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Proceedings of the Central and Arctic Regional Science Advisory Process on the Recovery Potential Assessment of Redside Dace

Compte rendu du processus régional de consultation scientifique du Centre et de l'Arctique sur l'évaluation du potentiel de rétablissement du méné long

14 December 2007
Canada Centre for Inland Waters
Burlington, ON

le 14 decembre 2007
Centre canadien des eaux intérieures
Burlington (Ont.)

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Foreword

The purpose of these Proceedings is to document the activities and key discussions of the meeting. The Proceedings include research recommendations, uncertainties, and the rationale for decisions made by the meeting. Proceedings also document when data, analyses or interpretations were reviewed and rejected on scientific grounds, including the reason(s) for rejection. As such, interpretations and opinions presented in this report individually may be factually incorrect or misleading, but are included to record as faithfully as possible what was considered at the meeting. No statements are to be taken as reflecting the conclusions of the meeting unless they are clearly identified as such. Moreover, further review may result in a change of conclusions where additional information was identified as relevant to the topics being considered, but not available in the timeframe of the meeting. In the rare case when there are formal dissenting views, these are also archived as Annexes to the Proceedings.

Avant-propos

Le présent compte rendu a pour but de documenter les principales activités et discussions qui ont eu lieu au cours de la réunion. Il contient des recommandations sur les recherches à effectuer, traite des incertitudes et expose les motifs ayant mené à la prise de décisions pendant la réunion. En outre, il fait état de données, d’analyses ou d’interprétations passées en revue et rejetées pour des raisons scientifiques, en donnant la raison du rejet. Bien que les interprétations et les opinions contenus dans le présent rapport puissent être inexacts ou propres à induire en erreur, ils sont quand même reproduits aussi fidèlement que possible afin de refléter les échanges tenus au cours de la réunion. Ainsi, aucune partie de ce rapport ne doit être considéré en tant que reflet des conclusions de la réunion, à moins d’indication précise en ce sens. De plus, un examen ultérieur de la question pourrait entraîner des changements aux conclusions, notamment si l’information supplémentaire pertinente, non disponible au moment de la réunion, est fournie par la suite. Finalement, dans les rares cas où des opinions divergentes sont exprimées officiellement, celles-ci sont également consignées dans les annexes du compte rendu.

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SUMMARY

A regional science peer review meeting was held on 14 December, 2007 in Burlington, Ontario. The purpose of the review was to provide science advice on the recovery potential of Redside Dace (*Clinostomus elongatus*) including the 17-step process outlined in the Fisheries and Oceans Canada (DFO) Recovery Potential Assessment (RPA) framework. The advice was intended to feed the recovery process, under Canada's *Species at Risk Act* (SARA), for Redside Dace, which had been designated as Endangered by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). The advice will be provided to the DFO Minister for his consideration in any listing decision under the SARA for this population and for any socio-economic analyses, consultations and recovery planning related to this population. Meeting participants included DFO Science, Fish Habitat Management and Policy sectors of the Central and Arctic Region, and specialists from the Ontario Ministry of Natural Resources, Royal Ontario Museum, Trent University, University of Toronto, and Lake Simcoe, Halton, and Central Lake Ontario conservation authorities. This proceedings report summarizes the relevant discussions and presents the key conclusions reached at the peer-review meeting.

This report will be published in the Canadian Science Advisory Secretariat (CSAS) Proceedings Series. A CSAS Research Document was produced from the working papers presented at the workshop. The advice from the meeting will be published as a Science Advisory Report.

SOMMAIRE

Une réunion régionale d'examen scientifique par des pairs a eu lieu le 14 décembre 2007 à Burlington, en Ontario. Le but de cet examen était de formuler un avis scientifique sur le potentiel de rétablissement du méné long, y compris procéder à un examen scientifique par des pairs de l'unité désignable attribuée par le Comité sur la situation des espèces en péril au Canada (COSEPAC) et des 17 étapes du cadre d'évaluation du potentiel de rétablissement (EPR) de Pêches et Océans Canada. L'avis avait pour but d'orienter le processus de rétablissement enclenché en vertu de la *Loi sur les espèces en péril* (LEP) du Canada pour le méné long qui a été désigné en tant que population en voie de disparition par le COSEPAC. L'avis sera fourni au ministre des Pêches et des Océans et lui servira à prendre une décision concernant l'inscription de cette population à la liste de la LEP et orientera la tenue d'analyses socio-économiques et de consultations ainsi que la planification du rétablissement pour cette population. Parmi les participants, mentionnons des représentants des secteurs des Sciences, de la Gestion de l'habitat du poisson et des Politiques de la Région du Centre et de l'Arctique du MPO ainsi que des spécialistes du ministère des Richesses naturelles de l'Ontario, des offices de protection de la nature du lac Simcoe, de Halton et du lac Ontario central, du Musée royal de l'Ontario, de l'Université Trent et de l'Université de Toronto. Le présent compte rendu résume les discussions tenues au cours de cette réunion d'examen par des pairs et présente les principales conclusions formulées.

Le compte rendu sera publié de la série des comptes rendus du Secrétariat canadien de consultation scientifique (SCCS). Un ou des documents de recherche du SCCS seront aussi produits en lien avec le ou les documents de travail présentés à l'atelier. L'avis découlant de la réunion sera publié en tant qu'avis scientifique.

