
6.1	Recreational activities						not applicable
6.2	War, civil unrest & military exercises						not applicable
6.3	Work & other activities		Negligible	Small (1-10%)	Negligible (<1%)	High (Continuing)	Research, but negligible or small. Some sampling is controlled very strictly in parts of its range. Lethal sampling generally not permitted.
7	Natural system modifications	A	Very High	Pervasive (71-100%)	Extreme (71-100%)	High (Continuing)	
7.1	Fire & fire suppression						not applicable
7.2	Dams & water management/use	AB	Very High - High	Pervasive (71-100%)	Extreme - Serious (31-100%)	High (Continuing)	Reservoir development has occurred in Spencer Creek, Bronte Creek, Sixteen Mile Creek. Extent of future development is unknown. Storm-water ponds, change in water flow patterns occurring. Dewatering from mining.
7.3	Other ecosystem modifications	A	Very High	Pervasive (71-100%)	Extreme (71-100%)	High (Continuing)	Channel alterations have occurred in several catchments (e.g., Rouge River, Carruthers Creek). Extent of future development is unknown. Drain maintenance from agriculture. Removal of riparian vegetation.
8	Invasive & other problematic species & genes	AC	Very High - Medium	Pervasive (71-100%)	Extreme - Moderate (11-100%)	High (Continuing)	
8.1	Invasive non-native/alien species/diseases	AC	Very High - Medium	Pervasive (71-100%)	Extreme - Moderate (11-100%)	High (Continuing)	Introduced centrarchids and salmonids (Spencer Creek, Credit River) throughout historical range of the species. Dace is extirpated from sites with introduced salmonids.

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
8.2	Problematic native species/diseases						Atlantic Salmon (lake Ontario population) considered extinct, therefore restocking is considered non-native. No current stocking of Brook Trout but this will be discussed in Jan 2017 (December 2017 update – no new information).
8.3	Introduced genetic material						not applicable
8.4	Problematic species/diseases of unknown origin						not applicable
8.5	Viral/prion-induced diseases						not applicable
8.6	Diseases of unknown cause						not applicable
9	Pollution	B	High	Pervasive (71-100%)	Serious (31-70%)	High (Continuing)	
9.1	Domestic & urban waste water	B	High	Pervasive (71-100%)	Serious (31-70%)	High (Continuing)	Storm-water management considered a problem at highly urbanized sites. Leaching from historical landfills is occurring in the Don River. Chloride is a problem as well.
9.2	Industrial & military effluents		Unknown	Small (1-10%)	Unknown	High (Continuing)	Mining effluents and sedimentation
9.3	Agricultural & forestry effluents	CD	Medium - Low	Pervasive (71-100%)	Moderate - Slight (1-30%)	High (Continuing)	Considered an issue wherever agriculture is practiced (often just upstream of occupied sites) and accidental manure spill.
9.4	Garbage & solid waste						Leaching from historical landfills accounted for under 9.1
9.5	Air-borne pollutants						not applicable
9.6	Excess energy						not applicable
10	Geological events						
10.1	Volcanoes						not applicable
10.2	Earthquakes/tsunamis						not applicable
10.3	Avalanches/landslides						not applicable

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
11	Climate change & severe weather		Unknown	Pervasive (71-100%)	Unknown	High (Continuing)	Climate change is expected to increase frequency of extreme weather events leading to floods, lower flow rates, and elevated temperature regimes. Impact cannot be quantified presently. ECCC report on predicted water-level changes as a result of climate change to be looked into. Unknown severity to be looked into.
11.1	Habitat shifting & alteration						applicable. Scored overall
11.2	Droughts		Unknown	Pervasive (71-100%)	Unknown	High (Continuing)	applicable. Scored overall
11.3	Temperature extremes		Unknown	Pervasive (71-100%)	Unknown	High (Continuing)	applicable. Scored overall
11.4	Storms & flooding		Unknown	Pervasive (71-100%)	Unknown	High (Continuing)	applicable. Scored overall
11.5	Other impacts						applicable. Scored overall