Fisheries and Oceans Canada — Pêches et Océans Canada
Science — Sciences

C S A S — **S C C S**

Canadian Science Advisory Secretariat — **Secrétariat canadien de consultation scientifique**

Research Document 2007/074 — **Document de recherche 2007/074**

Not to be cited without
permission of the authors *

Ne pas citer sans
autorisation des auteurs *

Scientific information used in the recovery potential assessment for the speckled dace (*Rhinichthys osculus*)

Évaluation du potentiel de rétablissement du naseux moucheté (*Rhinichthys osculus*)

Brian Harvey

1755 Emerson St.
Victoria, B.C. V8R 2C

ISSN 1499-3848 (Printed / Imprimé)

Canada

CONTENTS

ABSTRACT

Speckled dace *Rhinichthys osculus* is a small, bottom-living, minnow-like river fish. While common in the western United States, its geographic range protrudes into Canada in one place only: the Kettle-Granby River drainage in the west Kootenay area of southern British Columbia. Speckled dace have been observed in approximately 300 km of river here; availability of suitable riffle or other fast water habitat has been suggested as the main factor limiting its abundance. COSEWIC designates the species as *Endangered* because of its isolation in a single drainage basin and the impossibility of re-colonization after a catastrophic event. It is not listed under the *Species at Risk Act* (*SARA*).

Abundance is poorly known; best estimates range from 11,546 to 23,092 fish. Lack of any consistent census means we have no knowledge of trends in abundance, which appears to vary dramatically depending on time of year and water flow. A quantitative target abundance for speckled dace cannot be established without better census data. To set a generic lower benchmark when the population is not necessarily declining may ignore the purpose of recovery targets.

As a stream-dwelling species that appears to prefer fast-water riffle habitat, the speckled dace can potentially be affected by long-term changes in water volume and velocity. Concerns have been raised that increasing withdrawal for irrigation may affect the population. Instream flow rates based on a percentage of mean annual discharge have been proposed to conserve habitat such as that preferred by speckled dace in the Kettle River, but there are insufficient data to allow us to quantify the expected harm to dace at different flow rates. Ensuring adherence to any benchmark is complicated by the wide margin for further surface water extraction under existing licenses, unlicensed withdrawal of ground water and a poor understanding of the connection between surface water and aquifers. Licensing of groundwater extraction, further research to determine the connection between surface and ground waters in the basin, and alternative agricultural practices, including trickle irrigation, are proposed.

A proposal for a 25-megawatt run-of-river hydroelectric generation project at Cascade Falls on the Kettle River was approved in 2006 after modification to reduce potential fish habitat impacts. A qualitative risk assessment supported by a quantitative population viability model concluded that the project posed a negligible risk to the speckled dace population. The procedure followed in determining its potential impact on speckled dace could be applied to any subsequent proposed activities on the river that could disrupt fish habitat.

Infestation by mountain pine beetle (*Dendroctonus ponderosae*) could degrade stream habitat through collapse of dead trees (reducing stream canopy and increasing snowpack), as well as through salvage logging that further exacerbates flooding. Logging damage to stream habitat can be minimized in various ways that reduce runoff, maintain diversity of cover and avoid sensitive terrain.

In interior B.C. streams, climate change is expected to increase the number and severity of droughts. For flow-sensitive species like speckled dace, such alterations may be of concern.

A model developed to allow contemplation of various scenarios for removal of speckled dace habitat by the Cascade Falls hydropower project demonstrated that it was possible to make some quantitative predictions for a data-poor species like speckled dace. Development of alternative models for dace population viability depends on better knowledge of abundance, spatial distribution, habitat availability and recruitment.

RÉSUMÉ

Le naseux moucheté *Rhinichthys osculus* est un petit poisson de rivière semblable au méné, vivant près du fond. L'aire de cette espèce commune des régions occidentales des États-Unis ne s'étend, au Canada, que dans le bassin des rivières Kettle-Granby situé dans la région de Kootenay, dans le sud de la Colombie-Britannique. Le naseux moucheté a été observé sur près de 300 km de rivière dans cet habitat; la disponibilité limitée des radiers et autres habitats de qualité en zones de courant fort serait le principal facteur limitatif de son abondance. Le COSEPAC désigne cette espèce comme étant *en voie de disparition,* en raison de son isolement dans un seul bassin versant et de son incapacité de recolonisation aux lendemains d'une catastrophe. L'espèce n'est cependant pas inscrite à la liste des espèces protégées en vertu de la *Loi sur les espèces en péril* (LEP).

L'abondance est mal connue; les estimations les plus fiables varient entre 11 546 et 23 092 poissons. En l'absence d'un recensement méthodique, nous ignorons tout des tendances de l'abondance qui semble varier substantiellement selon l'époque de l'année et le débit d'eau. Aucun objectif quantitatif ne peut être fixé pour le naseux moucheté sans l'appui de données de recensement plus précises. Établir un seuil générique pour une population qui n'est pas nécessairement en déclin nous éloignerait peut-être de l'objectif des cibles de rétablissement.

Espèce semblant privilégier les habitats de radiers à courant relativement rapide, le naseux moucheté pourrait être souffrir sérieusement de modifications de longue durée du volume et de la vélocité des cours d'eau. Certaines préoccupations ont été soulevées quant à l'effet que pourrait avoir sur la population de naseux la sollicitation croissante de cette réserve hydrique aux fins d'irrigation. Des débits minimums calculés en fonction de pourcentages du débit annuel moyen ont été proposés comme mesures de conservation d'habitats tels que celui que privilégie le naseux moucheté de la rivière Kettle. Nous disposons toutefois de trop peu de données pour être en mesure de quantifier les effets négatifs que pourrait avoir différents débits sur le naseux. Par ailleurs, l'application de points de référence est compliquée par l'importante marge de manœuvre accordée au soutirage des eaux de surface sous permis et à l'exploitation des eaux souterraines sans permis, ainsi que par le peu de connaissances des liens existants entre les eaux de surface et les réserves aquifères. On propose donc la délivrance de permis régissant les prélèvements d'eaux souterraines, un examen plus approfondi du lien entre les eaux souterraines et de surface du bassin, ainsi que l'instauration de pratiques agricoles différentes, notamment l'irrigation au goutte-à-goutte.

