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Recovery Potential Assessment for the Umatilla Dace (*Rhinichthys Umatilla*)

Évaluation du potentiel de rétablissement du naseux d'Umatilla (*Rhinichthys umatilla*)

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ABSTRACT

Dace are minnows belonging to the Order Cypriniformes. Adult Umatilla Dace *Rhinichthys Umatilla* are usually under 10 cm in fork length, with morphology intermediate between that of speckled and leopard dace, implying that Umatilla Dace is the result of hybridization between the other two species. Umatilla Dace was designated *Special Concern* by COSEWIC in 1988, and was included on Schedule 3 of the Species at Risk Act (SARA) in 2004. In April 2010 the species was assessed as threatened by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) based on the limited area of occupancy, <10 locations, and the expected future loss of habitat or deterioration of habitat quality due to potential threats.

Umatilla Dace in Canada are found at the upper limits of their global distribution and the Canadian distribution represents only 5% of the total global distribution. The length of time they have occupied this area is unknown, nor is how their occupancy of a fringe area of the overall range relates to adaptability. In Canada, the species' occurrence is limited to the Similkameen River, Tulameen River, Columbia River below the HLK Dam, Kootenay River below Bonnington Falls, lower Slocan River, lower Pend d'Oreille River, and the Kettle River below Cascade Falls. There have been no new surveys for Umatilla Dace for most of their range within the past 20 years (around five generations); there is therefore great uncertainty about persistence of the species in some watersheds. In the light of such significant uncertainties, setting numerical "recovery targets" is impossible. The logical next step is to fill data gaps, starting with annual sampling using consistently applied methods in enough locations to provide a better understanding of distribution and recent population trajectories. The minimum level at which the population would be considered recovered is when its risk assessment status changes from Threatened to Special Concern. Such a change would require addressing and clarifying some of the assumptions and uncertainties within the COSEWIC report, or the elimination, reduction or mitigation of potential threats to habitat quality that were given as reasons for the threatened designation by COSEWIC in 2010. Downgrading to Special Concern would not, however, mean that management actions were not required.

Threats to Umatilla Dace in the Canadian portion of its global range include; hydroelectric development, flow changes related to existing dam operations, introductions of alien species, water extraction, resource extraction, land use (agriculture, transportation corridors, timber harvest) and scientific over-sampling. Allowable harm to Umatilla Dace in the Similkameen River, in the limited Kettle River habitat below Cascade Falls, and in the Columbia, Kootenay and Slocan Rivers should include scientific sampling for the purpose of further understanding abundance, distribution, and habitat use of the species, but total harm should not increase beyond current levels.

RÉSUMÉ

Les naseux sont des ménés de l'ordre des Cypriniformes. À l'âge adulte, le naseux d'Umatilla (*Rhinichthys umatilla*) mesure généralement moins de 10 cm de longueur à la fourche. Sur le plan morphologique, il se situe entre le naseux moucheté et le naseux léopard, ce qui sous-entend qu'il est le résultat de l'hybridation de ces deux espèces. Le naseux d'Umatilla a été désigné espèce Préoccupante par le Comité sur la situation des espèces en péril au Canada (COSEPAC) en 1988 et a été inscrit à l'Annexe 3 de la *Loi sur les espèces en péril* (LEP) en 2004. En avril 2010, l'espèce a été désignée Menacée par le COSEPAC en raison de son aire d'occurrence limitée (moins de 10 zones), de la réduction prévue de la superficie de son habitat et de la détérioration de la qualité de ce dernier attribuable aux éventuelles menaces.

Les naseux d'Umatilla présent au Canada sont à la limite septentrionale de leur aire de distribution et sa distribution canadienne ne représente que 5 % de la distribution mondiale. Personne ne sait depuis combien de temps il occupe cette région du monde et dans quelle mesure sa présence en périphérie des zones qu'il occupe partout dans le monde entretient un lien avec sa faculté d'adaptation. Au Canada, cette espèce ne se trouve que dans la rivière Similkameen, la rivière Tulameen, le fleuve Columbia sous le barrage Hugh L. Keenleyside (HLK), la rivière Kootenay sous les chutes de Bonnington, le cours inférieur de la rivière Slocan, le cours inférieur de la rivière Pend d'Oreille et la rivière Kettle sous la chute Cascade. Aucune nouvelle recherche n'a été réalisée dans la plupart des zones de répartition du naseux d'Umatilla au cours des 20 dernières années (environ 5 générations). Par conséquent, l'incertitude règne à l'égard de la présence de l'espèce dans certains bassins hydrographiques, et il est donc impossible de définir des cibles de rétablissement quantitatives. Logiquement, la prochaine étape serait de recueillir les données manquantes, en commençant par effectuer un échantillonnage annuel à l'aide d'une méthode uniforme dans suffisamment de zones pour permettre de mieux comprendre la répartition et les récentes trajectoires des populations. Pour conclure à un rétablissement de la population, il faudrait à tout le moins que la désignation quant à sa situation passe de Menacée à Préoccupante. Changer la désignation sous-entend étudier et éclaircir certaines des hypothèses et des incertitudes du Rapport de situation du COSEPAC, ou encore éliminer, réduire ou atténuer les menaces à la qualité de l'habitat évoquées par le COSEPAC en 2010 pour justifier la désignation Menacée. Quoi qu'il en soit, faire passer la désignation à Préoccupante ne signifie pas que des mesures de gestion ne sont pas requises.