NTRODUCTION

In May 2007, the Committee on the Status of Wildlife in Canada (COSEWIC) designated the Redside Dace as Endangered. Assuming that an extended listing process needs to be undertaken for this taxon, the Minister will be required to decide whether or not to list it under the *Species at Risk Act* (SARA) by late 2008. To inform this decision and to provide the basis for other SARA-related functions, a Recovery Potential Assessment (RPA) meeting was held in Burlington on December 14, 2007. The RPA process was developed by DFO Science to be considered by the DFO Minister when making listing decisions under the SARA and for any socio-economic analyses, consultations and recovery planning related to species at risk. If Redside Dace gets listed as Endangered, a SARA-compliant recovery strategy must be prepared within one year and subsequently an action plan must be developed. The RPA will be used to provide science advice to the recovery team in the development of these documents and to Fish Habitat Management. It will also provide Allowable Harm information for permitting purposes.

The purpose of the meeting, as described in the Terms of Reference (Appendix 1) made available prior to the meeting, was to assess and provide advice on the recovery potential of Redside Dace. The RPA is a science-based peer review and includes assessing the current status of the population, what is known about its habitat, the scope for human-induced mortality and scenarios for mitigation and alternatives to activities that negatively impact the population and its habitat. The RPA framework developed by DFO includes 17 questions (Appendix 2).

Meeting participants (Appendix 3) included representatives of DFO Science, Fish Habitat Management and Policy sectors of the Central and Arctic Region, and specialists from the Ontario Ministry of Natural Resources, Royal Ontario Museum, Trent University, University of Toronto, and Lake Simcoe, Halton and Central Lake Ontario conservation authorities. The meeting generally followed the agenda as outlined in Appendix 4.

This proceedings report summarizes the relevant discussions and presents the key conclusions reached at the peer review meeting. A CSAS Research Document was produced from the working paper presented at the workshop (Vélez-Espino and Koops 2008), which provided the basis for the discussions. The Science Advisory Report is the synopsis of the advice from the meeting.

DETAILED DISCUSSION

Species Status and Habitat Requirements

Presenter: N. Mandrak

Species Status

The first section in the draft recovery potential working paper provides the background information on the species and is taken from the COSEWIC status report (COSEWIC 2007). Discussion centred on the table of key life history characteristics, Appendix 1 in the working paper.

The appendix should be updated to reflect that the Redside Dace is found in three Holland River tributaries not one.

It was agreed that aquatic insects should be added to the diet section as they may be eaten when terrestrial insects are not available.

There is a difference between the adult lengths and maximum length reported in the table. The adult length is the range of averages across the distribution of the species and should be better reflected in the caption.

The sex ratio reported came from sub-samples of a single population in the U.S. and may not be representative of all populations.

Participants questioned the meaning of “other species as habitat” and whether Common Shiner and Creek Chub would be considered as providing spawning habitat? This characteristic refers more specifically to one species using another as habitat, such as mussel glochidia using the gills of a host species as habitat. That does not apply in this case. However there has been some observational data that indicates a dependency on other species for spawning but there was some concern that the description was too restrictive. Redside Dace shares nests, and spawn with other cyprinid species such as Common Shiners and Creek Chub. Participants questioned whether there is certainty in the dependency and whether the relationship is obligate or facultative? Common Shiner or Creek Chub occur in 93% of Redside Dace locations in Ontario (77 out of 83 sites). Regardless, Redside Dace have been known to spawn in aquaria without other species present and have been found associated with species other than Common Shiner or Creek Chub. It was suggested that they would find a way to spawn if there were no Common Shiners or Creek Chub present but the association makes it easier for them.

COSEWIC 2007 was cited in the table and, although it was appropriate for some of the information such as range, the original reference should be used elsewhere (e.g. spawning temperature). Similarly Parker *et al.* 1987, the previous COSEWIC status report, is not a primary reference and should be replaced. Froese and Pauly (2007), and Schwartz and Norvell (1958) should be added to the list of references. There should be a reference added that includes a description of the diet of Redside Dace based on stomach content analysis. Daniels and Wisniewski (1994) included both diet and spawning information. Novinger and Coon (2000) have physiological information.

The preferred habitat indicates a preference for pools and areas of slow flows in small headwater streams although they have been sampled in riffles in a braided channel area. Preferred habitat may be better described as non-spawning, resident or adult habitat.

There was a question as to why 441 km was chosen for the Canadian Range and whether it was the Extent of Occurrence or Area of Occupancy. Extent of occurrence, as defined by COSEWIC, uses the convex polygon method where points around the extreme population locations are joined to form a polygon. The area within the polygon is the extent of occurrence as well as a traditional measure of range. Area of occupancy can use the number of stream kilometres in which the fish is actually found or can be based on the grid system used by COSEWIC. It was suggested that both Area of Occupancy (as stream length) and Extent of Occurrence are important for the recovery strategy and it is also important to be consistent with COSEWIC whenever possible. Both measures, as well as others used, should be provided with an explicit description of the meaning of each. How the information might be used should be considered and, if it is to be used further we should be more circumspect. For example, the kilometre grid measure used by COSEWIC as a tool in their assessment of Endangered for this species, may have limited biological significance. It was suggested that a note be added describing the measures and that they differ from those presented by COSEWIC.

Participants agreed that data from outside of Ontario should be presented separately. Two tables, or an additional column in the existing table, should be added with data based on Canadian populations and data for overall populations (Ontario and U.S. combined).

Habitat Requirements

Critical Habitat is a legal definition. In the RPA process (DFO 2007), Science is to provide the science-based information that will allow someone else to identify Critical Habitat for the species. This may be defined within the Recovery Strategy by the Recovery team. In the RPA process, we are to outline what is known about the habitat requirements of the species for all its life-history stages. Habitat requirements are presented for four stages in the report.

Information from Canadian populations should be flagged in this section as well. The Koster (1939) and Goforth (2000) citations are American. Canadian observational data may be provided by participants, or from the earlier McKee and Parker studies. For example, if there are dates and temperatures that can be used instead of, or to complement and agree with, the statements such as ‘around May when temperatures reach 18°C’, they should be added. Information should be consistent between this section and the earlier table (e.g. 16-18°C range from the earlier table). Participants were asked to add observational data that could be cited as *pers. comm.*. or unpublished data for Canadian populations, as well as any missing references.