Un projet de centrale hydroélectrique au fil de l'eau de 25 mégawatts aux chutes Cascade, sur la rivière Kettle, a été approuvé en 2006 après avoir été modifié de manière à réduire les impacts potentiels sur l'habitat. Une évaluation qualitative du risque, fondée sur un modèle quantitatif de viabilité de population, a permis de conclure que le projet ne présentait qu'un risque négligeable pour la population de naseux mouchetés. La méthode ayant servi à déterminer l'impact potentiel sur le naseux moucheté pourrait être utilisée à nouveau pour toute proposition subséquente d'activité susceptible de nuire à l'habitat de la rivière.

Une infestation de dendroctones du pin ponderosa (*Dendroctonus ponderosae*) pourrait entraîner une dégradation de l'habitat lotique par la chute d'arbres morts dans l'eau (perte du couvert au-dessus du cours d'eau et augmentation de l'accumulation de neige)

et la réexploitation forestière qui crée un milieu plus propice aux inondations. Pour minimiser les dommages causés par l'exploitation forestière aux habitats des cours d'eau, il existe plusieurs moyens qui permettent de réduire le ruissellement, de maintenir la diversité du couvert forestier et d'éviter les sols sensibles.

L'on estime que les changements climatiques risquent d'augmenter la fréquence et l'ampleur des épisodes de sécheresse dans les cours d'eau intérieurs de la Colombie-Britannique. Pour les espèces sensibles au débit des cours d'eau telles que le naseux moucheté, ces changements peuvent se révéler inquiétants.

Le modèle employé pour explorer divers scénarios de perte d'habitat du naseux moucheté dans le cadre du projet hydroélectrique des chutes Cascade témoigne de la possibilité de faire certaines prédictions quantitatives, même dans le cas d'espèces comme le naseux moucheté pour lesquelles il existe très peu de données. L'élaboration d'autres modèles pour l'évaluation de la viabilité de la population de naseux requière une connaissance plus approfondie de l'abondance, de la répartition spatiale, du recrutement et de la disponibilité des habitats.

INTRODUCTION

A Recovery Potential Assessment (RPA) provides technical advice to the Minister of Fisheries and Oceans concerning the amount of allowable harm to an aquatic species. This document is an RPA for the Canadian population of the speckled dace (*Rhinichthys osculus*), a freshwater fish found only in the Kettle River/Granby system in southern British Columbia.

Ideally, an RPA precedes listing of a species or population under *SARA*, and is used to help make the decision whether or not to list. If the species is already listed, the RPA contains information and technical advice on status, threats, critical habitat and abundance that can be used to develop recovery plans. Speckled dace belongs to the first category: it is designated *Endangered* by COSEWIC but is not listed under *SARA*.

The "allowable harm" described in an RPA anticipates Section 73 of *SARA*, under which the Minister may authorize activities that affect a listed aquatic species, any part of its critical habitat, or the residences of its individuals if all reasonable alternatives that would reduce the impact of the activity have been considered and the best solution adopted so that the activity will not jeopardize the survival or recovery of the species. The RPA attempts to answer the question: Can the species recover if human-induced mortality is greater than zero? Ideally, the RPA contains information the Minister must place on the *SARA* Public Registry to document the reasons for issuing a Section 73 permit.

This RPA for speckled dace generally adheres to the three-phase format based on the Moncton Protocol and summarized in DFO (2004), with some collapsing of categories (for example, where threats to habitat are human-caused). It begins with a description of the species and its status; threats to the species (including human activities) and their effects are listed next; finally, various scenarios that would reduce the threats and potentially allow harm under Section 73 of *SARA* are presented.

As a risk assessment, an RPA reflects the data available. For a cryptic, non-exploited species like speckled dace, data are limited, and there is little knowledge of the species' biology. In a case like that of the speckled dace, an RPA can only provide the "best advice with the information available," while noting specific information gaps that need to be filled. Where data from similar species are used to form an opinion on allowable harm (as is necessary with dace and noted in the document), the RPA becomes a relative risk assessment.

The Recovery Potential Assessment for speckled dace was written for DFO by Brian Harvey under contract to the Science Branch of Fisheries and Oceans Canada. The author consulted with the following experts during its preparation: Mike Bradford (DFO), Shawn Hamilton (Shawn Hamilton and Associates Ltd.), Mike Miles (M. Miles and Associates Ltd.), Alex Peden (Curator Emeritus, Royal B.C. Museum), Sue Pollard and Ron Ptolemy (B.C. Ministry of Environment), and Neil Schubert (DFO). Mike Bradford and Neil Schubert provided helpful comments on various drafts, and preparation of the final draft was facilitated by reviews from Don McPhail, Gordon Hartman, John Richardson and staff of the B.C. Ministry of Environment.

CURRENT STATUS

BASIC BIOLOGY AND TAXONOMY

Dace are minnows belonging to the Order Cypriniformes, a large group that dominates the freshwater fish and whose greatest diversity is in southeast Asia. There are three families within the Cypriniform order in Canada; dace belong to the Family Cyprinidae, which also includes chub, tench, carp, shiner, minnow and goldfish. Speckled dace is small (51-76 mm in length), with a prominent snout (*Rhinichthys*) and a sucker-like mouth (*osculus*).

Taxonomy

The common name "dace" is used for several genera in Canada; they occur from Nova Scotia to B.C. The genus *Rhinichthys* occurs from Nova Scotia to Manitoba as blacknose dace *Rhinichthys atratulus*, from Labrador to B.C. as longnose dace *Rhinichthys cataractae*, and in the Columbia and Fraser River drainages in B.C. as leopard dace *Rhinichthys falcatus*. Speckled dace *Rhinichthys osculus,* while very widely distributed in western North American rivers (south-central B.C. to northern Mexico), is confined in Canada to a short section of the Columbia drainage (Scott and Crossman 1973; Wooding 1994).

There is one more member of the genus *Rhinichthys*, the Umatilla dace *Rhinichthys umatilla.* Its taxonomic relationship to speckled dace is still uncertain. The two forms coexist within a short section of the Canadian portion of the Columbia drainage; however, differences in anatomy, especially mouth morphology, have led some authors to conclude that the two forms occupy different ecological niches and merit the distinction of separate species (Peden and Hughes 1988; Peden 2007 pers. comm.). The limited number of genetic analyses of *Rhinichthys* species occupying the Columbia drainage is insufficient to resolve this taxonomic question (Haas 2001). Mitochondrial DNA analyses of populations of speckled dace in Oregon did, however, identify significant genetic divergence between basins and recommended that the dace in these basins be regarded as evolutionary significant units (Pfrender *et al.* 2004). Similar evidence of genetic isolation in speckled dace was presented by Oakey *et al.* (2004) for 59 populations in the Colorado and Snake Rivers. The speckled dace population in Canada lacks mandibular barbels, a morphological characteristic that strengthens the argument for genetic uniqueness.