Les menaces dont le naseux d'Umatilla fait l'objet dans la portion canadienne de sa répartition mondiale comprennent l'aménagement hydroélectrique, les changements sur le plan de l'écoulement attribuables à l'exploitation des barrages hydroélectriques, l'introduction d'espèces étrangères, le soutirage d'eau, l'extraction des ressources, l'utilisation des sols (agriculture, couloirs de transport, récolte du bois) et le suréchantillonnage. Les dommages admissibles causés au naseux d'Umatilla dans la rivière Similkameen, dans l'habitat limité de la rivière Kettle sous la chute Cascade et dans le fleuve Columbia, la rivière Kootenay et la rivière Slocan comprennent l'échantillonnage dans le but de mieux comprendre l'abondance, la répartition et l'utilisation de l'habitat des espèces, mais l'ensemble des dommages ne doit pas être plus important qu'il ne l'est aujourd'hui.

1 ABOUT THIS RECOVERY POTENTIAL ASSESSMENT

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. A RPA precedes a listing for a species or population under Species at Risk Act *SARA*, and assists the Minister in the listing decision. The RPA also contains information and technical advice on status, threats, habitat and abundance that can be used to develop recovery plans.

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 helps 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 or agreement.

Umatilla Dace (*Rhinichthys Umatilla)* was designated *Special Concern* by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) in 1988, and was included on Schedule 3 of SARA in 2004. In April 2010 the species was re-assessed as threatened by COSEWIC based on the limited area of occupancy, <10 locations, and the expected future loss of habitat or deterioration of habitat quality due to potential threats. Currently the species is red listed by the province of BC. The American Fisheries Society considers it to be “vulnerable.”

This RPA for Umatilla Dace was prepared according to revised guidelines that stress a species’ ability to recover from known human activities within the uncertainties posed by limited data (DFO 2007). As a risk assessment, the RPA reflects the data and information available. In the case of Umatilla Dace, where data on the species’ natural history, abundance, distribution, and habitat use are very limited, the RPA can only provide limited advice while noting specific information gaps that need to be filled. The knowledge base on this species consists of a few peer-reviewed papers and unpublished reports, and first-hand experience remains confined to a small number of experts in academia, government, industry and the consulting sector. Lack of specific Umatilla Dace knowledge requires us to consider related species such as speckled (*Rhinichthys osculatus*) and leopard dace (*Rhinichthys falcatus*). Uncertainties arising from this extremely limited knowledge base are noted throughout the RPA.

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2 CURRENT/RECENT SPECIES STATUS

2.1 SPECIES BIOLOGY

Dace are minnows belonging to the Order Cypriniformes, a large group that dominates the freshwater fish fauna 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. Umatilla Dace's species name is taken from the location of its first description, in Umatilla , Oregon (Hughes and Peden 1989).

2.1.1 Appearance

Adult Umatilla Dace are usually under 10 cm in fork length (Figure 1). The largest specimen reported in Canada had a fork length of 128 mm (Peden and Orchard 1993). Both sexes are marked with irregular blotches on the sides and back. Umatilla Dace coexists with leopard dace *R. falcatus* in the Columbia, Kootenay and Similkameen Rivers, and the two species are often confused. Umatilla Dace also coexists with speckled dace *R. osculus* in a short section of the Kettle River in British Columbia; in this case, however, the morphological differences are greater. McPhail (2007) details the distinguishing features (such as snout length, barbel and mouth position) of these three closely related species (see Taxonomy, below, for a discussion of this interrelatedness).

Adult females are generally larger than males. While neither sex develops the spawning tubercles that are seen in most *Rhinichthys* species, male and female Umatilla Dace can also be told apart by the different length of their pelvic fins (longer in males).

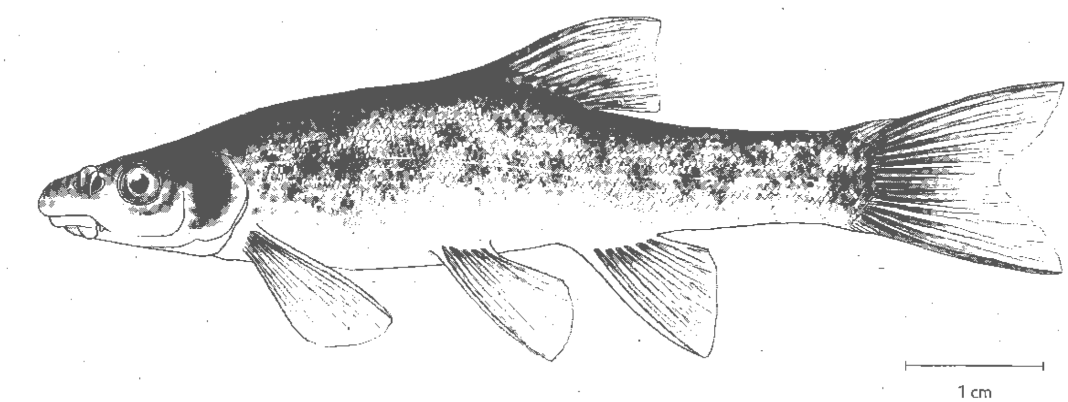

Figure 1. Umatilla Dace (illustration by D.L. McPhail, from McPhail 2007, used with permission from J.D. McPhail).

