AMERICAN FISHERIES SOCIETY
ONTARIO CHAPTER

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To the members of the Redside Dace Recovery Team:

The Ontario Chapter of the American Fisheries Society (AFS-OC) is pleased to see that Fisheries and Oceans Canada (DFO) has published the "Recovery Strategy and Action Plan for the Redside Dace (*Clinostomus elongatus*) in Canada" (hereafter the "Recovery Strategy"). Concerns about Redside Dace declines were voiced over 40 years ago (McKee and Parker 1982), and they have been listed in some official threat category for almost 25 years: they were first assessed by the Committee on the Status of Species at Risk in Ontario (COSSARO) as Threatened in 2000 and upgraded to Endangered in 2009, with habitat formally protected in 2011; by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) as Endangered in 2007; and under the federal Species at Risk Act (SARA) as Endangered in 2017. In the decade since their first assessment under COSEWIC in 2007, their range contracted by 4.4%, the area within that range occupied declined by 47%, and their population size declined by 81% (COSSARO 2020). This amount lost is not reported in the Recovery Strategy, nor is the fact that COSEWIC (2017) and COSSARO (2020) both projected a 50% population decline in the next 10 years—and we are several years into that period. Thus, it is critical that we have even a much overdue strategy to prevent further decline and promote recovery.

We acknowledge that we did not submit these comments during the official comment period. However, we would still like to present our analysis of the Recovery Strategy as it contains inaccuracies, unfounded speculations, and an incorrect description of biological interactions. Additionally, it lacks any new guidance which is necessary for protection and fails to appropriately prioritize recovery measures, so in our opinion is inadequate to effect meaningful change. We hope that DFO (and other agencies and partners involved in the goal of supporting recovery) will take these comments seriously, share them with other groups to raise awareness of these issues, and use them to improve actions towards our common goal of recovering this unique species of fish.

First, we summarize our comments on the Recovery Strategy, then go into further detail on each issue below:

- Permits to harm Redside Dace or their habitat are always approved, and the Recovery Strategy provides no new measures to address this
- Northern Pike, Brown Trout, and Rainbow Trout are incorrectly blamed for negatively impacting Redside Dace populations through 'direct competition and eventual elimination'
- The hypothesis that Round Goby compete with Redside Dace is not plausible
- Revisions to the 10% impervious landscape cover and 30 m riparian buffer guidelines are needed
- Using artificial propagation for reintroduction ignores the known harms of hatcheries
- Maintaining barriers for Redside Dace will limit population recovery, and conflicts with goals to remove the same dams for the restoration of other native species

- Spawning and schooling associate species are necessary for reproduction and predator dilution, yet their populations are not included as part of the Recovery Strategy
- Restricting baitfish harvest is an easy management tool to prevent harm yet is dismissed as low priority
- Water temperature guidelines are incorrect based on all of the data showing a lower temperature preference

Finally, we critique several of the Recovery Strategy's recovery measures, especially their priority ranking, based on science and the Recovery Strategy's own acknowledgement of known threats.

Permitting

The most important threat to Redside Dace, according to multiple studies, is physical habitat alteration. This includes changes to the streams (affecting flow and riparian/habitat structure) and the increase in impervious cover of the watershed (increasing flashiness and turbidity, decreasing groundwater, increasing water temperature), in addition to contaminated runoff, intensive agriculture, and the construction of reservoirs or stormwater management ponds. These types of impacts are most effectively reduced through permitting controlled by the provincial and federal governments: under the provincial Endangered Species Act, "no person shall damage or destroy the habitat" of that species, and under section 73 of SARA, permits are only issued if the activity "will not jeopardize the survival or recovery of the species". Yet, there have been ~500 provincial permits granted for activities that affected Redside Dace (as of 2020); Redside Dace are one of the most common at-risk species affected by permits to allow harm; and no permits to harm the species or its habitat have ever been denied (OAGO 2021). Even "overall benefit" permits can cause harm, as 8 of these permitted over 2 years allowed more damage to Redside Dace habitat than what was restored (OAGO 2021). From 2013–2017, most permitted projects in Redside Dace habitat were water crossings (e.g., bridges, culverts) and streambank work (e.g., stabilization, infilling, retaining walls, riparian vegetation management) (Lebrun et al. 2020). As we lost many Redside Dace during this same period (COSSARO 2020), it is obvious the mitigation measures do not work, or are not being followed. Since no permits are denied, what is to stop actions such as the Ministry of Transportation's (MTO) desire to remove "1/3 of riparian vegetation where projects are occurring even if they are located in Redside Dace habitat" (DFO 2019a)? In fact, MTO obtained "an overall benefit permit in 2021 for a highway crossing over a creek that allowed the damage and destruction of 0.46 hectares of redside dace habitat, but only required 0.08 hectares of habitat to be created or enhanced" (OAGO 2021).