<u>Spawn to Hatch</u>

The term “redd” is used here and it differs from a nest. A redd is a depression or excavation whereas participants have observed minnows collecting stones, piling them and then spawning in the pile. Nest is a more appropriate term.

<u>Young-of-the-Year</u>

There are collections of Young-of-the-Year (YOY) in the same habitat as adults. When a pool is seined or electrofished it yields a collection of different life stages in the same area. A statement should be added that as YOY and adults have been collected together, YOY habitat is the same or similar to adult habitat (participants unpublished data). It was agreed that this generalization does not necessarily apply to larval fish and a statement should be added indicating there is no information available about the habitat requirements of larval dace.

<u>Adult</u>

The statement used under the adult section was already discussed in regards to the summary table and is consistent with the recovery team definition.

The term “relatively small streams” should be replaced by “5 – 10 m watercourses”.

Redside Dace are not always found in headwater streams so “headwater” should be removed.

Coker *et al.* (2001) has a definition of cool water that should be included. Novinger and Coon (2000) has complementary data regarding temperatures and physiological tolerances (including upper tolerances) that should be added.

Spawning substrate is on gravel Schwartz and Norvell 1958 and Koster 1939).

The identification of Redside Dace in the early literature was questioned but participants felt it was not an issue as there were often collections associated with the work and most of the observations made seem to be corroborated by current researchers.

Over-wintering habitat for adult Redside Dace is unknown but participants wondered if information from Rosyside Dace, which inhabits similar habitats, could be used. There are some recent observations in the American Midland Naturalist for Rosyside Dace. This might also support the presumed occurrence in deep pools.

Residence
The most recent guidance from DFO Headquarters is that in order for something to qualify as a residence, it must be constructed by the organism. Since we don't know of instances of Redside Dace constructing habitat, the residence concept probably does not apply to this species.

Recovery Targets

Authors: A. Vélez-Espino and M. Koops
Presenter: M. Koops

Two types of Recovery Targets are needed: an abundance Recovery Target (i.e., how many Redside Dace are needed to consider a population to be recovered) and a distribution Recovery Target (i.e., how many populations do we need to consider the species to be recovered). Both are quantitative targets but other population attributes (e.g., growth rate or level of recruitment) may also be considered as requirements for recovery. There are no specifications on how to set the targets as long as the approach taken is scientifically defensible. The long-term goal in the Recovery Strategy is to restore viable populations of Redside Dace in a significant proportion of their historic range in Canada by (1) protecting existing healthy self-sustaining populations and their habitat, (2) restoring degraded populations and habitat, and (3) reintroducing Redside Dace to sites of former distribution where feasible. The intent is to be consistent with this goal when setting quantitative Recovery Targets.

There are several approaches to setting Recovery Targets:

- Status quo (i.e., current population size). This is not usually considered acceptable unless there is evidence the population is healthy.

- Maximum numbers (i.e., as many individuals as possible or carrying capacity which can be based on the historic baseline, i.e., as many as there were in the past). This target aims for abundant, not just healthy, populations in excess of what is needed to consider a population recovered.

- Social dynamics, in order to maintain social behaviours. This requires long-term demographic and behavioural information which, in many cases is not available.

- Ecological function, which requires community and ecosystem-based research with which to maintain interactions between ecosystem components. This type of Recovery Target is often included to describe reasons to recover a population. Usually there is not enough information available to set Recovery Targets based on these criteria.

- Evolutionary potential, which aims to maintain genetic diversity. The idea of an effective population size would influence this, but there is often not enough information to use it.

- Demographic sustainability, which is quantitative and is the most tractable approach available to us now, fitting well into our current modelling. It uses Population Viability Analysis (PVA). The abundance target is set to give a reasonable probability of maintaining the target over the long term.

Abundance Target [1]
Demographic sustainability was used to set abundance targets. The long-term demographic sustainability used was the 99% probability of persistence over 40 generations. This is a fairly conservative target based on Reed *et al.* (2003), a meta-analysis developed for all vertebrates. They found a relationship between minimum viable population size (Y-axis) and maximum population growth rate (X-axis). The faster a population can grow, the lower the minimum viable population size. Assumptions of this analysis are that there is no habitat loss and the populations are discrete and isolated (no immigration). A limitation of this analysis is that, while the meta-analysis is based on vertebrates, it is heavily biased towards mammals and birds and very limited for fishes. The range in population growth rates used in this analysis was compared to those observed at low abundances and found to be consistent with what would be expected for fishes. This relationship is used to generate minimum viable population sizes.

The analysis table has weight for Age-2 and Age-3 individuals (depends on the age of maturity of the population). For other species maximum population growth rate is calculated from population matrices but there is not enough information to do this for Redside Dace. A published allometry that predicts maximum annual population growth rate based on body size provided the range of annual population growth rates from the predicted weights. The minimum viable population size ranges from 57 to 568[2] depending on the weights used.

An Abundance Recovery Target of 568[3] adults for each population was proposed. The upper bound is the most precautionary given the range in body sizes, its effect on producing the wide range in minimum viable population sizes and the uncertainty about where the species falls in this range. The minimum area needed for population viability is calculated based on the concept of area per individual. Knowing the number of adults allows the prediction of how much area of appropriate habitat an animal of a particular body size needs. The analysis showed that a minimum of 15 m^2 to 145 m^2 of exclusive habitat[4] would be necessary to support these population sizes.