2.1.2 Life history

A habitat use and life history assessment related to threats posed by operations of the Hugh HLK Dam in the lower Columbia River is currently being performed under contract to BC Hydro (BC Hydro 2009); that study may provide more information on Umatilla Dace life history. McPhail (2007) draws on his personal observations, as well as R.L.and L. Environmental Services Ltd. (1995) and Peden and Orchard (1993) to conclude that Umatilla Dace spawn in mid-summer, with fecundity crudely estimated at up to 2,000 eggs per female. McPhail (2007) reported Umatilla Dace fry (about 10mm in length) were dip-netted along the margins of the Slocan River in early August and near-ripe females were found in early July, thus suggesting a July or early August emergence. If spawning can occur earlier is not known. Spawning sites and behaviour in the wild have not been observed, but some inferences may be drawn from limited laboratory spawning studies, in which the adhesive eggs hatched after six days (at 18 C); the resulting fry were around seven mm long. McPhail (2007) suggests these fry spend a week or so in gravel before emerging to feed on exogenous sources. After the first growing season in which most Umatilla Dace grow to less than 30 mm, males mature the following year, and likely spawn the year after that. Females mature a year later than males. It should be noted that the above conclusions regarding age structure and time of spawning require validation.

While data on life history of the Umatilla Dace are very limited, some inferences may be drawn from the slightly better-known speckled dace (Harvey 2007; Peden and Hughes 1981; 1988). Based on laboratory observations, reproductive behaviour in speckled dace is triggered by some combination of increased photoperiod and rising water temperature (Kaya 1991). The released adhesive eggs are scattered over cobble. Those that escape predation by falling into cracks hatch within a week and feeding larvae appear in the river in early August (again, application of these findings to Umatilla Dace is uncertain, especially when we do not know the time of spawning). Survival at the various life stages is unknown; this knowledge gap makes it hard to estimate recruitment and adds to the challenge of predicting allowable harm.

Scott and Crossman (1973) make the generalization that most dace species live three or four years; the oldest Umatilla Dace in its Canadian range was a female in its sixth summer (exact location not specified; McPhail 2007).

2.1.3 Food and feeding

The sparse data on food and feeding suggest that Umatilla Dace adults feed mainly on aquatic insect larvae, especially chironomids. Periphyton and detritus may also be consumed in winter. Adult dace sampled from the Columbia River appeared to consume a low diversity of food items, including Ephemeroptera, Chironomidae, periphyton and detritus (R.L. and L. 1995). Preliminary indications are that juvenile diet is similar to that of the adults.

2.1.4 Taxonomy and genetic characterization

Morphology of the Umatilla Dace, which is intermediate between that of speckled and leopard dace, implies that Umatilla Dace is the result of hybridization between the other two species. It is, however, considered to be a separate species (COSEWIC 2010). The arguments for separate species status are summarized by McPhail (2007). These arguments are: Umatilla Dace are morphologically different from speckled and leopard dace; there are significant mitochondrial-level differentiation at multiple cytochrome B sites; and there are many locations at which Umatilla Dace occurs with only one, or none, of its putative parent species (Haas 2001). While very likely originating from past hybridization between speckled and leopard dace, Umatilla Dace are able to persist on their own as self-perpetuating populations. Based on the relatively low amount of molecular differentiation from its parents, Umatilla Dace may have arisen quite recently, perhaps during the mid-Pleistocene (McPhail 2007).

COSEWIC (2010) summarizes the morphological, behavioural and biochemical arguments for considering Umatilla Dace a separate species, concurring that Umatilla Dace has arisen from repeated hybridization events, with mixed affinities to leopard and speckled dace depending on the population sampled. It is not known whether these multiple hybridization events have produced lineages of Umatilla Dace with differing adaptive qualities. Umatilla Dace satisfies criteria for species status based on reproductive isolation in sympatry (because they are not believed to breed with leopard or speckled dace).

Can Umatilla Dace be further subdivided into genetically distinct populations? It has been suggested that the Similkameen and Columbia populations were derived from different hybridization events (Haas 2001). McPhail (2007) also feels the limited molecular evidence supports such differentiation in Canada between Umatilla Dace in the Similkameen River and those in the mainstream Columbia. COSEWIC (2010) adds a third group (the Yakima River group) inhabiting tributaries of the Columbia River in Washington State. Adaptive characteristics of putative separate populations are unknown, but could differ. Because the molecular evidence for further differentiation remains limited, COSEWIC conservatively assessed the Umatilla Dace in Canada as a single population. However, the threats faced by Umatilla Dace throughout its Canadian range do vary by watershed and possibly by location (that is, not all current known locations of Umatilla Dace are subject to the same threats).

2.1.5 Community ecology and interactions with other species

The Canadian range of Umatilla Dace is shared with 25 other native fish species, of which 8 are considered rare or endangered (McPhail and Carveth 1994). Umatilla Dace's ecological interactions with these species are not well known, although the sparse data for speckled dace indicate competition with sculpins for riffle habitat in some California streams (Moyle 2002). Peden and Orchard (1993) suggest competition with other small benthic species such as sculpins and longnose dace. There are no available data addressing the question of whether such competition represents a limiting factor for populations of Umatilla Dace. Umatilla Dace are often recorded with longnose dace.

Like other small minnows, Umatilla Dace are probably an important link in aquatic and terrestrial food chains, as food for larger fish and birds (their adhesive eggs are another possible food source). Like speckled dace, Umatilla Dace are likely eaten by many piscivorous fish including northern pike minnow (Harvey 2007). While predation by native species may not be a limiting factor (Hughes and Peden 1989), predation and competition by introduced fish species needs to be considered (see Threats below).