Federally, DFO has issued 154 permits so far under section 73 of SARA for activities affecting Redside Dace (https://species-registry.canada.ca/index-en.html#/permits?sortBy=issueDate&sortDirection=desc&pageSize=10&keywords=redside%20dace). There was no additional protection provided by the government under SARA: "This impact [of added costs to infrastructure projects] is expected to be negligible, as restrictions imposed on infrastructure projects that affect Redside Dace habitat are already in place due to this species being listed under Ontario's *Endangered Species Act, 2007* and the prohibitions under SARA are

not anticipated to result in any additional impacts to the delivery and implementation of infrastructure projects" (Government of Canada 2017). This is despite DFO stating that the addition to SARA strengthens the government's ability to protect Redside Dace (DFO 2007). Additionally, the Ministry of the Environment, Conservation and Parks (MECP) committed to "protect Redside Dace and its habitat through the ESA" and to "develop and enforce a regulation protecting the specific habitat of the species" (MECP 2017). Since the legislation that has been in place since 2007 has resulted in the loss of over 80% of the remaining Redside Dace, existing protections are clearly ineffective. Urban development is the main threat to Redside Dace, and the government has not demonstrated any ability to actually protect this species from development. Yet this Recovery Strategy fails to suggest ways to strengthen legal protections and actually make a difference. For example, why is there no recommendation to consider the cumulative impacts of habitat loss when each permit is issued, and why are there no guidelines on when MECP or DFO should say 'no' to a permit, or to development in general?

When asked why there was no mention of allowable harm in the Recovery Strategy, Rachel Jones (DFO Communications Advisor) said that the strategy was meant to "provide an overview of the species, including its distribution, threats, the identification of critical habitat, and the measures needed to support its recovery", with a species' scope for allowable harm determined in the Recovery Potential Assessment (pers. comm.). Because Redside Dace have a negative growth rate, that assessment document states that "there is no scope for allowable harm to the population" (DFO 2019b)—population sizes of Redside Dace have declined by an estimated 81% and we are in the process of losing half of the remaining 19%, with most of the current populations probably too small to be viable (COSSARO 2020)—information which was not shared in the Recovery Strategy. This decline means that "any human induced mortality or habitat destruction would jeopardize survival or recovery" (van der Lee et al. 2020). How does a Recovery Strategy, whose purpose is to "identify the threats to survival of the species", not talk about those threats in the context of this dire population decline? There is clear evidence that the federal government, by allowing the continued increase in urbanization (reflected in water quality, stormwater discharge, flow variability, the magnitude of high flow events, declines in groundwater, etc.) and loss of riparian cover, is willfully permitting the extirpation of this species: urban development is the single biggest contributor to their decline, and thus the single largest issue that needs to be curtailed to facilitate population persistence. If the social-economic value of continued urban development is prioritized over the recovery or continued existence of this species in Ontario, then that should be a policy trade-off acknowledged within the Recovery Strategy, with all subsequent priorities written with that limitation clearly stated.

Predators/competitors

The Recovery Strategy incorrectly discusses the effects of predators and competitors on Redside Dace (page 19). If the intended hypothesis was that current predation is the main threat reducing Redside Dace numbers to an unacceptably low level, then it should have been presented as such. Instead, it was presented as being only problematic if non-native species were the predators. It also twisted earlier speculative statements about predation into a foregone conclusion invoking competition, stating that "Non-indigenous species, such as Brown Trout,

Rainbow Trout, and Northern Pike have been associated with negative impacts on Redside Dace populations through direct competition and eventual elimination" (in biology, predation is very different than direct competition). We searched the literature for any demonstration of either population-level effects or elimination in a watershed or stream reach due to predation or competition, and were not able to find any evidence that either had happened. This incorrect statement should be removed from the Recovery Strategy.

1) Northern Pike are a native species, not non-indigenous as the Recovery Strategy claims; they may have expanded their range or been introduced to a new area within a watercourse, but they are native to all Lake Ontario watersheds. Northern Pike that were moved above a barrier into a man-made reservoir (e.g., Mountsberg on Bronte Creek; Christie on Spencer Creek) are still native to those watersheds, and so are properly termed 'introduced', not 'non-indigenous'—these terms are not interchangeable. We encourage the authors to take a more nuanced view of these terms, as a better classification for Northern Pike is either a natural or assisted migrant ('new native': Lemoine and Svenning 2022). The choice of terms is not a small matter, as people make assumptions about the worth of a species based on labels such as these, and communicating this requires correctly conveying their status.

2) The evidence for predation by Brown Trout on Redside Dace is much weaker than laid out in the Recovery Strategy. The Recovery Strategy states that "Redside Dace disappeared from two Wisconsin streams after the introduction of Brown Trout". However, the original source (Lyons et al. 2000) says 'expansion', not 'introduction'; these words have different meanings and the Recovery Strategy should not use words that alter the original context. The Recovery Strategy failed to mention the additional observation from the same study that Redside Dace also disappeared from two other creeks without Brown Trout (Lyons et al. 2000). This missing context is important for the reader to understand that there is no cause-and-effect relationship, but simply speculation.

