RECOMMENDATIONS FOR SPECKLED DACE (KETTLE RIVER) CRITICAL HABITAT

Speckled Dace. Photo credit: G. Andrusak.

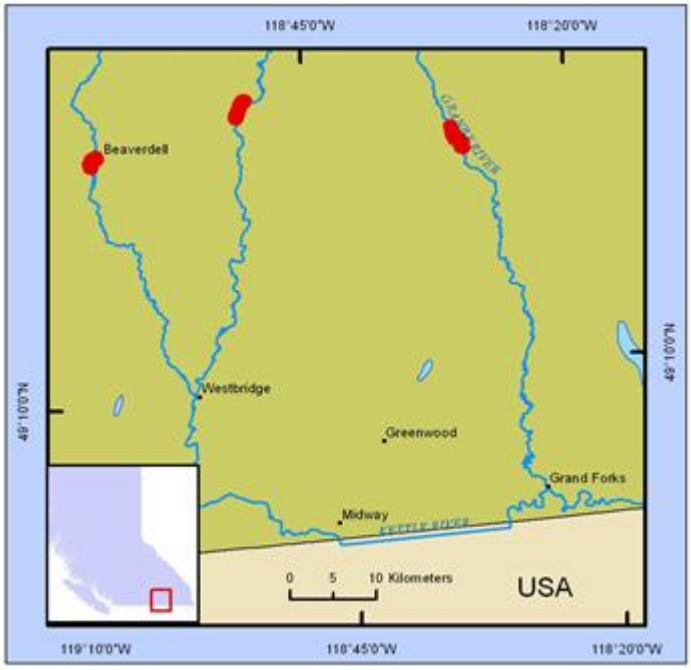

Figure 1: Red polygons denote recommended critical habitat for Speckled Dace.

Context

In 2009, Speckled Dace (Rhinichthys osculus), Kettle River population, was listed as endangered under the Species at Risk Act (SARA). Thus, critical habitat for the species must be identified in the Recovery Strategy or Action Plan(s) to the extent possible based on the best information available. If this critical habitat is unknown, the Recovery Strategy or Action Plan must include a schedule of studies that, when completed, would allow the species' critical habitat to be identified. Once identified, provisions of SARA and/or other federal legislation protect the critical habitat from destruction.

This Science Advisory Report provides recommendations for critical habitat of Speckled Dace to the extent possible based on best available information.

This Science Advisory Report has resulted from the Fisheries and Oceans Canada, Canadian Science Advisory Secretariat Pacific Regional Advisory Meeting of April 19th, 2012. Additional publications from this process will be posted as they become available on the DFO Science Advisory Schedule.

SUMMARY

- In Canada, the Speckled Dace population is limited to one watershed (Kettle River) and the species is found in three locations within that drainage. Hundreds of populations exist in the western United States. However, the Kettle River population is unique in Canada.
- The Canadian distribution of Speckled Dace is peripheral and disjunct because the population is located above a barrier (Cascade Falls), and is at the extreme northern extent of their North American range. Rescue from downstream systems is not possible. The known range of the population has increased slightly since the COSEWIC (2006) assessment. This is likely due to increased survey effort and not due to an actual range extension by dace.
- Speckled Dace appear to be distributed widely and somewhat evenly throughout their approximately 300km Canadian range. Their use of habitat extends from the river margins (as juveniles) to the main channel (as adults). There appears to be abundant, suitable, and widely distributed habitat for the species.
- The Kettle River Speckled Dace population was estimated at over 900,000 mature dace, but this single estimate is insufficient to draw any conclusions regarding population trends. However, it is suggested that the species' abundance is robust over its entire range.
- Speckled Dace are bottom feeders that eat benthic insects and consume filamentous algae associated with autochthonous pathways.
- The primary activities likely to threaten Speckled Dace critical habitat include: excessive water draw-down during late summer (mainly agricultural) and sedimentation from forest operations. It appears that the human induced threats to Speckled Dace habitat have not increased over the last decade. The human population of the Kettle basin has declined slightly in numbers and increased in mean age. Forestry production has declined by 40% over the last decade.
- There has been a major shift to unregulated groundwater extraction from more regulated surface water withdrawal. The impact of this shift warrants further studies.
- Recommended critical habitat necessary to maintain the minimum viable population levels is 2.4 km of river (total width) in each of the upper Kettle (East Kettle), West Kettle, and Granby Rivers.
- Further research should include population estimates within each of the three recommended critical habitat sites to insure these sites contain the population necessary to maintain and recover the species, examination of winter ecology and winter habitat use, and continued research on the extent and effects of groundwater versus surface water extraction.