2.2 RANGE, NUMBER OF POPULATIONS AND ABUNDANCE

The Umatilla Dace in Canada are found at the upper limits of their global distribution; the length of time they have occupied this area is unknown, nor is how their occupancy of this small area within their overall range, relates to adaptability. The Canadian distribution represents only 5% of the total global distribution (Figure 2). In Canada, the species' occurrence is limited to the Similkameen and Tulameen Rivers, the Columbia River below the HLK Dam, the Kootenay River below Bonnington Falls, the lower Slocan River, the lower Pend D'Oreille River, and the Kettle River below Cascade Falls (Figure 3). As COSEWIC (2010) points out, there have been no surveys for Umatilla Dace for some of the above watersheds within the past 20 years (around five generations); there is therefore great uncertainty about persistence of the species in some watersheds.

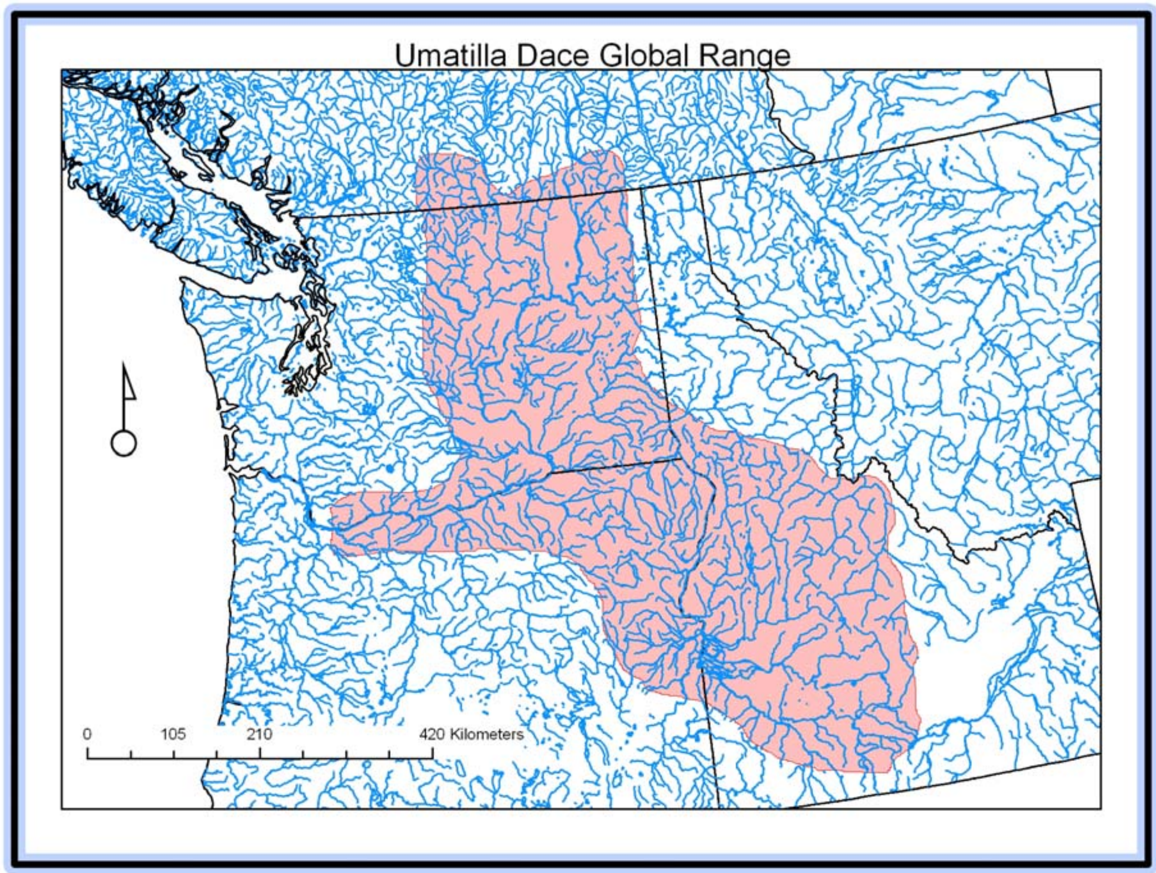

Figure 2. Global range of Umatilla Dace (based on COSEWIC 2010)