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[1] The values for Recovery Targets and minimum area for population viability reported here are the values presented at the workshop. These values were revised following the workshop based on comments from workshop participants. The final values are reported in Vélez-Espino and Koops (2008) and in footnotes 2-6.
[2] The revised values are 2,421 to 4,711.
[3] The revised value is 4,711.
[4] The revised values are 618 m^2 to 1,202 m^2 (0.2 to 0.4 stream km of exclusive habitat assuming 3 m stream width).

Discussion

The Recovery Target is for each population, which is essentially the number of interacting adults that may reproduce. If streams are sufficiently large, the degree of reproductive isolation may result in multiple populations. But even if there are multiple spawning sites, they still may be considered a single population if there is no spawning site fidelity.

Preliminary tagging studies on Redside Dace suggest that movement is farther than expected for a small-bodied species, with some individuals moving up to 800 m. Redside Dace can also jump and may be able to cross some barriers. This would affect the definition of population and would suggest that the precautionary Recovery Target is low.

Why is maximum population growth rate used? Reed *et al*. found it to be a good predictor of minimum viable population size. And when a species is at low abundance, it is reasonable to expect a maximum population growth rate, however as abundance increases the rate declines and density-dependant effects come into play.

If the precautionary target is set at 568 individuals, and there are currently some healthy populations above that number, does this mean they can be reduced? No, it is a Recovery Target not an Allowable Harm target.

Is the use of population growth rates calculated with age at maturity = 2 and age at maturity = 3 within the range used in the Reed *et al.* paper (i.e. is it a higher number than they use)? Are we comfortable with the Recovery Target of 568? Is it biased and if so, is it low or high? If it was biased, it would probably be negatively biased and would underestimate the number of adults needed. The bias is accommodated and the number is a minimum. Maximum body size plays a role in calculating population growth rate. Uncertainties and biases have to be documented.

The COSEWIC designation is not always strictly about a low number of individuals within a population, but sometimes about the number of sites of occupancy. Redside Dace have undergone an overall range contraction, with a large reduction in number of sites where they are found, but they are often abundant at the sites where they are found. It is also important to think about the actual amount of habitat that individuals use. Assuming a Recovery Target of 568 individuals, and based on area per individual (API) with a more conservative habitat area required than the 145 m^2 (230-390 m^2), a density of individuals can be calculated and compared to actual densities for a range of healthy population sizes. Actual densities can be determined by multiple-path electrofishing. The difference in the density of individuals is sometimes equivalent at the low end but is as much as 100 times less dense in reality than what is predicted. In the healthy populations sampled, the density of individuals is 20 to 30 times less than what it would be under the conservation viability modelling.

A different approach could be taken by extrapolating the number of individuals needed, based on field observations of the density in healthy populations rather than using the API. Instead of looking to protect several hundred metres of Redside Dace habitat, one or more kilometres of habitat would need to be protected to maintain population (i.e., 568 individuals) viability over time.

Is the difference related to the patchiness of the habitat? If several kilometres of stream are protected, not all is necessarily Redside Dace habitat. The actual distribution of Redside Dace habitat within a stream is unknown and we are estimating how much we think is needed. It is unlikely that habitat will be distributed in a stream along a continuous 145 m^2

stretch. The density calculations come from field sampling of Redside Dace habitat without patchiness. If patchiness were incorporated, then it would be even longer. From the tagging study, Redside Dace were moving on average 200 m, which is a larger area than the highest minimum area to support population viability.

The calculation for minimum area for population viability (MAPV) assumes the area contains exclusively suitable habitat for Redside Dace; it doesn't take into account patchiness of habitat (i.e., areas of unsuitable habitat). There is also overlap with other life-stages of Redside Dace, which increases the MAPV[5] which is just effective habitat, not any other habitats. It is a minimum number. Participants had concerns that the extrapolation used to determine the amount of habitat that needs protection was not credible. There was discussion of how the MAPV calculation was to be used. It is a measure of whether there is enough habitat to support the recovered population or if there might be habitat limitation for recovery. It doesn't mean that 568 adults are in an area of 145 m^2 or that habitat can be restricted to 145 m^2. It suggests that if 568 adults is the Recovery Target, the available habitat should not constrain that. It will be clear and qualified in the document that these numbers are not meant to make management decisions about incremental habitat loss.

The use of field density estimates (per area) for healthy populations (with mixed age classes) should be used in the calculation of the MAPV in the Research Document to ensure that it is realistic.

Participants questioned the lower bound for weight at age at maturity (i.e., 1 g) as it seems too low. It was based on Ontario data (McKee and Parker 1982). A more realistic weight for age at maturity of 3 years would be 4 to 5 g (Schwartz and Norvell 1958). The unrealistic numbers for the lower bound of age-two fish does not affect the Recovery Target because the upper limit is used. Participants requested that the maximum upper size for age 3 fish be used. If the weight was increased the Minimum Viable Population would be 770[6] adult fish.

Conclusion
In general, the there was agreement with the estimate for the minimum population size once it is recalculated to reflect new information and discussions.

Distribution Target
The COSEWIC report indicates there are 14-19 extant populations and 6-10 extirpated populations. COSEWIC used the number of populations for assessment criteria: less than or equal to 5 populations for Endangered and, less than or equal to 10 populations for Threatened. Although there is no set number of populations at which a species is considered healthy, based on the COSEWIC criteria there would have to be in excess of 10 populations of Redside Dace for this species to be considered not at risk. COSEWIC also looks at the trend or the rate of change in the number of populations and this is a concern for this species. A secondary consideration is rescue effect.