INTRODUCTION & BACKGROUND

Every Recovery Strategy or Action Plan developed for a species listed as threatened or endangered must identify critical habitat to the extent possible, using best available information. This document recommends critical habitat for Speckled Dace to the extent possible based on best available information. It describes the logic and methods used in development these recommendations. As well, it provides information on the threats to this recommended critical habitat.

A key distinguishing characteristic of critical habitat (as defined by The Species at Risk Act or SARA) is that critical habitat is the component of habitat necessary for survival or recovery of the species. Consequently, habitat functions, habitat biophysical features and its attributes should be clearly delineated as integral components of critical habitat identification. The recovery goals and

population objectives or targets as indicated in the Recovery Potential Assessment (RPA), and other recovery documents, are important factors in defining a species' critical habitat. SARA critical habitat identification is directly based on the recovery goal(s), population targets, and distribution targets. Unfortunately, the recovery targets for Speckled Dace were not clearly stated and considerable new information has ensued following the COSEWIC (2006) assessment and writing of the RPA. The critical habitat identification process is an inherently iterative approach that is only complete when the recovery goal(s) is achieved. When critical habitat is identified, examples of "activities likely to destroy critical habitat" should be provided. These activities must be of human origin. This serves to establish a baseline to identify and communicate to the Canadian public the kind of activities that are likely to lead to critical habitat destruction.

Persistence of Speckled Dace in Canada was considered to be habitat-limited by COSEWIC (2006). However, the main reasons for designation as endangered included: restricted range in Canada, populations limited to three locations, no rescue potential from downstream due to Cascade Falls, and the projected increase in drought and water demands that could lead to a decline in habitat quality. In 2007, the RPA for Speckled Dace (Harvey 2007) noted significant knowledge gaps concerning life history and habitat use, but accepted a poorly substantiated abundance estimate of 11,000-23,000 fish. The RPA concluded that the main human-caused threat to the species was alteration in stream flow, to which this presumably flow-sensitive fish would be especially susceptible during low summer flows.

Subsequent to the COSEWIC assessment and RPA, several of the recommendations for further research made in the 2007 RPA were pursued. Perhaps most important, field research by Batty (2010) provided strong evidence for a Canadian population of close to 1 million mature adults (40 times the number suggested in the RPA). A field study by Andrusak and Andrusak (2011) filled in many gaps concerning habitat use by mature and immature speckled dace. Abundance of Speckled Dace appears to be robust, and the large population suggests that suitable habitat is abundant. Speckled Dace appear to be distributed widely and somewhat evenly throughout their approximately 300km range. The post-2008 reports and data analysis have prompted suggestions that the status of Speckled Dace as an endangered species be re-evaluated and perhaps revised (Batty 2010).

General Description

Speckled Dace are members of the genus *Rhinichthys.* They are small fish (51-94 mm in length), with a prominent snout and a sub-terminal mouth (Figure 1). Kettle River Speckled Dace live longer than the four-year span previously accepted, with males spawning in their third summer and females in their fourth. Mitochondrial sequence data indicate Speckled Dace above Cascade Falls have diverged from Snake River and lower Columbia dace populations (McPhail 2007). Mitochondrial DNA analyses of populations of Speckled Dace in Oregon and elsewhere did identify significant genetic divergence between basins. Thus, the Speckled Dace population in the Kettle River appears to be unique.