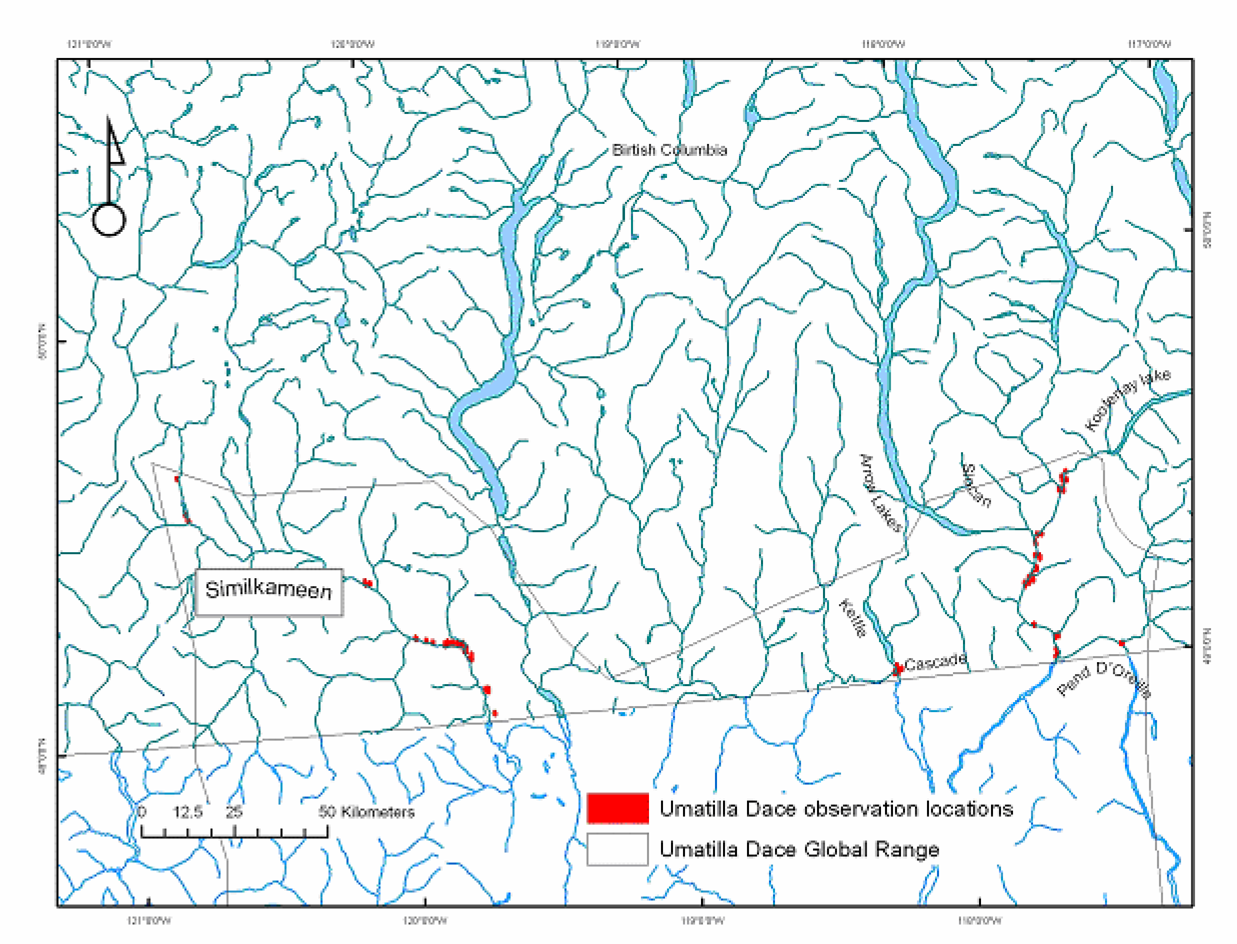

Figure 3. Known locations for Umatilla Dace in Canada

Within the species' Canadian distribution, the largest stretch of relatively unaltered habitat is found in the Similkameen River. Nevertheless, the species is relatively rare here, perhaps because the cooler waters of the mainstream Similkameen upstream of the Tulameen tributary limit its dispersal (Hughes and Peden 1989). The species appears to have been extirpated from several locations, including Otter Creek (a tributary of the Tulameen) and Otter Lake; it may also no longer exist in the Pend D'Oreille River. McPhail (2001) has suggested that scientific over-sampling may be at least partially responsible for the extirpation of Umatilla Dace in Otter Creek (cited in COSEWIC 2010).

Within this Canadian range, the number of genetically distinct populations of Umatilla Dace is unknown, as is the number of independent hybridization events. The degree of morphological and genetic variability between populations of Umatilla Dace has already been noted (see Taxonomy, above); further studies using DNA characterization methods are needed to reduce this uncertainty. New surveys could provide a better understanding of relative abundance and distribution.

2.2.1 <u>Abundance</u>

There is uncertainty concerning abundance of Umatilla Dace within its Canadian range. Presence/absence data and site counts obtained on *ad hoc* surveys are a poor substitute for designed sampling, because results are so easily influenced by sampling effort, the species may be nocturnal but has not been adequately sampled at night, and is difficult to differentiate from other dace species. Problems with identifying the species tend to compromise the few existing historic records. BC Hydro has trained consultants in dace species identification to address this problem for a number of studies in the Columbia River (G. Birch, BC Hydro, 2010, pers. comm.). It is worth noting that electro-shocking may underestimate abundance of adult dace regardless of depth, and adults have been observed by divers beyond electro-shocking depths (R.L. and L. 1995). Dace fry (10mm) are difficult to sample by electro-shocking. In general, the relative inefficacy of all sampling methods, combined with difficulties in identification, inability to adequately sample deeper habitats, and the reliance on daytime sampling, conspire to make estimates of Umatilla Dace abundance highly problematic.

COSEWIC (2010) notes that dace populations "do not appear" to have declined in the recent past (that is, they are considered to be stable) with the exception of Otter Creek (where they were presumed to be extirpated) and the Pend D'Oreille River (where only one Umatilla Dace was ever sampled). Umatilla Dace continue to be caught in most of the locations where they were historically caught. Nevertheless, their historic and current abundance is unknown but current abundance is presumed to be low, because few individuals are caught. This large uncertainty has important implications for decision-making regarding allowable harm.

2.2.2 Allowable Harm

Allowable harm to Umatilla Dace in Canada is based on the summary of abundance and trends drawn from COSEWIC (2010), which consolidates the available information by watershed, with Otter Creek considered extirpated and Pend d'Oreille likely extirpated. Abundance and habitat use data for the Lower Columbia, from the early 1990s to the present, have also recently been summarized (Golder Associates 2011a). A non-lethal survey to establish presence is required for both Otter Creek and the Pend d'Oreille River; for the latter, the search should be extended to the Salmo River. An estimation of distribution and abundance, based on verifiable metrics, is also required for all the systems. In all of the systems discussed below, allowable harm needs to include the scientific sampling required to fill important gaps in our knowledge of distribution, abundance and habitat use.