Brown Trout have been present in Lake Ontario tributaries for decades (they were first stocked in 1929 in the Canadian side of Lake Ontario; Crawford 2001) and continue to be stocked into watersheds containing Redside Dace, and there was no reason given as to why they are suddenly a problem now. Adult Brown Trout are generalist piscivores, and the anecdote shows that they can consume Redside Dace. The proper context for this observation is a hypothesis that any predation-related mortality puts Redside Dace at risk due to the continued decline in their population size, which by logical extension would have to include all predators (including native Brook Trout [*Salvelinus fontinalis*], birds, and mammals). The Recovery Strategy's focus only on non-native predators is not justified, but seems to represent an unfortunate stance that 'non-native' automatically equals bad. This is further exemplified by the statement that "Resident Brown Trout are highly likely to directly prey on Redside Dace, as they do with native Brook Trout" (for which no scientific support was provided). The relevant comparison would be whether Brown Trout regularly consume species that are similar in body size, habitat use, and behaviour to Redside Dace—not whether they consume Brook Trout simply because they are native (Brown Trout don't know the difference between predating on native and non-native species). The Recovery Strategy could have performed an analysis to determine the status of Redside Dace sites sympatric with Brown Trout, but did not, so it is hard to see why this

was prioritized as a threat. McKee and Parker (1982) stated that no predation on Redside Dace by other animals has been reported; "abundant populations" of Brown Trout have co-existed with Redside Dace in the upper portion of the Credit River for at least 75 years (MNR and CVC 2002); and a high density of Redside Dace coexisted with wild and stocked Brown Trout in a Wisconsin stream (Mason et al. 1967). If the hypothesis is that predation now causes too much harm due to the low abundance of Redside Dace, then every animal that may consume Redside Dace should be considered a threat and the Recovery Strategy should reflect that, instead of scapegoating Brown Trout and ignoring the evidence that they can coexist (see point 3 below).

The Recovery Strategy also presented the puzzling hypothesis that "The bright yellow and red colour pattern of the Redside Dace may make it more visible to predators, thus affecting survivorship." Bright colouration is not inherently bad, and is ubiquitous across Ontario's fish fauna; many abundant native small-bodied fish species have bright spawning colouration, including Rainbow Darter (*Etheostoma caeruleum*), Western Blacknose Dace (*Rhinichthys obtusus*), Northern Redbelly Dace (*Chrosomus eos*), Northern Pearl Dace (*Margariscus nachtriebi*), Common Shiner (*Luxilus cornutus*), and Rosyface Shiner (*Notropis rubellus*), as well as juvenile stages of other species like Brook Trout and Rainbow Trout (*Oncorhynchus mykiss*). This hypothesis implies that either Redside Dace were always heavily predated and never evolved predator-avoidance behaviours to counter it (an unlikely scenario), or that only new (non-native) predators are attracted to these colours (an unlikely bias, and no evidence was presented to support this scenario) more than to the more abundant species that live with Redside Dace and have similar colouration (e.g., Common Shiner). In fact, an experiment with Redside Shiner (*Richardsonius balteatus*, which also have bright red colour during spawning) showed that antipredator behaviour, not colour, was more important in determining mortality by Brown Trout (Nannini and Belk 2006)—yet this was not referenced. Thus, this hypothesis is another example of speculation (which has no place in a science-based recovery document), and appears to be a further attempt to place blanket blame on predators instead of focusing on known habitat-related threats.

3) The Recovery Strategy chose to focus on the use of barriers to prevent further interactions of Redside Dace with the species they deemed as problematic. It was surprising that there was no mention of the literature that shows the more holistic methods for alleviating interactions with predators. Notably, habitat restoration and complexity led to the coexistence of native fishes with Brown Trout (Billman et al. 2013; Belk et al. 2016) and Rainbow Trout (Hanisch et al. 2012), and Kirk et al. (2017) found that agricultural land use and landscape covariates were more important than the presence of Brown Trout in predicting the occurrence of Redside Dace. The Recovery Strategy also downplays the evidence that Redside Dace (and other sensitive species) have been lost from locations where there are no Brown Trout (e.g., German Mills Creek, Lower West Don River: Toronto and Region Conservation 2009) and that Redside Dace declines have happened concurrent with other species (such as Blacknose Shiner *Notropis heterolepis*) that also require clear, heavily vegetated habitat (Allen and Mandrak 2019). Thus, the overwhelming evidence is that habitat modification, not predation, drives the population status of Redside Dace, and even with predation, improving habitat allows for their coexistence. Further, the Recovery Strategy did not identify that maintaining barriers and their head ponds may also contribute to the decline in Redside Dace, as these result in downstream increases in

water temperature, alteration of riverine processes, and changes to food webs. There are at least two Redside Dace populations that have undergone significant decline or loss and are downstream of significant reservoirs (Mountsberg Dam in Bronte Creek, and Christie Dam in Spencer Creek), yet the barrier itself was not identified as a potential cause of decline/loss.