Life history

Our fragmentary knowledge of the species' natural history within its Canadian range is based mainly on the published work of Peden and Hughes (1981; 1984). By considering also the observations of other researchers for a number of American populations, we can draw a picture of the life history of the speckled dace in Canada. The picture is, however, a rough one, for two reasons. First, the Canadian population was sampled mostly in lower water conditions (summer and fall), and during the day; what these animals do at night is not documented. Second, the many speckled dace populations in the United States and Mexico utilize a wide variety of stream habitats, many of them quite different from those in the Kettle River; drawing inferences about the life history of an 'outlying' population like the one in Canada is risky.

Within its Canadian range, speckled dace is an essentially bottom-living river fish that appears to prefer riffle or other faster water areas with a rocky bottom. Riffles may, however, be less important at night, as unbaited minnow traps set in quiet water often provide large catches of speckled dace (MacPhail 2007 pers. comm.). Both juveniles and adults appear to feed mainly on aquatic insect larvae; the morphology of the dace intestine suggests that the filamentous algae occasionally found in the gut are ingested inadvertently (COSEWIC 2002; Peden 2007 pers. comm.). There are no quantitative diel and seasonal assessments of stomach contents for the Kettle River population; seasonal shifts in diet do, however, occur in other *Rhinichthys* species in western North America. Speckled dace in the Kettle River system appear to live approximately four years, spawning in their third summer (males) and fourth summer (females), beginning roughly in mid-July. Males are rare in most collections, suggesting that they prefer deeper, faster water which is more difficult to sample (Peden 2007 pers. comm.). Individuals also sort by life stage, using different environments in the river: juveniles are found near the edge and adults farther out in deeper water (Peden 2007 pers. comm.; COSEWIC 2006).

The Canadian range of speckled dace is shared with other fish species including rainbow trout, brown trout, northern pikeminnow, redside shiner, largescale sucker, slimy sculpin, chiselmouth, chub and mountain whitefish. Its ecological interactions with these species are not well known, although speckled dace are known to compete with sculpins for riffle habitat in some California streams (Moyle 2002) and are likely eaten by pikeminnow (Harvey *et al.* 2004). Dace are probably an important link in aquatic and terrestrial food chains, as food for larger fish and birds.

Spawning has never been observed in nature. Based on laboratory observations, reproductive behaviour is triggered by some combination of increased photoperiod and rising water temperature (Kaya 1991), and results in the release of adhesive eggs that are scattered over cobble. Those that escape cannibalism by falling into cracks hatch within a week and appear in the river as feeding larvae in early August. Survival at the various life stages is not known; this knowledge gap makes it hard to estimate recruitment.

Listings

Several of the many populations of speckled dace within the western U.S. are listed under that country's *Endangered Species Act* (as of March 2007, four were listed as *Endangered* and one as *Threatened*). The species is not found on the IUCN Red List. The Canadian population of speckled dace was designated *Special Concern* by COSEWIC in 1980, and upgraded to *Endangered* in 2002 based on that year's status report (COSEWIC 2002). Its status was further updated in an Assessment and Update Status Report of 2006 (COSEWIC 2006). The species is not listed under *SARA* but is red-listed by the B.C. Conservation Data Centre. The main reason for concern in Canada is its very limited geographic range in being restricted to a single catchment.

Because our knowledge of the species within its Canadian range is fragmentary, an absolute risk analysis is impossible. The existence of the species in several better-studied locations in the western United States means, however, that some inferences can be drawn concerning its behaviour and habitat requirements.

RANGE, CRITICAL HABITAT, RESIDENCE AND ABUNDANCE

Populations of speckled dace throughout its extensive geographic range beyond the Kettle River use enough different kinds of habitat (swamps, sloughs, desert springs, shallow streams, large rivers) and substrates (coarse gravel, cobble, sand, silt) to suggest that the species' habitat requirements are inherently plastic. This fact, combined with our minimal knowledge of the life history of speckled dace in Canada, makes it very difficult to state which habitats are critical.

Range

While speckled dace is common in the western United States (there are hundreds of populations of the species from Washington to northern Mexico), its geographic range protrudes into Canada in one place only: the Kettle-Granby River drainage in the west Kootenay area of southern B.C. The Kettle River drains 8,300 square km within B.C., flowing through an ecological transition zone between the Okanagan Valley and the Monashee Mountains. It is one of twenty designated Heritage Rivers in B.C. The Kettle Valley is within the traditional territory of the Okanagan Nation (Okanagan Indian Band 2007).

The Canadian population of speckled dace is geographically isolated upstream of Cascade Falls. Canadian speckled dace coexists with a separate species, Umatilla dace, in a short section of the Kettle River below Cascade Falls, where the occasional individual is probably washed (Peden and Hughes 1984). However, Umatilla dace cannot enter the Canadian portion of the Kettle system upstream of Cascade falls, so speckled dace habitat in the Canadian portion of the Kettle system is effectively isolated. 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, recolonization by other populations from below this 30-metre natural barrier would be impossible (McPhail 1973; McPhail undated).

Within the Kettle-Granby system, speckled dace have been collected or observed at a number of locations that encompass approximately 300 km of river length (Triton 1994a,b; Peden and Hughes 1984). Strictly speaking, the linear range of the Canadian population of speckled dace is slightly shorter than this, because the Kettle River dips across the international border into the United States for 47 km (roughly between Midway, B.C. and Grand Forks, B.C.) before continuing to Cascade Falls. After the falls, it turns south once again and crosses the U.S.- Canada border permanently. Any recovery actions performed in Canada thus have theoretical cross-boundary implications.

Further sampling is needed to establish whether the species' upstream limits, including penetration into tributaries, are defined by water temperature and competition from other fish species (Bradford 2006). Based on the amount of suitable habitat believed to be available in the system, speckled dace presently occupy an approximate total aquatic area of 7.47 km^2 (COSEWIC 2006). The actual land area through which the three rivers flow is around 3,000 km^2.