2.2.2.1 Similkameen River

There have been no targeted population counts for Umatilla Dace in the Similkameen River. Based on collections for the Royal B.C. Museum in the early 1990s, including one unpublished report from 2005, COSEWIC (2010) concluded that recruitment appears to have been successful because the species has repeatedly been caught in locations where it had previously been found, with the exception of Otter Creek. Sampling success appears to be affected by flow conditions. In contrast, a broad multi-species sampling survey summarized by Rosenfeld (1996) concluded the species was rare in the watershed, and McPhail (2007) considered the Similkameen form to be "in trouble." In view of this large uncertainty, allowable harm to Umatilla Dace in the Similkameen River should include scientific sampling for the purpose of further understanding abundance and habitat use of the species, but total harm should not increase beyond current levels.

2.2.2.2 Kettle River

There have been no targeted population counts for Umatilla Dace in the Kettle River. Royal B.C. Museum sampling surveys identified Umatilla Dace only in the short section of the Kettle downstream of Cascade Falls, where they coexist with the occasional speckled dace (Hughes and Peden 1989). The researchers concluded that the fish found in Canada were part of a much larger population to the south (the international border cuts the Kettle River several kilometers below Cascade Falls). There are no population estimates for this population and subsequent sampling north of the border failed to find Umatilla Dace (Haas 1998). In view of their apparently limited distribution, very low numbers, possible extirpation and possible recruitment from the south, the level of allowable harm is difficult to access. A new survey and population estimate are required. Allowable harm to Umatilla Dace in the limited habitat below Cascade Falls in the Kettle River should include scientific sampling for the purpose of further understanding abundance and habitat use of the species, but total harm should not increase beyond current levels.

2.2.2.3 Columbia, Kootenay and Slocan Rivers

There are few targeted population counts or estimates for Umatilla Dace in the Columbia, Kootenay and Slocan Rivers (here treated as a single group, but potentially separable according to the kind of threat to which they are exposed). What knowledge we have of their abundance comes from sampling related to environmental impact assessments for new hydroelectric facilities and water use plans for existing dams. The stretches of river below the Hugh L. Keenleyside Dam (HLK), (Columbia River) and the Brilliant Dam (Kootenay River) have consistently provided the highest densities of Umatilla Dace in their Canadian range (1.2 fish/m^2 and 1.3 fish/m^2 respectively; R.L. and L. 1995). While the numbers counted appear to be quite sensitive to sampling time and method (AMEC 2003), recruitment is occurring. Umatilla Dace were recorded in the lower Kootenay River during studies carried out for the Columbia Power Corporation between 1990 and 1994. They were not captured during 1997 investigations (R.L. and L. 1999), although this finding may simply reflect fluctuation in annual catch numbers rather than any long term decline (Golder Associates 2011a). The species has been observed in the Brilliant and South Slocan reservoirs (Hughes and Peden 1989), although later surveys failed to find any (R.L. and L. 1999), a recent survey by Golder Associates (2011a), has again found Umatilla Dace in the Slocan pool. The species has also been collected at various locations in the lower Slocan River. McPhail (2007) considered Umatilla Dace to be “locally abundant” in these three rivers.

In their summary of Umatilla Dace distributional data for the lower Columbia River between 1991 and 2009, Golder Associates (2011a) noted that, in most studies and in most locations, catches and CPUE were quite low (less than 50 individuals per site, and less than 2 fish/100m^2). Comparing CPUE for the various studies was not possible due to differences in sampling; methods, season, time of day, location, study objectives, and reporting methods. It was not possible to determine if distribution of Umatilla Dace has changed since the 1990s, and systematic studies of the lower Columbia using methods that optimize catch of Umatilla Dace have not been conducted for over eight years. While some limited inventory data suggest that Umatilla Dace could have declined in the Lower Columbia and Kootenay River between 1994 and 1997, several studies specific to the species suggest there is no declining trend. Data collected relative to stranding between 2001 and 2010 were not specifically directed to determine abundance and were not sufficiently rigorous to indicate any temporal trends in abundance.

Allowable harm to Umatilla Dace in the Columbia River system should include scientific sampling for the purpose of further understanding abundance and habitat use of the species, but total harm should not increase beyond current levels.

2.3 CURRENT OR RECENT LIFE HISTORY PARAMETERS

The ability of a species to maintain itself in a given environment is expressed by its "vital rates", which include things like sex ratio, fecundity, mortality at different life stages, growth rate and age at maturity. Knowledge of vital rates allows us to predict recruitment to the population, to establish a target population and to set conservation benchmarks. When we don't know vital rates, or when a species has an unknown capacity to adapt to a variety of environments—both of which may happen with the Umatilla Dace in Canada, especially in the light of its having been sampled in several hydroelectric reservoirs— predicting recruitment carries a high degree of uncertainty. All we have to go on is a rough idea of fecundity and age at maturity (see *Life history*, above). Survival at the various life stages is not known; this knowledge gap makes it hard to estimate recruitment and adds to the uncertainty of predicting allowable harm.

An example of predicting recruitment in a small freshwater minnow may be provided by recent work on mountain sucker *Catostomus platyrhynchus* (Belica and Nibbelink 2006), a species that appears to have a similar short age structure and a species that frequently coexists with Umatilla Dace (for example in the Similkameen and Tulameen Rivers). The main utility of the mountain sucker model was to help identify critical stages in the life history of mountain sucker, not to predict population viability or time to extinction. Survival through the first three years was found to be critical in sucker population dynamics, with first-year survival accounting for the overwhelming majority of sensitivity. A similar sensitivity to early survival in Umatilla Dace may be reflected in preliminary findings related to the species' vulnerability to stranding: because fry and early juveniles reside in shallower water, these stages might be expected to be vulnerable to stranding (R.L. and L. 1995), although it is not possible to determine whether avoidance or escape behaviours might reduce the susceptibility to stranding. Overall, the authors concluded that mountain sucker populations were quite tolerant of stochastic fluctuations in offspring production, but were vulnerable to variations in survival, especially before recruitment. These findings are cited as an example of an approach to risk planning, and cannot be assumed to apply automatically to Umatilla Dace.