4) The Recovery Strategy states that "...declines in Redside Dace populations have been observed in Spencer Creek, concomitant with the introduction of Golden Shiner (*Notemigonus crysoleucas*) (S. Staton, DFO, pers. comm. 2020) and predatory Northern Pike (*Esox lucius*) (Holm 1999)." The updated report by Holm (2004) does not show the stated concomitant relationship, as Redside Dace were already rare in 1984 sampling and Northern Pike didn't become more common until 1998 sampling. Golden Shiners were already present in 1958 (Holm 2004), so they were not a recent addition to the fauna. Additionally, Holm (2004) shows that many species were newly found or at higher abundance in 1991 or 1998 samples compared to earlier, including Goldfish (*Carassius auratus*), Spotfin Shiner (*Cyprinella spiloptera*), Striped Shiner (*Luxilus chrysocephalus*), Rosyface Shiner, Black Crappie (*Pomoxis nigromaculatus*), Rainbow Darter, Johnny Darter (*Etheostoma nigrum*), Blackside Darter (*Percina maculata*), Bluntnose Minnow (*Pimephales notatus*), Blacknose Shiner, River Chub (*Nocomis micropogon*), Brown Bullhead (*Ameiurus nebulosus*), Largemouth Bass (*Micropterus salmoides*), and Pumpkinseed (*Lepomis gibbosus*). Why were Northern Pike and Golden Shiner singled out and not any of these other 14 species? Additionally, the Recovery Strategy failed to mention the concomitant decline in water quality of Spencer Creek during the time frame that Redside Dace declined: Holms (2004) concluded that in 1986, "the fish community reflected a shift in ecological conditions from clear, fast flowing streams with a gravelly substrate to warm, turbid, slow flowing streams with an organic substrate on the bottom." Additionally, the streams in the subwatersheds of Spencer/Flamborough Creek have only 20.8–41.2% of streambanks vegetated and have numerous online ponds that warm water and restrict fish movement (Hamilton Conservation Authority 2011, 2012a,b), Similarly in Bronte Creek, the Recovery Strategy partially blamed Redside Dace declines on "the introductions of Black Crappie (*Pomoxis nigromaculatus*), Largemouth Bass (*Micropterus salmoides*), and Northern Pike to a reservoir in the upper portion of the watershed". Yet other introduced species (e.g., Pumpkinseed and Green Sunfish *Lepomis cyanellus*) were not mentioned, nor was the construction of Mountsberg reservoir itself in the same timeframe which resulted in extensive channel alterations and created lake-like conditions and thermal impacts (Featherstone and Watson-Leung 2002). Strangely, the observation that "multiple smaller impoundments built by landowners on various Bronte Creek tributaries also provide habitat for introduced species" is listed under invasive species and not under development or system modifications, yet ponds are clearly a type of habitat degradation, with their use by introduced species possible because we created this habitat for them. Thus, here again, habitat conditions seem like a much more plausible explanation for Redside Dace declines than the focus on select (seemingly arbitrary) species that have no scientifically supported impact.

5) The Recovery Strategy's statement that "Non-native, resident Brown Trout (*Salmo trutta*) and migratory Rainbow Trout (*Oncorhynchus mykiss*) have been introduced into several Toronto-area streams" is misleading. The wording implies that Brown Trout (resident or migratory is irrelevant; they are the same species) and Rainbow Trout were introduced to the area

in past discrete events, and only to Toronto. This is obviously incorrect, as both species were purposefully introduced to many areas across Lake Ontario and its tributaries (Brown Trout almost 100 years ago, Rainbow Trout 150 years ago), and their stocking is ongoing. The Recovery Strategy states that "Brown Trout is known to have negative impacts on native Brook Trout and is considered an invasive species in some jurisdictions (Global Invasive Species Database 2020)". Brown trout are not invasive in Lake Ontario (they are still being stocked to this day by management agencies), so this is an irrelevant statement seemingly included to support the opinion that Brown Trout are inherently bad. By this logic, the Recovery Strategy should also mention that Brook Trout are considered invasive in some areas where they have negative effects on native Brown Trout (e.g., Larranga et al. 2019; Loven Walleius et al. 2022). Additionally, because Brown Trout are a popular species for angling, they are given a pass for their negative effects on Brook Trout in some fisheries management plans (e.g., MNR and CVC 2002), yet this contradiction is not mentioned.

The Recovery Strategy also blames Brown Trout for competitive effects with Redside Dace, stating that "Greeley (1938) reported that Redside Dace competes with trout for food". However, Greeley's (1938) statement was simply an observation that both species eat surface insects (a similar statement was made by Raney [1969] but also included Creek Chub in the same category). Either the Recovery Strategy's authors did not read the original reference, or they failed to realize that the evidence needed to establish competition is quite strict. The implication is also that Redside Dace lose in that interaction, yet as specialized surface feeders, they may outperform Brown Trout. We encourage the authors of the Recovery Strategy to read original references and have a full understanding of the biological literature instead of repeating unfounded conclusions, as that does not form the basis for a sound recovery strategy.

6) The Recovery Strategy states that "Although there are no studies on Round Goby/Redside Dace interactions, potential impacts of Round Goby on the fish community and on Redside Dace are of concern." This statement provides no mechanism of interaction between Round Goby and Redside Dace (another unfortunate omission), therefore we (and everyone using the document) have to infer what the authors intended; we assume exploitative competition was the mechanism omitted. However, this statement fails to acknowledge that Round Goby are a benthic species, and all documented negative competitive interactions of Round Goby (including the Thomas and Haas 2004 paper cited in the strategy) are with other benthic species; species that do *not* overlap in diet with Round Goby show *no* evidence of interspecific competition (Firth et al. 2021). Redside Dace are in this category, as they are not a benthic species. Thus, any focus on Round Goby interactions is entirely unfounded based on fundamental principles of interspecific exploitative competition. Inaccurate speculation is not a reason to suggest the use of barriers.