Critical Habitat: water

While speckled dace seem widely distributed in the Kettle-Granby catchment, their occurrence is probably limited by the total amount of suitable or preferred habitat (Bradford 2006). Adult speckled dace seem to prefer areas with hiding places, especially between rocks in riffle areas where the river runs fastest (Peden and Hughes 1981), although riffle areas may represent daytime hiding places out of which speckled dace move at night to feed (MacPhail 2007 pers. comm.). Such areas are thought to make up only 20-25% of the Kettle system, which is dominated by lower gradient glide and pool habitat (COSEWIC 2006); the presumed highest quality habitat is found in the 9 km reach immediately upstream of Cascade Falls.

Habitat use appears to vary with age and season, with younger fish more likely to be found near the river margins in shallow, slower-moving water where clean, 15-40 cm cobble affords protection. The fish move to flooded vegetation for shelter during freshet. Adults are found around boulders larger than 40 cm, where there is faster water flow. Larger dace prefer waters deeper than 0.5 m and appear to avoid rocks that are heavily overgrown with algae, although they have been found in large numbers within seasonal growth of the aquatic moss *Fontinalis* in the Kettle system (Peden and Hughes 1981). Sandy bottoms, such as those in the lower Granby River, are not preferred. Overwintering behaviour appears to involve seeking out deeper waters behind large rocks, logs and bridge foundations. Males are collected much less frequently than females, and may prefer deeper, swifter water that is hard to sample with electro-fishing gear.

The depth and current preferences of different life stages of speckled dace have implications for their survival. Side channels are used throughout the year by juveniles, who prefer edge habitat in spring and fall; adults seem to use shallow waters mainly in summer. Protracted low water, which may be natural (drought) or caused by water withdrawal, may cause isolation or death. In arid areas in the southern part of the range of speckled dace in the U.S., however, isolation through dewatering appears to be common (Oakey *et al.* 2004) and has probably led to the existence of many morphologically distinct populations or 'subspecies' (McPhail 2003). One needs to be cautious about predicting the effects of low water in such a drought-resistant species.

There have been several studies of speckled dace in the southern part of their range, and some of these include observations on preferred water depth and velocity. Extrapolating these results to the Kettle system, however, ignores large differences in stream size and climate. For example, the species is found at greater depths in the Kettle River than in Arizona (Peden and Hughes 1981); its preferences for current velocity on the Olympic Peninsula are the opposite of those for the species in Canada (Wydoski and Whitney 2003). The body of quantitative information on optimal water flow for adult and juvenile speckled dace in Canada is very limited. Laboratory experiments by Haas (2001) suggest that speckled dace prefer lower water velocities than related *Rhinichthys* species, and their relatively poor performance in stream tank tests suggests they are among the weaker dace swimmers (MacPhail 2007 pers. comm.). Haas noted that these results were consistent with field observations, but the sampling gear used (backpack electrofishing) precluded sampling deeper habitats in the Kettle River. Anecdotal observations of pronounced fluctuations in seasonal water flow in the Kettle system (Peden 2007 pers. comm.) would seem to support the idea that speckled dace have adapted to variable water flows.

Concerning water temperature and clarity, we do know that tributaries are generally cooler than the mainstem in summer, which may limit their use by speckled dace. Speckled dace is at the northern limit of its geographic range in southern B.C. Sebastian (1989) recorded average August temperatures of 19-20°C in the Kettle and West Kettle Rivers, dropping to less than 5°C during winter. In contrast, Robinson and Childs (2001) describe populations in sections of the Colorado River where summer water temperature is 26°C, and John (1964) mentions acclimation of speckled dace in the laboratory to a water temperature of 31°C. Water clarity is high over most of the year, although water chemistry (including alkalinity, total phosphorus and total nitrogen) varies, not surprisingly, with seasonal water flow (COSEWIC 2006).

Critical Habitat: spawning and residence

Laboratory observations of Kaya (1991) and Haas (2001) indicate that the adhesive eggs of speckled dace adhere to the undersides of stones. In nature, however, spawning times, duration and site characteristics for the Canadian speckled dace population are unknown, so their spawning habitat can only be inferred from these laboratory observations and studies of the species in more southern parts of its range in Arizona and New Mexico (John 1963). The latter suggest spawning occurs over clean gravel and may include preparation of a nest site 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.

Identifying potential critical habitat

There are large knowledge gaps concerning habit use by speckled dace in Canada, and they cannot be filled simply by extrapolating from studies on the species in the southern part of its range, where temperature and water flow are so different from conditions in the Kettle system. We know the species displays remarkable behavioural plasticity over its wide range. In B.C., it uses habitat from the river margins to further midstream (but we don't know how far or how deep or at what times of day); we assume it spawns over rocks (but have never seen this happen); we know it is more often found by day where flow is greatest (but flow in the microhabitats preferred by dace may be very different from overall flow; we also know that the species can tolerate lower flows than other species of *Rhinichthys*). Given these and other uncertainties, any evaluation of potential critical habitat should assess the biological consequence of alternative habitat configurations in a risk management context and consider the serious knowledge gaps concerning habitat use by speckled dace in Canada.

Abundance

There has been no consistent census of speckled dace within its Canadian range. Our present knowledge of the abundance and natural history of speckled dace in Canada is based on two sources. The first includes observations made in the course of sampling trips by the Royal British Columbia Museum to the Columbia Valley between 1977 and 1990. In all, 1,075 speckled dace were collected by electro-shocking and identified (the number includes a small number of fish sampled in the American portion of the Kettle River system). These field collections, which were generally annual, were for the purposes of extending the museum's ichthyological collection and did not initially target the species. Once the species was identified as of interest to the Museum, however, many useful observations were made concerning its habitat, behaviour and apparent abundance.