All extant (19) Canadian populations should be identified for recovery to, or above, the abundance target that is consistent with the recovery strategy goal. Is that sufficient for a distribution target? Should additional populations be considered that would involve reintroduction? The reversal of the criteria for designation could be used. The reason for designation was the loss from 24 historical sites, so the Recovery Target would be the

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[5] The revised MAPV value is 17,308 m^2 (5.77 stream km assuming 3 m stream width).
[6] The revised MVP value is 4,711 if the weight was 4.9 g.

reversal of this listing designation. This is consistent with what is in the Recovery Strategy, which requires re-establishment of extirpated populations. There was discussion about what would be considered recovered by COSEWIC and DFO. Stopping the decline might be sufficient even if there were fewer populations than historically so long as those population abundances were above the threshold. If the downward trend were to continue, then they would remain Endangered.

The feasibility of the Recovery Target was questioned but this would be relevant in the discussion of threats. It was part of the recovery strategy. There was discussion about development and urbanization and how this fits with recovery. It was suggested that from a science perspective if there is understanding of habitat issues and mitigation of threats, then it should be possible to have both Redside Dace and development.

Population Status

Presenter: N. Mandrak

Table 1 in the RPA working paper was updated by all participants on a population-by-population basis. The intent was to capture more information in support of a status designation. Certainty of the information was assessed as: (1) expert opinion; (2) supporting data; and, (3) rigorous quantitative analysis.

Participants discussed what constitutes a population (i.e., no gene flow) and how to deal with fragmentation that may have occurred due to barriers or unsuitable habitat between sites. Permitting may require more detail than is needed for socio-economic analysis. There was consensus to use the watershed-based approach used by COSEWIC.

Information captured in the table included whether there is fragmentation (no gene flow) along with the number of fragments. Occurrence, whether limited or widespread within the population, and the broadest and narrowest distribution of a single population was also recorded. To give some context for the range of Redside Dace distributions, the most restricted single population may be found in Irvine Creek within about a 1-km stream stretch while the most widespread single population may be found in the Humber River within about a 100-km stream stretch.

The population sizes ranged from small (i.e., a few individuals) to hundreds. Population trajectory was described as stable, declining, increasing or unknown (not enough data points or observations). Population status was a qualitative evaluation of the previous four variables.

Threats

Presenter: N. Mandrak

Table 2 in the RPA working paper presents ranked threats for Redside Dace taken from the literature across the entire range of the species. The magnitude of each threat was ranked as low (sometimes a threat), medium (often a threat), or high (always a threat). Probability of the threat actually occurring in Canada was removed from the table as it was scale dependant. Participants reviewed and discussed the magnitude identified for each of the threats. Agriculture was considered a Medium threat although there was some discussion about whether it should be rated as High. The strongest argument to keep it as Medium was that some of the healthiest populations of Redside Dace occur in areas where agricultural activities are of low intensity. Where there is more intensive agriculture, populations have been extirpated.

Table 3 in the RPA working paper presents threats to individual populations. Agriculture is a higher magnitude threat for certain populations. The current distribution pattern of Redside Dace is likely the result of past and present agriculture practises. They are often, but not always, still a threat for this species.

There was further discussion about threats and whether more detail is needed. For example, habitat alteration is an aspect of other threats such as urbanization and agricultural activities.

There was concern about the lack of standardization of the term “threat” used in COSEWIC reports, how they are used and what they mean. To overcome this, the threats are linked to Habitat Management’s Pathways of Effects model, which provides specifics about what the potential impact might be and how it can be prevented.

Threats that would affect Redside Dace in Canadian locations were considered (Table 3). Extirpated populations were included since threats that prevent reintroduction of the species were relevant to the assessment. The magnitude of each threat and the probability of it occurring were considered. Participants worked together to fill in and discuss the contents of the table.

There was considerable discussion about what was meant by succession. It was considered to be the process by which the forest canopy closes in (i.e., the change from open grassland to dense forest), which is thought to be negative for Redside Dace. Probability was defined as the probability of succession occurring in the watershed, which will vary. Since succession may not always be a threat, the magnitude was set at medium for all populations except for Morrison Creek which was high because it has changed from shrubs to trees for some of the range of the species.

There was discussion about scientific sampling and whether it applied to monitoring by consultants along with scientific research sampling by species experts. For example, Sixteen Mile Creek was an example of a location where routine sampling/monitoring was undertaken frequently in an attempt to show the absence of Redside Dace.

There was some concern that effects of climate change on Redside Dace may be underestimated, particularly if it results in lower water levels that force populations further into headwater areas, which are the first to dry up.

It was agreed that in areas where no urbanization has occurred yet, or is expected to occur in the near future, the probability of this threat should be zero. For these discussions, urbanization was defined as an area containing less than 1000 people.

Allowable Harm
Authors: A. Vélez-Espino and M. Koops
Presenter: A. Vélez-Espino

Discussion of Allowable Harm is one of the most important parts of the meeting. Allowable Harm is related to the provision in the SARA where, under certain circumstances, the

Minister can allow harm if it doesn't jeopardize the survival or recovery of the species. Section 73 (2) of the SARA provides the Competent Minister with the authority to allow normally prohibited activities affecting a listed species, its critical habitat, or its residence, even though they are not part of a previously approved recovery plan. The Competent Minister may authorize these activities by entering into an agreement or by issuing a permit. Such activities can only be approved if (1) they are scientific research relating to the conservation of the species and conducted by qualified persons, (2) they will benefit the species and are required to enhance its chance of survival in the wild, or (3) affecting the species is incidental to the carrying out of these activities.

A model to examine Allowable Harm in Redside Dace was developed by Vélez-Espino and Koops (2008). Life history data compiled from the relevant literature were used to determine the growth patterns and age-specific annual survival and fertility to populate the model. Depending on the type of data available, different kinds of deterministic and stochastic approaches were more applicable. The basis for the modelling is perturbation analysis that indicates how the population growth rate changes when vital rates are perturbed, either by harm or recovery efforts. Allowable Harm and recovery efforts are the two types of perturbations considered. Analysis of population momentum is incorporated into the modelling. There are several types of outputs and the precautionary approach is used to determine the maximum Allowable Harm and the minimum recovery effort.