The six points described above detail many problems with the Recovery Strategy's conclusions that four non-native species (Northern Pike, Brown Trout, Rainbow Trout, and Round Goby) are responsible for declines in Redside Dace, have affected Redside Dace to the point of "elimination", and warrant the maintenance of barriers (including identifying new barriers) to limit species interactions. It is disappointing to find these sentiments, where a few species are scapegoated, in a science-based recovery plan, especially as the Recovery Strategy fails to acknowledge that improving habitat alleviates all these potential issues.

Impervious and riparian cover

The Recovery Strategy states that "A study of streams in the Lake Ontario basin (Stanfield et al. 2004) demonstrated that native salmonid species only occurred in streams with a catchment that was less than 10% impervious cover." According to the Stanfield et al. (2006) paper which appears to be based on the same data (we could not find a copy of the 2004 project report), all three salmonid species (non-native Brown and Rainbow Trout, and native Brook Trout) required a percent impervious cover (PIC) of less than 10. However, PIC, as used in that paper, is a metric, not an actual percentage; it varies from 1 (fully forested) to 20 (fully urbanized), so these values reflect a landscape that is 33% urbanized or 65% agriculture (Stanfield et al. 2006), not 10% impervious cover as stated. The Stanfield et al. (2006) results were also a model, and so did not "demonstrate" where species occurred; it *predicted* occurrence or absence with an associated classification success—an important distinction. For example, Brook Trout can be found in areas with 100% impervious cover if other vital stream conditions remain intact (Blair et al. 2021). As the Recovery Strategy will be used by managers, agencies, and partners, it needs to report the results of other studies accurately.

We know that the <10% impervious cover guideline (Environment Canada 2013) will not be maintained in the Greater Toronto Area, where 80% of remaining Redside Dace occur. Thus, protecting the populations in less urbanized watersheds is essential. Instead of maintaining the 10% threshold for those areas, the Recovery Strategy should have emphasized that "significant impairment in stream water quality and quantity...can often begin before this threshold is reached" (Environment Canada 2013). It seems this impairment affects Redside Dace at lower levels, meaning that even 10% impervious cover is too high, or that current best management practices to reduce effects of higher levels of impervious cover are insufficient, considering the severe population declines that are ongoing. MECP (2017) also recognized that "activities on the landscape beyond the associated riparian habitat can have profound cumulative impact(s) on Redside Dace habitat, particularly in urban areas. It is also important to note that Best Management Practices (BMP's) limited to stream channel considerations have typically been ineffective in addressing changes in water balance", yet no measures were suggested to address this. The Recovery Strategy also acknowledged that we don't know if what we are doing is working, stating that "further study is required to identify appropriate techniques to mitigate the influence of impervious cover in our watersheds, in order to maintain healthy Redside Dace populations". This is an unacceptable knowledge gap, yet was relegated to only a 'medium' priority (see Recovery Measure 10 below), which is in stark contrast with the first 'high' priority recovery measure maintaining the (ineffective) status quo for mitigating against the highest threat of urbanization. We encourage the authors to require and prioritize actual scientific study of mitigation and recovery measures, as done for other species (e.g., see Gray et al. 2024). The premise that we can mitigate for urbanization is still in the 'proof of concept' stage in general, and has failed for Redside Dace in particular. Knowing this, the Recovery Strategy could have stated that development should not occur until appropriate mitigative approaches had been found, if at all. Failing that, it should set precautionary thresholds for urbanization/impervious cover based on the existing science to support cold/coolwater fish species, while keeping in mind that Redside Dace are "more sensitive to environmental disturbance than most fish species in the Ontario streams where they occur" (COSEWIC 2007).

The designation of a 30-m buffer from the meander belt as Redside Dace habitat has been in place since 2011 and has not led to population stabilization or recovery. The 30-m buffer is described as a "general guideline minimum" (Environment Canada 2013). The evidence suggests that Redside Dace require either larger riparian buffers, or require larger buffers in conjunction with a watershed-wide limit on impervious cover, as urbanization is the largest driver of Redside Dace loss (Reid and Parna 2017). By omitting these changes, the Recovery Strategy missed the opportunity to lay the groundwork for real legislation to support stabilization/recovery of this species. Without them, the Recovery Strategy is instead encouraging us to monitor the extirpation of a species.