Speckled Dace are bottom feeders that eat filamentous algae and bottom dwelling aquatic insects (Peden and Hughes 1981; Batty 2010). The diet of juvenile Speckled Dace is similar to that of adults, but with a greater emphasis on algae and Chironomidae (McPhail 2007), while very young fry have been noted feeding exclusively on algae. This implies that Speckled Dace are either directly consuming algae or foraging in habitats associated with algae throughout their lives. Based on stable isotope analysis, Batty (2010) concluded that "filamentous algae are likely an influential food in the diet of insects that Speckled Dace feed on."

Habitat Attributes

The East Kettle, West Kettle and Granby rivers are accessible for most of their length, especially the more southern portion of the watershed. The region is arid and the river is snowmelt-dominated, with 78% of the annual discharge occurring between April and June (Maaciak et al 2007). Most of the river is less than 0.5 m deep during the low flow, late summer season and the lack of pools and large woody material is noticeable.

Findings by Andrusak and Andrusak (2011) and Batty (2010) suggested that habitat utilization is life stage-specific. These researchers concluded that immature dace were associated with river margins, with no preference for woody debris. Adult habitat extended to deeper waters and was less associated with river margins, and adult dace exhibited no preference for woody debris or overhanging vegetation. Mature dace were not captured at West Kettle sites in autumn and immature dace did shift from riffle to deeper habitats in autumn. This suggests a possible adult migration in autumn. Habitat preferences should be refined by further studies.

Immature dace used small gravel or cobble substrates, with low to moderate embeddedness. Mature dace used boulder or cobble substrates with low embeddedness. This implies that coarse substrate provides in-stream cover and that excessive sedimentation is a threat. Andrusak and Andrusak (2011) suggested that mature dace could benefit from strategically placed boulder and cobble groins.

Low flow conditions are due to a combination of a lack of storage within the watershed, changes in regional precipitation patterns, and water withdrawal. The Provincial Ministry of Environment considers the Kettle system a priority system, in part due to critical summer low flows. However, Batty (2010) noted that his abundance sampling, which estimated around a million mature fish in the system, was conducted five years after the 2003 extreme drought. This drought produced the lowest flows on record and in his view, Speckled Dace are either tolerant of drought or resilient to it. Recent droughts have occurred in 1987 and 2002-2004 (Aqua Factor Consulting Inc. 2004). Fish kills have been reported in the Kettle River below Grand Forks and above Westbridge, although dace were not included among the fish species listed as killed. While high water temperatures associated with low discharge may be a contributing factor, these kills occurred in early summer when discharge was slightly below threshold, but still well above the late summer/autumn low flows of drought years.

Dace have been observed over a wide range of velocities (Batty 2010; Andrusak and Andrusak 2011) indicating that they are an adaptable species. Juvenile dace were observed where water velocity was below 0.24 m/s, with a velocity preference of .01 m/s and at depths of less than 0.4 m, with a depth preference of .07 m. Mature fish were observed at velocities between 0.18 - 0.45 m/s, at depths between 0.2 - 0.5 m, and at a depth preference of 0.45 m.

Speckled Dace appear able to cope with changes in water temperature and are tolerant of high water temperature. Harvey (2007) summarized reports from other parts of its range and noted that the species can acclimate to a temperature of 31° C. Water temperature in the Kettle drainage is discharge-related, although the highest water temperatures occur in July prior to the lowest flows in autumn and winter. Daily maximum water temperature in the lower river routinely reaches 24° C by mid-July (Andrusak and Andrusak 2011).

A small increase in winter water temperature may also be a factor in the future fish diversity within the Kettle River system. In winter, water temperature falls below 0° C as the river surface is frozen and anchor ice can form. Winter mean water temperature has increased in south-eastern B.C. by 0.8°C during the last few decades and is predicted to increase by 2.0-7.0 °C in the next few

centuries (Allen et al. 2004). Winter warming may reduce the likelihood of severe winter ice conditions, increase the growing season of juvenile dace, and improve the competitive advantage of a species originating in a warmer region.

The habitat functions, features and attributes appropriate for inclusion in critical habitat (discharge, depth, substrate and temperature tolerances), are summarized in Table 1. None of the research on the species to date provides any quantitative relationship between habitat type and abundance.