Some habitat information (quality or quantity) can be used to examine population sensitivity to habitat loss. This was done for Black Redhorse but the information necessary for the analysis was not available for Redside Dace.

The deterministic solution depends on the analysis of sensitivities; in this case, the sensitivity of population growth rates to perturbations was considered. Matrices could also be directly manipulated. Growth information and vital rate values were used to build stage-structured projection matrices representing the most important attributes of the Redside Dace life cycle.

A stochastic approach to computing elasticities was used to incorporate the variation in vital rates and its effect on population responses to demographic perturbations. For this approach Monte Carlo simulation analysis was used. The model was populated with as much data as was available even in the absence of time series. If there are time series for different demographic parameters, they can be included in the modelling which improves the validity of the values. A stochastic matrix perturbation analysis was conducted to determine Allowable Harm following a precautionary approach. When determining Allowable Harm, consideration is given to a designation of population growth rate, based on information consistent with the COSEWIC assessment.

The modelling results demonstrated that Redside Dace population dynamics are particularly sensitive to perturbations that affect juvenile survival. Juveniles and adults apparently share the same habitat but the modelling suggested that mortality that targets adults has less impact than when juvenile survival is reduced.
From a precautionary perspective, the results indicated that a maximum mortality of 5% per year for a single discrete population, regardless of age, may be allowed. Any Allowable Harm beyond that threshold is expected to compromise the future survival and recovery of individual populations. Further, the results also indicated that human activities that harm fertility, but not survival, and reduce reproductive rates by 18% or more can compromise the future survival and recovery of individual populations.

This analytical approach can be used to develop Recovery Targets and provide estimates of recovery time-frames. However we need to know the population size, the amount of habitat available, and habitat suitability for translocations, in order to implement this approach pragmatically.

Discussion

Is there any underlying reason why the same life stage (i.e. juveniles) always comes up as the most sensitive? It is just a combination of life history traits (i.e., adult survival, juvenile survival, fecundity etc)? One thing this model doesn't take into account is maternal effects (older, bigger females may produce better offspring), because there isn't a lot of strong evidence for it in current literature. If it was included, older adults might become more sensitive.

There is evidence, for other fish species, that egg size changes in response to fish age. This has not been demonstrated for Redside Dace.

There was discussion around the 5% Allowable Harm level calculated from the modelling and the implications for sampling. There is less of an impact on the population if sampling methods only target older Redside Dace. However, when juveniles are susceptible to sampling methods, such as with electrofishing, care must be taken to minimise mortality to below 5%. If mortality rates cannot be reduced below this level by changes to the sampling procedures then less harmful alternatives should be used.

Most of the vital rates used in the model came from the literature and are described in Table 1 in Vélez-Espino and Koops (2008). Although there is not a lot known, the most important vital rate is age at maturity. Variation in age at maturity and longevity was used to generate vital rate variation resulting from changes in the stage structure of the population.

If all individuals from one location within a widespread population died as a result of a human-caused threat, that could potentially represent the 5% Allowable Harm permitted in a year. A 5% population reduction in one year without knowing the cause should also be considered part of the Allowable Harm. A one-time event that harms the population in the short term, but eventually stabilizes, would be different than a permanent change such as the loss of an important pool within the habitat. Would permits for scientific monitoring be denied or withdrawn following a perturbation (e.g., chemical spill) that caused a 5% level of harm?

The 5% level for Allowable Harm is the lowest value calculated to date. It is low because all life stages share the same habitat therefore mortality impacts them all, not just adults or juveniles. Theoretically if only adults were being sampled or if a threat only harmed adults then the Allowable Harm would be 32%, but since all life stages have to be combined the overall Allowable Harm is lower.

Could the results be an artefact of being a small-bodied fish? If the model was run on other species (cyprinids) with the same habitat impacts, that were very common throughout the Greater Toronto Area, and the results were the same, would this confirm they are an artefact of small-bodied fish? On the other hand, if the results came out different that would indicate that Redside Dace are very sensitive. Demographic attributes are underpinned by the species' vital rates and stage thresholds such as age at maturity and maximum reproductive age. The life-history literature documents the correlation between body size and both vital rates and stage thresholds. The importance of body size has been observed between and within species and is founded on the direct connection between body size, metabolic rates, and somatic growth. Therefore, the modelling results are not an artefact of body size; rather they reflect the real link between body size and life history traits.

A model that included field data would reduce some of the uncertainty.

Allowable Harm is separate from the Recovery Target. For example, if a population contained 800 individuals, which is above the proposed Recovery Target (568), a loss of 100 or so would not be allowed because it would exceed the 5% level set for Allowable Harm. The 5% level is based on what we've estimated as the population growth rate, and the target of not allowing population growth rate to drop below 1.

Originally, when Allowable Harm estimates were first made, it was suggested that if a population was healthy then it should be treated as a regular fish population under the *Fisheries Act*. Fish Habitat Management would evaluate the population and activities that could be permitted on a site-by-site basis. As the *Fisheries Act* requires no net loss of fish habitat, if a proposed activity would remove a pool then another pool would have to be put in place.

There was discussion as to whether the scope for harm statement should only apply to cautious or critical populations because a 10% removal in a healthy population would not jeopardize the Recovery Target. What is considered a healthy population? Should it be any population above the Recovery Target? There was disagreement on this point. How should healthy populations be dealt with? For populations already at or above the Recovery Target, Allowable Harm could be re-evaluated as additional information allows. How much of a decrease would be tolerated and how long would a decline be tolerated? There is more to the question than simply having the population above the Recovery Target.