Hatcheries

Artificial propagation (i.e., the use of hatcheries) is proposed as a measure to mitigate all threats and is listed as a high priority (see Recovery Measure 11 below). The science shows that hatcheries have a negative effect when cultured individuals are stocked on wild populations of the same species (McMillan et al. 2023), with fitness and productivity declining, and genetic, epigenetic, and morphological changes (among others) occurring when a species is in captivity. The Recovery Strategy highlights advances made in culturing Redside Dace, but does not discuss whether fish culture itself can ameliorate these hatchery effects to support effective supplementation or reintroduction. Is there any evidence to demonstrate that local co-adapted gene complexes (locally adapted traits) can be maintained both in a hatchery environment and in surrogate future habitats? For example, a conservation hatchery for Delta Smelt (*Hypomesus transpacificus*) resulted in epigenetic and transgenerational epigenetic effects despite intense genetic management efforts which resulted in fitness differences between hatchery and wild fish (Habibi et al. 2024) and reduced growth and survival (Chase. et al. 2024). Without ameliorating the reasons for the decline of wild fish, simply putting hatchery fish in the water has been demonstrated to be an ineffective approach to species recovery. Hatcheries are also not an appropriate refuge, as fish in a hatchery can become differentiated from their wild conspecifics within one generation (Christie et al. 2011). Hatcheries are not a solution to any problem faced by Redside Dace; protecting habitat is the only viable path forward.

Barriers

Though we agree with the Recovery Strategy's objectives to reduce any further human-assisted movement of native or non-native species to new areas, species partition barriers are not the way to accomplish this. The Recovery Strategy implied that the barriers listed are perfectly suited or currently used for this purpose; yet, this is not always the case. For example, Norval Dam on the Credit River is identified as a partition, yet Rainbow Trout are lifted above the dam every year for spawning by the MNR, and Brown Trout have been self-sustaining above the dam since 1962. Much of the identified Redside Dace habitat is actually below this barrier, so it already disconnects Redside Dace populations within the watershed. This dam was retrofitted to facilitate fish passage in 2009 (when a Denil fishway was built to allow upstream passage for non-jumping fish species) but is currently not being used by MNR to support any fish passage. The strategy of using species partition barriers was not paired with an assessment of how this

impacts population viability through fish movement or the ecological effects of dams. The Recovery Strategy also does not identify that many proposed species partitions conflict with other plans that are working to remove those same barriers. For example, the Lake Ontario Atlantic Salmon Restoration Program has the goals of removing Whitevale and Newman's dams on Duffins Creek to increase the chances of Atlantic Salmon (*Salmo salar*) restoration. Dams also fragment populations of all species, including schooling and spawning associates, and in general have a negative effect because they limit recolonization of new habitat (Toronto and Region Conservation 2009). It is also unclear why known negative population fragmentation effects are considered less risky than speculations on species interactions. In general, species need to disperse to find seasonally appropriate habitat, and overwinter habitat may be especially limiting to Redside Dace; Poos and Jackson (2012) only recaptured <10% of marked fish from the fall to the following spring. Redside Dace can disperse 300 m (Poos and Jackson 2012) so are not as sedentary as previously believed, and population expansion and reintroductions will require more, not less, connectivity for persistence and stability. Additionally, many of the identified dams are privately owned structures, classified as partitions without landowner notification, and may be removed by the landowner to eliminate their liability of owning these structures at any time. The Recovery Strategy does not identify purchasing these structures to ensure they act as a species partition, if it is demonstrated that they are needed. With no scientific evidence to show any species has larger negative effects on Redside Dace than habitat modification, the focus on 'easy' solutions (i.e., placing importance on barriers that already exist) does not provide the best path forward for Redside Dace restoration.

Spawning and schooling associates

The Recovery Strategy fails to mention that Redside Dace respond positively to White Sucker (*Catostomus commersonii*) (Drake and Poesch 2020) and school with Blacknose Dace (COSEWIC 2007), behaviours which presumably reduce predation pressure. Barriers often block the movement of these species, in addition to the necessary spawning relationships with Common Shiner and Creek Chub which also cannot pass barriers. Why was monitoring of these necessary spawning and schooling associates not included as part of the Recovery Strategy?

Baitfish harvest

The Recovery Strategy stated that "...only 17 events were required to reach the 95% threshold for species that were predicted to be frequently caught as bycatch (for example, Rock Bass [*Ambloplites rupestris*], Pumpkinseed [*Lepomis gibbosus*])." The wording used here is misleading, as Rock Bass and Pumpkinseed were with Redside Dace *in the same category* of low harvest effort, and not in a separate frequent-catch category; instead, these two species, and Redside Dace, were being compared to other species with frequent bycatch. Additionally, if the Recovery Strategy is taking a precautionary approach (consistent with their assumption in other sections that any additional mortality is bad), then the predicted lower harvest level for bycatch (156 events) should be the value of interest. Why didn't the Recovery Strategy report how many harvest events have occurred in waters containing Redside Dace? The Recovery Strategy also didn't consider that Redside Dace are often localized with high abundance in small areas (Poos et