2.4 HABITAT REQUIREMENTS AND USE PATTERNS

In 2010, COSEWIC designated Umatilla Dace as threatened based on the limited area of occupancy, < 10 locations, and the expected future loss of habitat. Thus, for designation purposes, habitat loss and decline in habitat quality is of more concern than the direct loss of individuals within the populations. Discussion of various scenarios and options for recovery of the species habitat (habitat improvement and removal of threats to habitat) is given in Section 2.1, "Probability that the recovery targets can be achieved."

Based on the limited information specific to Umatilla Dace plus knowledge from related species, feeding adults use glide portions of rivers with bank slopes less than 15%, with gravel-to-boulder substrate providing interstitial microhabitat refugia where water velocity is low. For reproduction, they use riffle areas associated with pools. Juveniles are found in shallower, near shore areas, including those with sand and silt substrate.

Data on habitat usage by Umatilla Dace are very limited. McPhail (2007) relied on his own personal observations, as well as reports from R.L.and L. Environmental Services Ltd. (R.L. and L. 1995) and Peden and Orchard (1993) to summarize what little was known. The following outline is based on McPhail's (2007) conclusions, supplemented by additional observations cited in COSEWIC (2010) as well as the life history literature review of sculpin and dace in the

Lower Columbia River compiled for BC Hydro by AMEC Earth and Environmental Ltd. (AMEC 2010).

In a study carried out by R.L. and L. (1995), Umatilla Dace were most often captured over substrates with large gravels to boulders; although mean water velocity might vary widely, they used micro-habitats with low velocities of 0-5 cm/sec; that is, they selected the slow-water refugia within faster-flowing stream sections. Umatilla Dace were most often found at bank slopes of 6-15%. Larger juveniles and adults may utilize cover provided by rocks and aquatic vegetation.

Umatilla Dace were often recorded at the same sites as longnose dace, although they were less common in shallow areas in winter and spring, when most occurrences were of young of the year and juvenile life stages. In summer and fall, older (larger) fish can be sampled in shallow areas, but the lack of larger individuals obtained from sampling studies in the Kootenay River suggest the older individuals move into deeper water habitat for feeding and holding in the winter. Because non-destructive sampling in deeper areas is near-impossible, the usage of deeper, swifter water by older age-classes (larger fish) can only be inferred. A diurnal cycle, in which Umatilla Dace move to deeper water at night, has been suggested (R.L. and L. 1995). Partitioning between shallow and deeper areas is another data gap that needs to be addressed in field studies.

In a survey of fish species composition and habitat use below the Brilliant Dam, R.L. and L. (1999) identified a number of specific areas they referred to as “critical habitats” based on their identified or potential importance for a variety of fish life history requisites (the term “critical habitats” is not used in the SARA sense here). These areas, some of which are considered important to Umatilla Dace, include channel margins along both banks and shoal areas. Particularly important shoal areas, where spawning by some species has been documented include; the north bank immediately downstream of the Highway 3A bridge, the south bank adjacent to the upstream end of the oxbow meander channel (south bank shoal), and directly north of the oxbow island.

2.4.1 <u>Adult habitat</u>

Based on anecdotal information from the mainstream Columbia River, adult Umatilla Dace appear to shelter between rocks that make up a cobble and boulder substrate in glide portions of the river where mean water velocities are above 0.5 m/s; velocity is likely much lower in sheltered areas between the rocks (R.L. and L. 1995). Similar findings come from snorkel surveys in the Similkameen, with adult dace found to a depth of about 1m. There is some evidence that the current velocity preference of Umatilla Dace is somewhere between that of leopard dace (which are found in higher velocities) and speckled dace (lower velocities; Haas 1991). The inability to sample deeper water habitats and lack of night sampling represents a major knowledge gap and increases uncertainty about habitat use.

Temperature use may cover a rather wide range, with Peden and Orchard (1993) reporting occurrence in waters of surface temperature from 8-21 C. Over-wintering in rivers that freeze over, such as the Kettle and Slocan, clearly implies considerable temperature tolerance (COSEWIC 2010).

Similar observations have been made for the better-studied speckled dace, about which more is known concerning depth selection, over-wintering and use of side-channel habitat. For Umatilla Dace, these observations yield only speculative and preliminary spatial and temporal information on the functional interaction of Umatilla Dace with their habitat. As has already been mentioned, recordings of adult dace in reservoirs suggest that these fish may be flexible in their use of very different habitat types. They may be able to persist despite quite profound changes in water flow, temperature and substrate. Temperature limitations on distribution, for example, need to be demonstrated rather than simply inferred. More data are required to help reduce this uncertainty regarding habitat use in reservoirs. Peden (1991), in a report to COSEWIC on the status of leopard dace *R. falcatus* in Canada, mentions the occurrence of both leopard and Umatilla Dace in the Kootenay River reservoir between the Brilliant and South Slocan dams (Brilliant Reservoir). He notes that the numbers appear to be low (based on sampling effort), and occurrence may be confined to upper reaches where there is some water flow as a result of frequent discharges for electricity generation. At this point it is not possible to judge whether populations of dace exist in reservoirs or, if they do, whether individuals in reservoirs contribute significantly to persistence of the species.