The 5% Allowable Harm level could be applied to scientific permits or baitfish harvesting, but how would it be applied to habitat-related threats? How does a 5% decrease in population relate to a decline in habitat or *vice versa*? This should be included in the sources of uncertainty, as the relationship between population size and habitat amount is unknown and is needed to quantity population loss based on habitat loss. The simplest assumption is that there is a linear relationship between density and reductions in survival: i.e., a 5% loss in habitat is the same thing as a 5% reduction in population size.

Participants discussed modifying the Allowable Harm statement to recognize that the scope for Harm can be revisited for populations considered healthy (i.e., where population size is above the Recovery Target and there is no evidence of decline). Participants agreed that a statement to this effect should be included in all RPAs. As it is possible for a population to be above the Recovery Target yet declining in numbers, the statement should indicate if population size is above the Recovery Target *and* whether the vital rates have changed since the last analysis was conducted.

Conclusion
All human-induced harm must be constrained to produce no more than a 5% reduction in survival across all life stages or an 18% reduction in fertility rates annually for each population, however that is defined. These limits assume there is no habitat loss or any other forms of mortality.

Time to Reach Recovery

Authors: A. Vélez-Espino and M. Koops

Time-to-recovery was estimated as the time needed to attain a 95% probability of reaching the Recovery Target. The corresponding abundance of YOY and juvenile stages was determined assuming a stable stage distribution. Probability of recovery was computed using Monte Carlo simulations. Probability of recovery at time *t* was computed as the proportion of realizations of population size reaching or exceeding the Recovery Target at time *t*.

Under current conditions and without any recovery effort, modelled Redside Dace populations with an initial adult population equivalent to 10% of the Recovery Target have low probabilities ($p < 0.11$) of ever reaching the Recovery Target even if environmental conditions remain relatively constant for a period of 150 years. By applying a management strategy that simultaneously increases survival of YOY, juveniles, and adults by 10%, at least 160 years would be needed to attain a 95% probability of reaching the Recovery Target. This recovery timeframe diminishes substantially to 35 years if the survival of fish in all stages is increased by 20%. In the case of a strongly proactive recovery strategy, at least 10 years (or approximately three generations) would be needed to achieve a 95% probability of reaching the Recovery Target (Figure 6, Vélez-Espino and Koops 2008).

A small population that is not considered healthy might never reach the Recovery Target. A population currently considered to be healthy, may have already reached it.

Mitigation Measures/Alternatives

Participants were asked to review the Pathways of Effects material and provide their comments following the meeting.[7] A teleconference would be arranged to discuss further if necessary. The mitigation measures proposed were not mandatory but were provided for use in the socio-economic analysis to determine the cost to protect or recover the species. To a large extent the proposed measure would be the same whether or not it involved a species considered at risk. If the requirements went beyond that normally considered under the *Fisheries Act*, then additional costs would apply.

Sources of Uncertainty

There was uncertainty around the magnitude and probability of threats for the populations. Most of the Redside Dace habitat is located around the Greater Toronto Area. There was uncertainty about how hardening of land surfaces may affect Redside Dace and their habitat.

More information is needed on vital rates (i.e. life history information) and population size estimates. For the modelling, there was uncertainty in the distributions of vital rates chosen (e.g., using the upper limits).

Next Steps

The documents resulting from the meeting will be revised based on the discussions from the meeting. The results of the modelling will be updated to include new information provided by participants (see Vélez-Espino and Koops 2008). Participants were asked to provide their input on the feasible mitigations and alternatives following the meeting which would then be

[7] Despite two follow-up requests, no additional information was received from participants.

added to the report. Further discussion may be arranged through a teleconference if considered necessary.

REFERENCES

Committee on the Status of Endangered Wildlife in Canada (COSEWIC). 2007. COSEWIC assessment and status report on the redside dace, *Clinostomus elongatus*, in Canada. Committee on the Status of Endangered Wildlife in Canada. Gatineau, PQ. 45 pp.

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APPENDIX 1: Terms of Reference

Recovery Potential Assessment of Redside Dace

Regional Peer Review Meeting – Central and Arctic Region

Canada Centre for Inland Waters
Burlington, ON

Redside Dace - December 14th, 2007

A. Background

In May 2007, COSEWIC designated the Redside Dace as Endangered. Assuming that an extended listing process needs to be undertaken for this taxon, the Minister will be required to decide whether or not to list it under the SARA by fall 2008. In the interim, a RPA and subsequent socio-economic and listing consultations need to be conducted.

The purposes of SARA are to protect wild species at risk and their habitats in Canada, and to promote their recovery. The Act stipulates that it is forbidden to kill individuals of a species listed under the Act as Threatened, Endangered or Extirpated or to harm, harass, capture or take them. The SARA also prohibits damaging or destroying their residence or any part of their critical habitat. Furthermore, the SARA provides for the preparation of a recovery strategy for species listed as Threatened, Endangered or Extirpated. The provisions of these recovery strategies must ensure that any possible threat to a given species and its habitat does not jeopardize its survival and recovery.

Section 73 (2) of the SARA provides the competent ministers with the authority to permit normally prohibited activities affecting a listed species, its critical habitat, or its residence, even though they are not part of a previously approved recovery plan. Such activities can only be approved if: 1) they are scientific research relating to the conservation of the species and conducted by qualified persons; 2) they will benefit the species and are required to enhance its chance of survival in the wild; or, 3) affecting the species is incidental to the carrying out of these activities.