al. 2012), meaning even one harvest event could remove many individuals—and even presuming their correct identification and release, there would likely be some mortality. Since Redside Dace's four known schooling and spawning associates are all listed as legal baitfish, 3 of those 4 species are frequently encountered during harvest, and over 100 million baitfish are sold annually (Drake and Mandrak 2014), the chances of bycatch may be higher than the model suggests. Indeed, COSEWIC (2017) noted that "Bait fishers have been observed capturing Redside Dace while seining for other species", and Becker (1983) noted Redside Dace have been reported in the tanks of baitfish dealers presumably because living in open areas of pools means they are easily taken by seine. The government committed to finalizing the "Framework for Managing Commercial Baitfish Harvest to Protect Redside Dace Populations" (MECP 2017) yet we cannot find any evidence that they have done so. The Recovery Strategy states that all commercial baitfish harvesters are prohibited from harvesting in Redside Dace streams during the spawning season (i.e., May 1 to June 30; COSEWIC 2017). Redside Dace start spawning as early as May 6 (Watt 2023) and after warm winters they may begin earlier, suggesting this start date may not always protect spawning fish (and definitely does not protect pre-spawn fish). The survival of pre-spawning and non-spawning adult fish is equally important considering the low population sizes of this species and that individuals can repeat spawn up to 4 years. The protection of juveniles is also vital, as the Recovery Strategy states "populations are particularly sensitive to activities that affect the survival of immature individuals" (this was also stressed in DFO 2019b). Why are restrictions only in place during spawning, despite the evidence that pre-spawn and non-breeding adults and juvenile fish during the rest of the year are equally important to population recovery? If all sources of potential mortality are being considered, an easy lever for management to pull is to prohibit the collection of any baitfish (not just Redside Dace) in waters containing Redside Dace year-round (not just during spawning).

Additionally, the Recovery Strategy states that "...incidental mortality as a result of sampling should be viewed as a potential threat". Reid and LeBaron (2021) found zero Redside Dace mortalities due to seining or electrofishing. In contrast, Poos et al. (2012) reported high levels of harm from an electrofishing pilot study, and Castañeda et al. (2020) reported a 5.8% (8 fish) electrofishing-related and 0.5% (1 fish) seining-related mortality. It seems that seining should be an acceptable alternative to electrofishing as it causes extremely low levels of harm—yet this activity is restricted far more than baitfish harvest, an activity which has the potential to cause a lot of harm.

Water temperature

The Recovery Strategy states that Redside Dace prefer summer water temperatures <24 °C, citing three sources, all of which rely on McKee and Parker (1982). However, the original McKee and Parker (1982) source states that most Redside Dace were found in streams <20 °C. All other published temperature data supports this cooler temperature preference: Coon (1993, as cited in COSEWIC 2007) suggested that the optimal summer temperature was 20 °C; Lamothe et al. (2021) found that Redside Dace prefer temperatures <19 °C; Hallam (1959) found that Redside Dace were associated with Mottled Sculpin (*Cottus bairdii*, which prefer temperatures of 16.6 °C; Scott and Crossman 1973); Turko et al. (2020) collected Redside Dace from an Ohio

stream that was 20 °C or less during the summer; Novinger and Coon (2000) found Redside Dace in streams with mean temperatures below 20 °C; and Parker et al. (1988) reported that they were usually captured in water less than 20 °C. The guidance for development for Redside Dace (https://www.ontario.ca/page/guidance-development-activities-redside-dace-protected-habitat) states that 24 °C is the *maximum* temperature for this species, but the Recovery Strategy stated that < 24 °C was the *preferred* temperature. This change drastically altered the meaning of the temperature target, and it is unacceptable that a document that will be used by DFO to mitigate impacts contains this error. The target temperature must be the documented preferred temperature of 20 °C, especially considering that urbanization can increase water temperatures by 5–8 °C and storm runoff can increase it by 4–8 °C (as cited in Turko et al. 2020). The Recovery Strategy also failed to include the data in Watt et al. (2023) that showed Redside Dace spawn at 14.5–18.5 °C, not just 16–18 °C.

Recovery measures

We examined the proposed measures considering that the priority designation reflects the degree to which it contributes directly to the recovery of, or is an essential precursor that contributes to, Redside Dace recovery.

Recovery measures 2 and 5: As stated above, all evidence suggests that barriers will limit population recovery and facilitate the continued degradation of ecosystem-based processes. Focusing on barriers scapegoats non-native species as the reason for population decline, despite an absence of scientific evidence for this.

Recovery measure 3 and 6: While monitoring is good, it is not a high priority. The Recovery Strategy identifies occupied Redside Dace habitat, and every single area needs to be protected. We do not need information on the current distribution of Redside Dace during permitting, as any habitat occupied during the last 20 years is protected. All efforts should be focused on protecting the remaining populations through effective legislation, not the maintenance of a database.

Recovery measure 7: The science clearly demonstrates that habitat is the most important factor affecting Redside Dace. If habitat evaluation is required for identifying priority rehabilitation projects, then it must be a high priority, not a low priority—it has a *direct* effect on recovery, as Redside Dace do not currently have enough livable habitat to support viable populations in several watercourses (Poos et al. 2012). It is unfortunate that this was downgraded from a high priority in the draft version to low priority in the final version. DFO (Rachel Jones, pers. comm.) defended this change saying that "the adjustment in priority reflects the focus on immediate, high-impact recovery measures that directly address Redside Dace population declines and threats". If populations are currently not viable because of habitat loss, how can DFO continue to defend its choice to rank recovering that lost habitat as a low priority, by suggesting it only plays a "supporting role" in the overall recovery effort?