The second source of abundance data is a series of studies done in the course of an environmental impact assessment regarding the proposed Cascade dam (see below). The bulk of these data represent collections at 20 electro-fished sites in the portion of the river upstream of the dam site (Triton Environmental Consultants 1994a,b). Using these limited density data and those provided by Sebastian (1989), and making assumptions about the amount of suitable habitat, Bradford (2006) arrived at total female abundances for five stretches of the Kettle-Granby system. In the 9 km immediately upstream of the dam site, abundance was estimated at roughly five times that in the remainder of the system, reflecting the much greater amount of suitable habitat near Cascade Falls. Over the total 284 km of assumed useable habitat within the system, his estimates for total adult abundance range from 11,546 to 23,092 fish (the two estimates reflect different assumptions about the amount of suitable habitat). The reliance on data gathered using sampling gear near the river margins suggests that the number of adult dace may have been significantly underestimated; anecdotal observations at sampling sites allowed Bradford to conclude that the species should not be considered scarce. We have no way of knowing whether their present abundance represents a decline or increase over historical numbers, although COSEWIC (2006) speculated on the accumulated effects of agricultural and mining development, as well as the construction of the railroad and a number of dams in the region.

In both the Canadian and U.S. portions of its range, speckled dace abundance appears to vary dramatically with time of year and water flow (Erman 1986; Peden 2007 pers. comm.). This phenomenon has long been observed for many stream fishes, where abundances in "low flow" and "high flow" years can vary by a factor of ten (Propst and Gido 2004). In Arizona, for example, the speckled dace has adapted to mountain streams where flash flooding and periodic drying have a drastic effect on fish abundance (Minckley 1973). A parallel may likely be drawn with seasonal flooding in a snowmelt river like the Kettle. The obvious lesson for any estimate of dace abundance is that, because entire fish assemblages in streams can be mobile and tend to fluctuate, the results of long-term population studies are sensitive to the timing and place of sampling (Decker and Erman 1992).

POPULATION AND DISTRIBUTION TARGETS FOR RECOVERY

Designation of the speckled dace population in Canada as *Endangered* reflects its isolation in a single drainage. While there are concerns about the potential impact of water withdrawal and other human-induced activities (see below), the population is widespread and likely abundant enough not to be at immediate risk. The best estimates of speckled dace population abundance, however, rest on assumptions about habitat suitability and estimates of the amount of that habitat; they are not supported by systematic sampling.

An appropriate abundance target for the recovery of an unknown population that may not even be in decline is "maintenance of a self-supporting population;" in the case of speckled dace this must allow for the natural fluctuations common in fish that inhabit rivers of widely varying flow. Bradford (2006) argued for a conservation risk threshold (lower limit) of 2,500 individuals by applying COSEWIC's small-population risk criterion of decline to 10% of the carrying capacity of the environment; another possible generic minimum viable population size could be the 5,000 – 7,000 adults adopted as an interim recovery target by Reed *et al.* (2003) for listed vertebrate species. Setting a generic lower benchmark when a population is not necessarily declining may, however, ignore the purpose of recovery targets (Rosenfeld and Hatfield 2006). A quantitative target abundance for a healthy population of speckled dace cannot be established without better census data.

An appropriate distribution target for recovery should, in the absence of any evidence that distribution has changed significantly, reflect the need to maintain the status quo, namely to preserve the species' current distribution in the West Kettle, Kettle and Granby Rivers and their side channels.

So long as the conservation goal is to maintain the current, apparently stable population, the time frame for recovery is "ongoing."

THREATS

SOURCES OF HUMAN-CAUSED MORTALITY AND HARM

For speckled dace, threats to critical habitat are human-caused, so the Moncton Protocol for recovery potential analysis has been modified to include both categories of harm under the same heading. Although speckled dace is not known to migrate, it is technically a transboundary species; pollution or severe flow alteration in the 47 km of the Kettle River that flow through the U.S. could potentially affect the downstream population in Canada.

The threats are presented here in declining order of importance.

Water withdrawal

In most of its geographic range, speckled dace is a fish typical of arid areas. It persists, sometimes in small populations, in streams that are reduced to pools in late summer. As a stream-dwelling population that appears to prefer fast-water riffle habitat, the speckled dace in Canada could nevertheless be affected by long-term changes in discharge. Water level in some portions of the Kettle can drop so far that dace become stranded in isolated pools (Peden 2007 pers. comm.). Riffle areas are more sensitive to flow reduction than other stream habitats such as glides, runs and pools (Bovee 1974; Stalnaker and Arnette 1976).

While the species' apparent short-term ability to withstand the large fluctuations in discharge typical of a snowmelt river like the Kettle likely provides some resilience, increasing demands for water withdrawal pose a threat to components of the population residing in areas where agricultural water use occurs (COSEWIC 2006). Water abstraction for irrigation in the Kettle basin has been identified as a conflict with fish habitat for many years (Bull 1973); surface water can come either from the river itself, for which a permit is required, and/or from groundwater sources which are only minimally regulated under B.C.'s *Groundwater Protection Regulation* of 2004 (Government of B.C. 2007).

While water withdrawal for irrigation is expected to increase and there may be climate change-related increases in drought frequency, there are two sources of uncertainty that make regulation difficult. First, the amount of water actually withdrawn from the river can either exceed the amount licensed (illegal withdrawal), or it can be less (in 2003, for example, water rights were twice the estimated usage). Either situation can make it hard to ensure adequate instream flow. Second, much of the water used for irrigation along the Kettle River, and for towns such as Midway and Grand Forks, comes from aquifers (Aqua Factor Consulting 2004). Some of the connections between ground and surface water in the area are known (for example, the Grand Forks aquifer is connected to the Kettle and Granby rivers), but in general the connection between underground aquifers and surface water is poorly understood. Diverting demand from one water source to the other may have little effect on overall supply. These uncertainties, combined with our lack of knowledge of the distribution of the speckled dace population in the basin and the capability of speckled dace to adapt to changes in water flow, provide additional support for the idea of monitoring abundance in selected reaches of the river.

The mean annual discharge (MAD) at Cascade recording station is 75 m^3/s. Spring snowmelt freshet, which typically peaks in late May or early June, is the dominant hydrological event of the year, and flow at this time can exceed 200 m^3/s (Environment Canada 2007). The low flow period can extend between August and March (Miles and Hamilton 2006). A flow of 10% MAD has been proposed as the minimum necessary for maintenance of riffle width in B.C. streams (Ptolemy and Lewis 2002); flows near 20% MAD are thought to be required to maintain riffle depth and velocity. Because reduction of late-summer flow below 7.5 m^3/s (10% MAD) is not uncommon (Figure 2), any increase in water withdrawal is cause for concern. Figure 1 shows instream flows for 2003, an exceptionally dry year during which MAD fell well below 10% for several months. Water withdrawals affect stream flow throughout the Kettle system.