Table 1. Summary of Habitat functions, features and attributes

Life stage	Function	Feature	Attribute
immature	rearing	pool, run, margin	small gravel/cobble; flow below 0.24 m/s and depth below 0.4 m; low to moderate embeddedness
mature	rearing	run and riffle	boulder/cobble; flow 0.18-0.45 m/s; depth 0.2-0.5 m although may be found over 1 m deep; low embeddedness
	spawning	run and riffle	Large, clean cobble

Residence

The adhesive eggs of Speckled Dace adhere to the undersides of stones, but the spawning habitat actually used by the species in B.C. can only be inferred from laboratory observations and those made of the species in more southern parts of its range in Arizona and New Mexico. A lack of field observation of possible nest guarding by males makes it hard to comment on residence requirements. Spawning probably occurs over clean gravel and may include preparation of a nest by males. If such site preparation occurs, it implies a residence requirement for the duration of spawning and perhaps during larval development as well. Since spawning in the Kettle system probably begins in July (Peden and Hughes 1981), and newly emerged fry appear in the river in early August, the period of residence is approximately one month. If residences do exist, they would be extremely difficult to identify in a natural setting.

Range, Distribution and Abundance

Speckled Dace are common in the western United States; there are hundreds of populations of the species from Washington to northern Mexico. In Canada, the species is confined to the Kettle-Granby system in the West Kootenay area of southern B.C. (Scott and Crossman 1973). This Canadian dace population exists at the extreme northern extent of its North American range. It is isolated from the central population by a geographic barrier (Cascade Falls). The designation of Canadian Speckled Dace as endangered reflects this isolation: if the population above Cascade Falls were to become extinct through some catastrophic event, natural colonization by other populations from below this 30-metre natural barrier would be impossible.

Within the Kettle-Granby system, Speckled Dace have been collected or observed at a number of sites that encompass 275-300 km of river length. Batty (2010) was able to catch Speckled Dace further upstream than previously recorded in the Kettle and Granby Rivers and he felt they may extend even further north in the Kettle system. Thus, there is no evidence of range contraction since the 2006 COSEWIC assessment. The fact that Batty (2010) found significant populations of adult fish in each of the three headwater segments of the Kettle River is significant and suggests that extinction from a single catastrophic event is highly unlikely to happen.

The abundance estimate derived from electro-fishing, when adjusted for capture efficiency, was 939,610 mature speckled dace. This number led Batty (2010) to describe the species as

"widespread and locally abundant." He concluded that the Canadian population is in relatively good health. On a linear basis, abundance was found to be highest in the West Kettle and lowest in the Granby. There remains concern that our understanding of dace habitat utilization, which is based on daytime backpack electro-fishing alone, is probably incomplete, especially for mature speckled dace

CRITICAL HABITAT ASSESSMENT

Approach to Identifying critical habitat

It appears that, over their lifespan, Speckled Dace in Canada are distributed fairly evenly over their range, occupy most habitat types within riverine sections, and utilize the entire width of the rivers. Best available knowledge, coupled with a robust and apparently resilient population, argue in favour of identifying critical habitat based on its ability to ensure that a given population target is maintained. Such habitat should be located in stream sections where the likelihood of disruption by any of the known threats, as well as any potential conflict with human activities, is minimal.

The proposed critical habitat for Speckled Dace depicts the length of river that will supply the amount of habitat necessary to maintain the population abundance required for the persistence of the species in each of the locations where it is presently found. If we accept that a population of 7,000 fish is the minimum population required for long-term persistence of the species (Reed et al. 2003), and if we assume 3.0 fish/metre is a reasonable estimate of abundance (Batty 2010), we arrive at 2.4 km of proposed critical habitat. To be conservative this length of river should be applied to each of the three upper locations to maintain three populations. The three sections of river recommended as critical habitat start at the uppermost site where Speckled Dace were captured during Batty's distributional study (Batty 2010) and extend downstream for 2.4 km. This approach minimizes the threats of large water withdrawals (mainly for irrigation in the lower watershed) and riparian removal. It is also likely that larval dace produced at these upper locations will drift downstream and could repopulate or supply genetic material to lower sections in the event of a catastrophic event or transient threat to lower reaches. However, it was not possible to locate all of the critical river sections upstream of all withdrawals or all cleared agricultural lands.