Recovery measure 8: How will having data on inbreeding depression and fragmentation be informative? There are already genetic data on these populations, as the Recovery Strategy summarizes that "populations are unique at a local level, as well as regional level, likely as a result of small population effects rather than local adaptation". It does not seem possible to

examine local adaptation and functional genes when, as cited above, small populations have undergone genetic drift and so unique alleles may not reflect local adaptation. It also makes no sense to include colouration as an important biological trait that we need to research, considering that there is no management implication of having that information, and considering that we lack information on all the actual threats to the population (which is where research must be focused).

Recovery measure 9: Species interactions are listed as a medium priority, yet there is no evidence (in contrast to abiotic habitat-related factors) that this is driving Redside Dace declines. We believe research efforts should be directed towards habitat protection and determining if current mitigation measures (e.g., stormwater management) are working. This is because even if all interactions with all these species listed (non-native salmonids, centrarchids, Northern Pike, other leuciscids) were investigated, there is little realistic way to then eliminate the species that are 'bad'. Instead of the Recovery Strategy's heavy focus on specific non-native species and biological interactions, it should have focused on fixing the main known abiotic drivers of population declines which will also happen to mitigate negative biological interactions.

Recovery measure 10: This states that actually knowing the key factors of urbanization that are driving population declines is only a medium priority (another unfortunate downgrading from a high priority in the draft version). The Recovery Strategy admitted this was a knowledge gap, stating that "research investigations are needed to test the effectiveness of current and new mitigation or restoration measures". All the science shows that urbanization is the main driver of population declines. Yet, despite knowing this, despite acknowledging we don't know how to mitigate its effects, and despite knowing that the current protections do not work, the Recovery Strategy does not list figuring out which specific mechanisms are causing declines as a high priority. Having the ability to "protect and rehabilitate Redside Dace habitat through urban planning, infrastructure retrofits, and the improvements of best management practices" must be listed as *the* highest priority. The current ranking is unconscionable and is why this strategy will fail.

Recovery measure 11: Why is artificial propagation/reintroduction a high priority when currently occupied habitats cannot sustain populations? Where are you going to put the new 18,000 to 75,000 adults that are needed at a minimum for each population (DFO 2019b)? Current populations are still declining, indicating even existing suitable habitat is rapidly becoming degraded, or that the fish are still temporally adjusting to past land-use changes. Is there any indication that any of the historic locations for Redside Dace have moved closer to 'restored' to facilitate reintroduction? Where is the evidence for meaningful restoration of any currently occupied or unoccupied habitat (e.g., a restoration project occurred and Redside Dace abundance increased), in light of the fact that currently occupied habitat is becoming more unsuitable, and that rehabilitation projects are a 'low' priority (see Recovery Measure 7 above)? The focus on hatcheries diverts resources away from activities that would have a positive effect.

Recovery measure 15: Though securing lands is an admirable and supported goal, according to Table 2, there are no healthy populations (ranks are fair to extirpated), so this measure is impossible. Thus, without significant funding and models that prioritize populations with the highest probability of persistence, it seems doubtful this measure can be scaled at an appropriate level.

Conclusion

Provincial and federal governments regulations are failing this species. The federal government took 9.6 years to develop advice to list the species under SARA—the third longest delay of any species (CESD 2022)—and missed the mandatory deadline for finalizing the Recovery Strategy, causing Ecojustice to file an application for judicial review (https://ecojustice.ca/news/environmental-group-celebrates-as-federal-government-finalizes-delayed-plan-to-protect-the-redside-dace-after-legal-pressure/). Despite this extra time, the Recovery Strategy prioritized measures that are not the root cause of decline, so are unlikely to protect the remaining populations, never mind contribute to recovery, as currently written. The provincial protection of Redside Dace habitat in 2011 and federal listing under SARA in 2017 are the legal tools to stop harmful activities—but the governments continue to allow harm, with no provincial permits ever denied (~500 approved as of 2020) and 154 federal permits currently approved. We have already lost an estimated 81% of the remaining Redside Dace, and are losing an estimated additional 5% per year. There is zero scope for harm to individuals or habitat due to this extreme population decline. This new Recovery Strategy had the critical role to summarize the existing science and new science needs, provide new guidance for protection (based on an assessment of existing regulatory tools and mitigation), and prioritize recovery measures based on the known primary drivers of population decline: stream habitat modification, urbanization, and alteration of the hydrology and groundwater inputs within watersheds. New guidance could have included designating protected status to entire watersheds/subwatersheds (impervious cover far less than 10%); increasing the protected riparian zone past 30 m; eliminating baitfish harvest; or setting limits for incidental death during permitted activities (e.g., if mortality of any Redside Dace occurs, work will be stopped immediately and DFO will be consulted to discuss changes to methodology). But instead of setting clear guidelines for how to reduce threats, the Recovery Strategy ranks monitoring as a higher priority than actually identifying the drivers of population loss. Without a change in legislation reducing allowable impervious cover, and without the government saying ‘no’ to land use permits that harms this species, the future prospects for wild populations of Redside Dace in southern Ontario look bleak.

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