The decision to permit Allowable Harm and the development of a recovery strategy must take into consideration the species' current situation and its recovery potential, the impacts of human activities on the species and on its ability to recover, as well as the alternatives and measures to reduce these impacts to a level which will not jeopardize the survival and recovery of the species.

Therefore, a species RPA process was developed by DFO Science to provide the information and scientific advice required to meet the various requirements of the SARA, such as the authorization to carry out activities that would otherwise violate the SARA as well as the development of recovery strategies. In the case of a species that has not yet been added to Appendix 1 of the SARA, the scientific information also serves as advice to the DFO Minister regarding the listing of the species under SARA. Consequently, the information is used when analyzing the socio-economic impacts of adding the species to the list as well as during subsequent consultations, where applicable.

B. Objectives

The intent of this meeting is to assess the recovery potential of Redside Dace. It is a science-based peer review of the designatable unit assigned by COSEWIC and the 17 steps in the RPA framework outlined in Appendix 2. The advice will be provided to the DFO Minister for his consideration in any listing decision under SARA for these species.

C. Products

The meeting will generate a proceedings report summarizing the deliberations of the participants. This will be published in the CSAS Proceedings Series. There may be CSAS Research Document(s) produced in relation to the working paper(s) presented at the workshop. The advice from the meeting will be published in the form of a Science Advisory Report.

D. Participants

Participants will include experts from DFO Science and Policy sectors, the Lake Simcoe and Central Lake Ontario Conservation Authorities, Royal Ontario Museum and Ontario Ministry of Natural Resources. Participants will not exceed a maximum of 20 people.

E. Timetable for FY 2007/08

The draft Science Advisory Report will be circulated to participants for comments in December 2007 and the final version will be submitted to the Canadian Science Advisory Secretariat (CSAS) for publication in early 2008.

APPENDIX 2: Topics that should usually be covered in a recovery potential assessment.

The topics (from the national framework) for which an assessment should be done for any species/designatable unit is as follows:

Phase I: Assess Current Species Status

1. Evaluate **present species status** for each population
2. Evaluate **recent species trajectory** for each population
3. Estimate, to the extent that information allows, the current or recent **life history parameters** for the species (total mortality [Z], natural mortality[m], fecundity, maturity, recruitment, etc) or reasonable surrogates; and associated uncertainties for all parameters.
4. Address the **habitat requirements and habitat use patterns** of the species using the separate Terms of Reference for describing and quantifying habitat outlined below (to the extent possible)
5. Estimate expected **population and distribution targets** for recovery.
6. Project **expected population trajectories** over three generations (or other biologically reasonable time), and trajectories over **time to the recovery target** (if possible to achieve), given current population dynamics parameters and associated uncertainties (step 3) using DFO guidelines on long-term projections.
7. Evaluate **residence requirements** for the species, if any.

Phase II: Scope for Management to Facilitate Recovery, Taking Account of Associated Uncertainties.

8. Assess the **probability that the recovery targets can be achieved** under current rates of population dynamics parameters, and **how that probability would vary with different mortality (**especially lower**) and productivity (**especially higher**) parameters**
9. Quantify to the extent possible the **magnitude of each major potential source of mortality** identified in the pre-COSEWIC RAP, and considering information in COSEWIC Status Report, from DFO sectors, and other sources.
10. Quantify to the extent possible the **likelihood that the current quantity and quality of habitat is sufficient** to allow population increase, and would be sufficient to support a population that as reached its Recovery Targets
11. Assess to the extent possible the magnitude by which current **threats to habitats have reduced habitat quantity and quality.**

Phase III: Scenarios for Mitigation and alternative to activities

To the extent possible with the information available:

12. Using input from all DFO sectors and other sources as appropriate, develop an **inventory of all feasible measures to minimize/mitigate** the impacts of activities in Steps 9 and 11.
13. Using input from all DFO sectors and other sources as appropriate, develop an inventory of all reasonable **alternatives to the activities** in tasks 9 and 11, but with potential for less impact. (e.g. changing gear in fisheries causing bycatch mortality, relocation of activities harming critical habitat)

14. Using input from all DFO sectors and other sources as appropriate, develop an inventory of all **reasonable and feasible activities that could increase the productivity or survivorship parameters** in steps 3 and 8.
15. Estimate, to the extent possible, the **reduction in mortality rate expected** by each of the mitigation measures in 12 or alternatives in 13. and **the increase in productivity or survivorship** associated with each measure in 14
16. Project **expected population trajectory** (and uncertainties) over three generations (or other biologically reasonable time), and to the time of reaching recovery targets when recovery is feasible; given mortality rates and productivities from 15 that are **associated with specific scenarios** identified for exploration. Include scenarios which provide as high a probability of survivorship and recovery as possible for biologically realistic parameter values.
17. Recommend **parameter values for population productivity and starting mortality rates,** and where necessary, specialized features of population models that would be required to allow exploration of additional scenarios as part of the assessment of economic, social, and cultural impacts of listing the species.

APPENDIX 3: List of Participants

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APPENDIX 4: Meeting Agenda

Recovery Potential Assessment of Redside Dace

Regional Peer Review Meeting – Central and Arctic Region

South Seminar Room
Canada Centre for Inland Waters
Burlington, ON

December 14th, 2007
9:00-5:00

Chair: Nick Mandrak

9:00 Welcome and Introductions (Mandrak)

9:15 Purpose of Meeting (Mandrak)

9:30 Species Status and Habitat Requirements (Mandrak)

9:45 Population Status (Mandrak)

10:30 Break

10:45 Recovery Targets (Velez-Espino/Koops)

12:00 Lunch (provided)

1:00 Threats (Mandrak)

2:00 Allowable Harm (Velez-Espino/Koops)

3:00 Break

3:15 Alternatives to Activities/Feasible Mitigation Methods

4:15 Wrap-up