Recovery Targets (Population Benchmarks)

The current abundance estimate for adult Speckled Dace in Canada (939,610, 90% confidence interval of 412,431-1,954,522 individuals) is 20-40 times higher than the one previously accepted in the RPA for the species (Harvey 2007). The large confidence interval reported by Batty (2010) is an indication of uncertainty. In many cases, only a few fish were caught at a given site, and catches were scaled by catchability trials that contribute uncertainty. Nevertheless, several factors suggest that the current estimate could be low. First, an estimation method other than electrofishing, such as snorkelling, (Andrusak and Andrusak 2011) might record more fish in deeper water. Second, all estimates made by Batty (2010) were derived from daytime sampling only. Third, a considerable length of un-sampled river exists above each of the uppermost sites at which fish were caught during the distributional study by Batty (2010). Thus, the total range (and hence the abundance) is likely an underestimate.

The RPA for Speckled Dace (Harvey 2007), despite being based on an estimated abundance that was a fraction of what we now know it to be, concluded that the population was at no immediate risk. Since distribution did not appear to have changed significantly over the decades during which

the area had been sampled, no recovery target population was set, and the goal was stated as "preservation of the species' current distribution." A benchmark of 2,500 mature fish was adopted in the RPA, based on the COSEWIC small population criterion used by Bradford (2006), to model consequences of the proposed hydro operation at Cascade Falls. This benchmark seems unnecessarily low in the light of what we now know about Speckled Dace abundance.

An option is to consider a higher generic benchmark, for example the 7,000 adults adopted as an "interim recovery target" by Reed et al. (2003) for listed vertebrate species. Since we have no evidence of whether the population trend is down, or up, or stable, the number cannot logically be called a recovery target, but it may be considered a conservative target for the maintenance of a population. The importance of identifying critical habitat would lie in protecting enough of it so that the species never fell below this lower limit, an event that, given the present abundance and distribution, seems very unlikely.

It is very important to conduct a detailed assessment within each of the proposed critical habitat locations to verify the length of stream required to maintain the population above the target. If the estimated abundance turns out to be lower than the target of 7,000, additional stream length should be added; by the same reasoning, if the estimated abundance is well above the target, reach length could be reduced. In other words, the length of stream considered critical habitat in the recovery strategy should relate to the resulting population estimates.

Activities That Threaten Critical Habitat

The overall socioeconomic trend within the Kettle system is for a declining, aging human population, and a shift away from forestry. Between 2001 and 2011, the population of the Boundary region declined slightly, despite overall growth for the Province of B.C. (Census of Canada-BC Stats 2012). Penfold (2010) predicted a 2.5% total growth between 2006 and 2020, with most of that growth in Nelson, a city outside of the Kettle River watershed; all of this anticipated growth will be in the 65+ age cohort. In Grand Forks, the largest city in the Kettle drainage, population fell below 4000 in 2010, the lowest in 15 years (Urban Systems Ltd. 2011).

Water Withdrawal

Water withdrawal is viewed as the single greatest threat, because it contributes to low summer-autumn discharge (COSEWIC 2006), which is also affected by the nature of the watershed, climate change and lack of storage. This threat may be somewhat mitigated by the species' ability to survive and adapt to low flows and warm summer waters, as noted in the more southerly portion of its global range. Agricultural production is heavily reliant on consumptive water use. Agriculture accounts for approximately 80% of the total annual water use, generally at a time of low seasonal flow. Storage for irrigation represents only 4% of the water used for irrigation.