Hydroelectric development

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 submitted in 1999 and approved in August, 2006 by the B.C. Environmental Assessment Office (EAO), after modification based on analysis of its potential fish habitat impacts. In his allowable harm assessment of the Cascade Heritage Hydroelectric Project, Bradford (2006) estimated that less than 2% of speckled dace habitat would be affected by the creation of a headpond for the dam, mainly by reduction of productive capacity due to inundation of riffle areas. Based on a qualitative risk assessment supported by a quantitative population viability model, Bradford concluded that the project posed a negligible risk to the speckled dace population. He nevertheless strongly recommended that, in the light of our poor understanding of the species' biology and natural history, quantitative estimates of its abundance by river reach, as well as studies of its habitat use by life stage and season, are urgently required. He also recommended a monitoring program be attached to the project.

Watershed alteration by logging

Infestation by mountain pine beetle *Dendroctonus ponderosae* has the potential to degrade stream habitat in many areas of interior B.C., including the Kettle-Granby watershed. Although the watershed is extensively forested with lodgepole and ponderosa pine, mountain pine beetle infestation rates are still relatively low. If the beetle does move into the southern pine forests in the future, the first effect will be a gradual, natural one, in which trees lose their branches and eventually collapse, reducing stream canopy and allowing understory vegetation to increase. Death of lodgepole pine in the watershed will 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. The increase in flooding would be about half of what would result if the entire watershed were to be clearcut (E. MacIsaac 2007, pers. comm.).

The bigger risk, however, would come from increased salvage logging, which can be twice the normal allowable cut. Logging can affect streams by removing non-target vegetation, reducing shade, increasing debris and runoff from road construction, increasing peak stream flows and removing any buffering effect on snowmelt and storms, soil loss and channel destabilization (Winkler *et al.* undated). Frequency and severity of floods will increase (Chatwin and Alila 2007). Speckled dace would likely be affected by new roads built to service the salvage activity, because roads and stream crossings will increase sediment loads to the main channels. There is some anecdotal evidence that this has already happened: in parts of the Granby River, cobble and boulder substrate have become smothered in sand from forestry in the watershed and are now almost devoid of speckled dace (McPhail 2007 pers. comm.).

Climate change

In interior B.C. streams, climate change is expected to increase the number and severity of droughts. Earlier breakup of snow pack, earlier spring floods and more protracted summer low flow periods are already being recorded not only in large rivers like the Fraser but also in smaller streams in south central B.C. (Aqua Factor Consulting 2004). For a species like speckled dace, the effects are difficult to predict. On the one hand, warmer winters and the attendant changes in water flow would likely exacerbate industrial and point source agricultural contamination such as have occurred from time to time in the Kettle system (Peden and Hughes 1981; COSEWIC 2002) while increasing demands for water abstraction. On the other hand, shorter, warmer winters may be less stressful for stream fish populations and the biota that support them—especially species like speckled dace, which are widely distributed in hot, arid areas.

Fisheries

There is no fishery on speckled dace. Its use as bait for recreational fishing for resident rainbow trout and other species is insignificant.

MAXIMUM SUSTAINABLE MORTALITY

The human-induced threats identified in the previous section are only quantifiable if we make assumptions about speckled dace reproductive potential, habitat preference and distribution. Such assumptions would have to be based on a weak data set. Quantitative models of population viability that rest on such assumptions would be useful for testing alternative scenarios but may only lend weight to the kind of common sense predictions that could be made by any competent field biologist. For speckled dace, one can only estimate maximum sustainable mortality based on general conservation principles; if one assumes a minimum population size of 2,500 fish based on the

COSEWIC criterion for small populations, maximum sustainable mortality works out to around 9,000 - 20,000 fish.

IS CRITICAL HABITAT LIMITING? WILL IT BECOME LIMITING?

Habitat trends in the Kettle-Granby watershed reflect the historic development of mining and rail transportation, and the more recent dependence on agriculture, timber harvest, ranching and tourism (the Kettle Valley Railway, a spur line built by the C.P.R. in 1914, is now a popular cycling route).

Availability of suitable habitat in the Kettle-Granby system has been identified as the main factor limiting abundance of freshwater fish in general (Sebastian 1989) and speckled dace in particular (Bradford 2006; see also *Critical Habitat*, above). In the lower Granby, for example, dace are largely confined to areas with cover and an absence of suspended sediments (Peden and Hughes 1981); in the Kettle River, the highest quality habitat is thought to occur in the 9 km reach above Cascade Falls (Bradford 2006).

Low water flow conditions can be expected to further reduce the already limited amount of critical habitat. As a general rule, reduction of streamflow to less than 10% of the mean annual discharge severely degrades water depth, velocity and riffle size (Tennant 1976) and likely increases risks to aquatic biota.

SCENARIOS FOR MITIGATION AND ALTERNATIVES

MINIMIZING HUMAN ACTIVITIES AND THREATS TO HABITAT

Current levels of human activity are unlikely to lead to the imminent demise of the speckled dace in Canada. Nevertheless, the Kettle-Granby watershed should be managed to ensure that harmful activity does not increase. The following discussion focuses on three such kinds of activity: water withdrawal, hydroelectric development, and logging.

Water withdrawal

While there are limitations on our ability to quantify the levels of water discharge at which dace are harmed, there are several tools that could be used to manage instream flow so as to protect dace habitat in the Kettle River (Instream Flow Council 2004). The method of Tennant (1976) has been adapted to reflect the hydrologic regimes and fish periodicity in B.C. streams and proposed as a platform for instream flow standards for rivers like the Kettle (Ptolemy and Lewis 2002). This rule-of-thumb method, which prescribes a 10% MAD standard to maintain width coverage in riffles, may not be appropriate for a river that flows through an arid region and is home to a little-understood, flow-sensitive species that has been designated endangered. At present, there are insufficient data on habitat availability and speckled dace abundance to quantify the expected harm at any level of reduced flow, another knowledge gap that will need to be filled if realistic discharge limits are to be set.