Much of the water withdrawn from the basin, for both domestic and irrigation needs, comes from aquifers (Aqua Factor Consulting Inc. 2004). Although the largest cities, Midway and Grand Forks, do hold licenses for diversion of surface water from the Kettle River, current water withdrawals are from the local aquifers. The City of Greenwood also obtains its water from an aquifer and abandoned its surface water license in 1997. Aqua Factor Consulting Inc. (2004) indicated that some ranches in other parts of the basin have also shifted from authorized water intake to drawing from unregulated groundwater sources. Most of the crops in the vicinity of Grand Forks are irrigated from groundwater supplied by the city and improvement districts.

A shift to groundwater from surface water withdrawal injects considerable uncertainty into our ability to link water withdrawal to the severity of its threat to speckled dace. If direct river withdrawals were restricted, unregulated groundwater usage would likely increase. If the linkage between aquifers and river discharge is extensive, mitigating fish stress in the Kettle basin may not be as simple as limiting direct water withdrawals from the rivers. In the Kettle River, groundwater and surface water appear tightly connected.

Cascade Falls

A proposal for a 25-megawatt run-of-river hydroelectric generation project at Cascade Falls on the Kettle River (about 2.5 km south of the community of Christina Lake) was approved in August 2006 by the B.C. Environmental Assessment Office. A 750m section of the Kettle River immediately upstream of a dam would become a pond (Hamilton 2005). Hamilton (2005) and Bradford (2006) concluded there would not be a significant loss of Speckled Dace habitat if the power project were built. The Cascade project is still in the review process and the area of potential development is well below the recommended critical habitat sites.

Resource Extraction

Historically, the Kettle Valley was first developed for mining in the late 1890s. In 1900, the population of Greenwood/Anaconda was estimated at 3,500, roughly three times today's census. Phoenix, in 1910, was a town of 4,000 to 5,000; it no longer exists. Rock Creek, Boundary Creek, and to a lesser extent the Kettle River were the scene of placer mining and some hydraulic operations. Much of the substrate of these water courses was washed and turned in the pursuit of gold, and considerable volumes of unconsolidated material were washed into the Kettle River. The lower Kettle River contains volumes of mobile sands and gravels (very porous substrate); some of this material may be attributed to early mining activities.

The economy of the area is now mainly logging, ranching and tourism, with mining much reduced from its 1900 levels. However, mining activity is dependent upon the price of metals; if prices continue to rise, old and new mines may become active. Most of the current mining applications are for mineral exploration. Mining could alter water quality and increase sedimentation and corresponding embeddedness, which is an important habitat attribute for speckled dace.

Forestry

Timber harvest within the Kettle River basin is concentrated in the more northern interior zones associated with the tributary valleys and slopes of the East Kettle, West Kettle, and Granby Rivers. These areas have a fire return interval of approximately 150 years. Sediment from new roads may be the single greatest remaining threat to streams, due to forestry activities in the Kettle basin. There is anecdotal evidence of sediment from road building in the Granby basin smothering cobble and boulder substrate. It is unlikely that high sedimentation will occur within the stretch of the Granby River proposed as critical habitat.

Infestation of lodgepole pine by mountain pine beetle (*Dendroctonus ponderosae)* has the potential to impact the forests of the Kettle-Granby watershed and may ultimately influence hydrology and water quality. Forest management practices currently attempt to manage harvests with the objective of "staying ahead of the beetle" by cutting blocks that are susceptible or expected to be attacked in the near future. Death of lodgepole pine in the watershed will ultimately result in deeper

snow pack (because of less interception of snow) and faster snowmelt (because of less shading); the overall result will be earlier, bigger and more frequent floods.

Between 2000 and 2008, the export value of wood and pulp and paper products from the region declined by 39% (Penfold 2010). All of the operating facilities are located in the lower watershed near the main river and there is a limited threat of point source pollution. Such point source pollution does not currently represent a direct threat to Speckled Dace habitat within the recommended critical habitats.

Sources of Uncertainties

The recommendation for the geo-spatial extent of critical habitat for Speckled Dace is based on two presumptions. One that the density of 3.0 fish/metre identified by Batty (2010) is consistent throughout its range; and two the interim recovery target proposed by Reed et al. (2003) of 7000 adults is conservative enough to ensure a sufficient population level to rebuild the species if a catastrophic event were to happen. Because of these uncertainties the recommendation is to apply 2.4km of stream length in each of the three systems as opposed to a total of 2.4km for the entire population.