Unfortunately, the licensed withdrawal of surface water is not the only cause of decrease in flow, so ensuring that discharge does not fall below some agreed-upon figure will not be straightforward. Unlicensed withdrawal of ground water is occurring more frequently in the basin. While we don't adequately understand the connection between surface water and aquifers, further groundwater extraction in the Kettle basin poses a risk, as it does elsewhere in Canada. Water users who turn more and more toward "unrestricted" aquifers in the Kettle Valley may simply be exacerbating the overall problem; in so doing they are only following a global trend that has led to a dramatic subsidence of water tables in many parts of the world. Two measures are thus required to prevent water withdrawal exceeding any specified limits: licensing of groundwater extraction, and further research to determine the connection between surface and ground waters in the basin. A ban on surface water abstraction in a drought season, under the Provincial Fish Protection Act (1997), is a third option.

Hydroelectric development

The site chosen for the Cascade Heritage Hydroelectric Project was based on its suitability for a small run-of-river facility. The measures taken to minimize its effects on speckled dace habitat include reducing the size of the headpond, identifying habitat restoration opportunities, and setting up a speckled dace monitoring program (Bradford 2006; Miles and Hamilton 2006). The expected harm for the present design is a possible impact on less than 2% of speckled dace habitat, confined to the immediate vicinity of the headpond; the viability of the speckled dace population is not expected to be reduced. The monitoring program, which is still in the development stage, is intended to measure dace abundance in the area immediately affected by the dam, as well as at several reference sites upstream (Hamilton 2007 pers. comm.). While it is uncertain when construction on the Cascade Heritage project will begin, the procedure followed in determining its potential effect on speckled dace could be applied to subsequent proposed activities on the river that have the potential to disrupt fish habitat.

Riparian alteration by logging

Managers have the option of removing lodgepole pine damaged or killed by mountain pine beetle, or allowing the trees to fall on their own. If removal is chosen, damage to stream habitat can be minimized by:

- minimizing harvesting within riparian areas;
- salvaging logs in stages to desynchronize runoff;
- avoiding sensitive terrain and soil types and developing erosion control plans;
- maintaining diversity of cover and minimizing post-salvage reforestation delays;
- leaving woody debris in openings to delay surface runoff;
- maintaining natural drainage around logging roads.

There are insufficient data on habitat availability and speckled dace abundance to quantify the expected harm using selective salvage logging that follows these principles.

ALTERNATIVES TO HUMAN ACTIVITIES AND THREATS TO HABITAT

The new design for hydroelectric generation at Cascade Falls replaces a much higher dam that operated at the same site between 1902 and 1919. Alternative technologies that are less invasive than the small run-of-river plant now approved for Cascade Falls do not presently exist; in cases where habitat degradation cannot be as adequately mitigated as at Cascade, the only alternative is not to build them.

There are alternative agricultural practices that would reduce extraction of surface and ground water in the basin. Current irrigation methods rely mainly on above-ground sprinkler guns and centre pivot systems that permit rapid and substantial evaporation and runoff. While irrigation method varies with the crop grown in the Kettle Valley (primarily fruit and forage), trickle irrigation can reduce evaporation and runoff, and requires less water (Irrigation Industry Association of B.C. 2007). Trickle systems require higher capital investment than conventional irrigation.

RECOMMENDED PRODUCTIVITY AND MORTALITY VALUES

Bradford (2006) developed a quantitative model to allow contemplation of various scenarios for removal of speckled dace habitat by operation of the Cascade Falls hydropower project. The model he chose, which is performed by commercially available RAMAS-Metapop software, sets a lower limit of population viability at 2,500 adults. The model demonstrated that it was possible to make some quantitative predictions for a data-poor species like speckled dace, but does little more than formalize the common-sense conclusion that the small dam proposed is unlikely to remove enough habitat to affect the population. In the absence of data for most population parameters, little more can be expected.

Development of alternative models depends on better knowledge of abundance, spatial distribution, habitat availability and recruitment. For the same reasons, productivity values are impossible to set.

REFERENCES

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. Web page posted September 29, 2004. http://www.eao.gov.bc.ca/epic/output/html/deploy/epic_document_55_19206.html

Bull, C.J. 1973. Fishery-Water Use Conflicts in the West Kettle River Watershed. Technical Report No. 1035, B.C. Ministry of Environment. 14pp.

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 (unpublished manuscript).

Chatwin, S., and Y. Alila. 2007. Changes in streamflow following mountain pine beetle attack. Journal of the Association of Professional Engineers and Geoscientists of B.C. May/June 2007: 26-27.

COSEWIC 2002. COSEWIC assessment and update status report on the speckled dace *Rhinichthys osculus* in Canada, Committee on the Status of Endangered Wildlife in Canada. Ottawa, 36 pp.

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.

DFO 2004. Revised Framework for Evaluation of Scope for Harm under Section 73 of the Species at Risk Act. DFO Can. Sci. Advis. Sec. Stock Status Report 2004/048.

Decker, L.M., and Erman, D.C. 1992. Short term seasonal changes in composition and abundance of fish in Sagehen Crek, California. Trans. Am. Fish. Soc. 121: 297-306.

Environment Canada. 2007. http://www.wsc.ec.gc.ca/hydat/H2O/index_e.cfm?cname=main_e.cfm)

Erman, D.C. 1986. Long term structure of fish populations in Sagehen Creek, California. Trans. Am. Fish. Soc. 115:682-692.

Government of B.C. 2007. www.qp.gov.bc.ca/statreg/reg/W/Water/Water299_2004/299_2004.htm

Haas, G.R. 2001. The evolution through natural hybridizations of the Umatilla dace (Pisces: *Rhinichthys umatilla*), and their associated ecology and systematics. PhD Thesis, Department of Zoology, University of British Columbia, Vancouver, B.C. 204 pp.

Harvey, B.C., White, J.L., and Nakamura, R.J. 2004. An emergent multiple predator effect may enhance biotic resistance in a stream fish assemblage. Ecology 85:127-133.

Instream Flow Council. 2004. Instream Flows for Riverine Resource Stewardship (2004 Revised Edition). 268 pp.

Irrigation Industry Association of B.C. 2007. Trickle Manual. http://irrigationbc.com/index.cfm?method=pages.showPage&pageid=22

John, K.R. 1963. The effect of torrential rains on the reproductive cycle of Rhinichthys osculus in the Ciracahua Mountains, Arizona. Copeia 1963: 286-291.

John, K.R. 1964. Survival of fish in intermittent streams of the Chiricahua Mountains, Arizona. Ecology 45(1): 112-119.

Kaya, C.M. 1991. Laboratory spawning and rearing of speckled dace. Progressive Fish-Culturist 53:259-260.

McPhail, J.D. Undated. Feature fish speckled dace *Rhinichthys osculus*. http://www.zoology.ubc.ca/~etaylor/nfrg/dace.pdf

McPhail, J.D. 2003. Report on the taxonomy, life history, and habitat use of the four species of dace (*Rhinichthys*) inhabiting the Canadian portion of the Coludrainage system. Report prepared for BC Hydro, Castlegar, B.C. 24 pp.

Miles, M. and Hamilton, S. 2005. Cascade heritage hydroelectric project hydrotechnical and fisheries assessment of proposed headpond and fisheries enhancement works.

Miles, M. and Hamilton, S. 2006. Habitat Enhancement Opportunities for Speckled Dace in the Lower Granby and Kettle Rivers. Contract report for Powerhouse Developments Inc. Vancouver, B.C.

Minckley, W.C. 1973. Fishes of Arizona. Sims Printing Co., Phoenix, Arizona. 293 p.Mueller, G.A. 1984. Spawning by Rhinichthys osculus in the San Francisco River, New Mexico. Southwestern Naturalist 29: 354-356.

Moyle, P.B. 2002. Inland fishes of California. Univ. California Press, Berkeley CA.

Oakey, D.D., Douglas, M.E., and Douglas, M.R. 2004. Small fish in a large landscape: Diversification of Rhinichthys osculus in western North America. Copeia 2004 (2): 207-221.

Okanagan Indian Band. 2007. www.okib.ca/history/te rritory.php

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

Peden A. E., and Hughes, G. W. 1984. Status of the speckled dace, Rhinichthys osculus, in Canada. Canadian Field-Naturalist 98: 98-103.

Peden, A.E., and Hughes, G.W. 1988. Sympatry in four species of *Rhinichthys* (Pisces), including the first documented occurrences of *R. umatilla* in the Canadian drainages of the Columbia River. Canadian Journal of Zoology 66:1846-1856.

Pfrender, M.E., Hicks, J., and Lynch, M. 2004. Biogeographic patterns and current distribution of molecular genetic variation among populations of speckled dace Rhinichthys osculus (Girard). Molecular Phylogenics and Evolution 30 (2004): 490-502.

Propst, D.L., and Gido, K.B. 2004. Responses of native and non-native fishes to natural flow regime mimicry in the San Juan River. Proc. Am. Fish. Soc. 133: 922-931.

Ptolemy, R., and Lewis, A. 2002. Rationale for Multiple British Columbia Instream Flow Standards to Maintain Ecosystem Function and Biodiversity. B.C. Ministry of Water Land and Air Protection. 48 pp.

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.

Rosenfeld, J.S. and Hatfield, T. 2006. Information needs for assessing critical habitat of freshwater fish. Can. J. Fish. Aquat. Sci. 63: 683-689.

Robinson, A.T., and Childs, M.R. 2001. Juvewnile growth of native fishes in the Little Colorado River and in a thermally modified portion of the Colorado River. North American Journal of Fisheries management 21: 809-815.

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

Sebastian, D. 1989. An analysis of rainbow trout production in the Kettle River system in south central BC. Fisheries project report FAIU-13, Min. of Env. Victoria BC.

Tennant, D.L. 1976. Instream flow regimens for fish, wildlife, recreation, and related environmental resources, in Instream Flow Needs, Volume II: Boise, ID, Proceedings of the symposium and specialty conference on instream flow needs, May 3-6, American Fisheries Society, p. 359-373.

Triton Environmental Consultants. 1994a. Cascade heritage power park: aquatic environmental impact assessment. Contract report for Powerhouse Development Inc.

Triton Environmental Consultants. 1994b. Cascade heritage power park: aquatic addendum II. Contract report for Powerhouse Development Inc.

Winkler, R., Maloney, D., Teti, P., and Rex, J. Undated. Hydrology, Maps, and Geographic Data for Watersheds Affected By Mountain Pine Beetle in the Interior of British Columbia. B.C. Ministry of Forestry. www.for.gov.bc.ca/hfp/mountain_pine_beetle/stewardship/hydrology/

Wooding, F.H. 1994. Lake, river and sea-run fishes of Canada. Harbour Publishing, Madeira Park, B.C. 303 pp.

Wydoski, R.S., and Whitney, R.R. 2003. Inland Fishes of Washington, second edition revised and expanded, American Fisheries Society, Bethesda, Maryland, 322 pp.

FIGURES

Figure 1. Daily discharge for the Kettle River near Laurier. *Adapted from*: http://www.wsc.ec.gc.ca/hydat/H2O/index_e.cfm?cname=graph.cfm

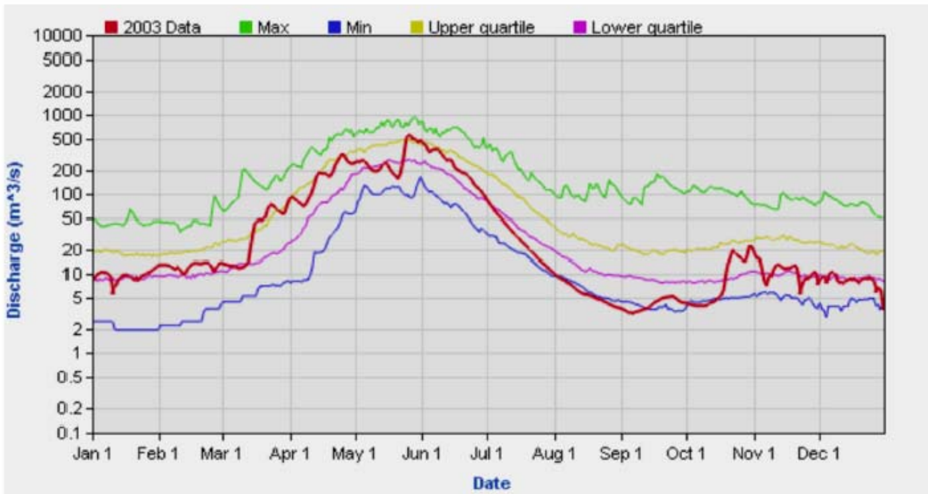

Figure 2. Recurrence of late summer low flows (Critical Period Summer Flow) for the Kettle River at Cascade, for the period 1916-2003, using Laurier data post 1935. The coloured horizontal line indicates 10% MAD. *Courtesy*: R. Ptolemy.