CONCLUSIONS AND ADVICE

For Speckled Dace, critical habitat is identified to the extent possible, using the best available information. The recommended critical habitat shown in Figure 1, which depicts the geospatial area that will supply the amount of habitat necessary to maintain the population abundance required for the persistence of the species in the three locations and over the range where it is presently found in Canada. The probability that a catastrophic event could drastically reduce or eliminate dace in all three locations at the same time is very low.

SOURCES OF INFORMATION

This Science Advisory Report has resulted from the Fisheries and Oceans Canada, Canadian Science Advisory Secretariat Pacific Regional Advisory Meeting of April 19th, 2012. Additional publications from this process will be posted as they become available on the DFO Science Advisory Schedule.

Allen, D.M., D.C. Mackie, and M. Wei. 2004. Groundwater and climate change: a sensitivity analysis for the Grand Forks aquifer, southern British Columbia, Canada. Journal of Hydrogeology 12(3): 270-290.

Andrusak, G. and H. Andrusak 2011. Identification of habitat use and preference of Speckled Dace within the Kettle River watershed. Report prepared for Fisheries and oceans Canada. 75 pp.

Aqua Factor Consulting Inc. 2004. Potential effects of the Cascade Heritage Power Project on the allocation of water in the Kettle River basin. Report prepared for BC Environmental Assessment Office, Victoria B.C. 96 pp.

Batty, A. 2010. Examination of Speckled Dace abundance, biology and habitat in the Canadian range. M.Sc. Thesis. School of Resource and Environmental Management, Simon Fraser University, Summer 2010.

Bradford, M. 2006. Impact of the proposed hydroelectric development at Cascade Falls on the conservation status of Speckled Dace (*Rhinichthys osculus*) in the Kettle River, British Columbia. Paper for Fisheries and Oceans, 24 Pages.

Census of Canada-BC Stats 2012. http://www.bcstats.gov.bc.ca/StatisticsBySubject/Census.aspx

COSEWIC. 2006. COSEWIC assessment and update status report on the Speckled Dace Rhinichthys osculus in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. 27 pp.

Hamilton, S. 2005. Appendix C: Status of Kettle river Speckled Dace (*Rhinichthys osculus*). Brief prepared by Shawn Hamilton and Associates, Saanich, BC. for Cascade Power. 5 pages.

Harvey, B. 2007. Scientific information used in the recovery potential assessment for the Speckled Dace (*Rhinichthys osculus*). Fisheries and Oceans Canada, Canadian Science Advisory Secretariat. Research Document 2007/074. 17 pp.

Maaciak, R., Ford, T., and Schroeder, J. 2007. Kettle River watershed analysis; Midway, British Columbia to stream headwaters. BC MOE. 22Pages. http://www.boundaryalliance.org/kettleriverstudy.pdf

McPhail, J. D. 2007. The Freshwater Fishes of British Columbia. University of Alberta Press, Edmonton, Alberta. Pages 620.

Peden, A.E. and G.W. Hughes. 1981. Life history notes relevant to the Canadian status of the Speckled Dace (*Rhinichthys osculus*). Syesis 14: 21-31.

Penfold, G. 2010. Economic overview: West Kootenay Boundary. Paper prepared for Regional Innovation Chair in Rural Economic Development, Selkirk College Castlegar, B.C. 39 pages.

Reed, M.J., O'Grady, J.J., Brook, B.W., Ballou, J.D., and Frankham, R. 2003. Estimates of minimum viable population sizes for vertebrates, and factors influencing those estimates. Biol Conserv. 113:23-34.

Scott, W. B. and Crossman, E. J. 1973. Freshwater Fishes of Canada. Bull. Fish. Res. Board Can. 184. 966 pp.

Urban Systems Ltd. 2011. City of Grand Forks sustainable community plan. Paper prepared for City of GrandForks. 68 pages.

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