The significant data gaps for adult habitat use, especially for partitioning between near shore and deeper areas and night-time movements, need to be addressed in targeted field studies.

2.4.2 Spawning habitat

While actual spawning has not been described in the literature, several authors suggest that Umatilla Dace may seek out riffle areas near pools for spawning, during which adhesive eggs are broadcast over gravel or cobble. Since spawning has never been observed in the wild, and may well occur in habitats that have been insufficiently sampled for the species, especially in deeper waters, this presents a large knowledge gap. Spawning in the systems that support Umatilla Dace in Canada probably begins in July (McPhail 2007).

2.4.3 Juveniles (less than one year of age)

Limited observations in the mainstream Columbia River indicate that, like speckled dace, juvenile Umatilla Dace shelter in near shore areas during summer, then shift to deeper, adult habitat with the coming winter (McPhail 2007). There are some similarities in the Slocan River habitats studied, where juveniles sought shelter during freshet (higher water flow) periods, often in flooded vegetation; when flow dropped, these juveniles adopted a position similar to adults but closer to shore. Because fry (post-hatch pelagic stage) and early juveniles appear to use shallower water, these stages would be expected to be most vulnerable to stranding (R.L. and L. 1995).

2.4.4 Young of the year (fry)

In the Slocan River, Umatilla Dace fry have been sampled in still, shallow sections of the river over a sand or silt substrate (McPhail 2007). Sampling through August revealed a gradual move toward deeper water for daytime foraging near rock and cobble substrate. In the Columbia River, the use by young of the year of shallow near shore waters appeared to be irrespective of season.

Large data gaps exist in characterization of all young of year and juvenile habitat. Their capture in areas with sand or silt substrate needs to be confirmed and quantified. Trends in habitat that could influence population survival, where they are known, are included in *Threats* (below).

2.5 POTENTIAL CRITICAL HABITAT

The occurrence data for Umatilla Dace are limited to a small number of collection sites (COSEWIC 2010), reflect different collection methods, indicate presence and not necessarily absence, and are complicated by difficulties with species identification. This leads to considerable uncertainty in describing overall distribution and specific habitat requirements of Umatilla Dace, and limits our ability to delineate potential critical habitat.

A general description of Umatilla Dace habitat was given by Haas (2001), who described it as riverine, higher velocity and silt free water, with coarse gravel, cobble, and boulder substrates. Although Umatilla Dace exhibit diurnal and seasonal habitat shifts and move from near-shore areas to faster, deeper waters as they grow (COSEWIC 2010), the requirement for coarse habitats with interstitial spaces between the rocks may limit their distribution and abundance and may be considered as important for survival and recovery. Potential critical habitats could thus be described as those riverine habitats with the above physical characteristics bordering confirmed Umatilla Dace sites.

2.6 POPULATION AND DISTRIBUTION TARGETS FOR RECOVERY

There is a complete lack of population census data for Umatilla Dace in Canada. Much of their habitat has not been surveyed. Preliminary trends in abundance, if indeed there are any, are qualitative and the variety of sampling methods and the conditions under which they have been used guarantee that any such trends are suspect. While at least two populations appear to have been extirpated, setting a target for those that remain is impossible. An alternative strategy, which has been employed for other fish species where there are severe data gaps, is to establish a target for maintaining the species in its known distribution. Unfortunately, the concept of a distribution target for Umatilla Dace is equally elusive, as most authors regard the species' "known distribution" as patchy and highly influenced by sampling effort. We don't know whether distribution is in fact patchy or not.

In the light of such significant uncertainties, setting "recovery targets" is impossible. The next logical step is to fill data gaps, starting with annual sampling using consistently applied methods in enough locations to provide an idea of recent population trajectories.

2.7 RESIDENCE REQUIREMENTS

In SARA, residence is defined as "the specific dwelling place, such as a den, nest or other similar area or a place that is occupied or habitually occupied by one or more individuals during all or part of their life cycles, including breeding, rearing, staging, wintering, feeding, or hibernating."

Umatilla Dace are assumed to be broadcast spawners whose adhesive eggs are not guarded. Thus, at first glance it appears the Umatilla Dace does not require a residence. However, *speckled* dace spawning may include preparation of a nest site by males (Harvey 2007). If such site preparation occurs for the closely related Umatilla Dace, it implies a residence requirement for spawning and perhaps during larval development as well. Clearly, more research is required before the issue of residence requirements can be addressed.

3 SCOPE FOR MANAGEMENT TO FACILITATE RECOVERY

The minimum level at which we would consider the population to be recovered is when its risk assessment status changes from Threatened to Special Concern. Such a change would require new knowledge that alters the assumptions and uncertainties within the COSEWIC report, or the elimination, reduction or mitigation of potential threats to habitat quality that were given as reasons for the threatened designation by COSEWIC (2010). Downgrading to Special Concern does not, however, mean that management actions are not required.

3.1 PROBABILITY THAT THE RECOVERY TARGETS CAN BE ACHIEVED

Given the large gaps in our knowledge of Umatilla Dace habitat use, distribution, and a complete absence of census data and population estimates, quantitative recovery targets cannot be established and the extent to which risk is amplified by potential stochastic catastrophes is unknown. There is also a degree of uncertainty within the COSEWIC (2010) status report as to the projected decline rate of habitat quality and number of existing locations. Recovery will require maintaining current abundance, distribution and locations of the existing populations but will also require addressing the uncertainties as to the number of locations, projected rate of habitat loss, projected rate of decline in habitat quality, and qualification of habitat threats.

In 1988, prior to the enactment of SARA, COSEWIC designated Umatilla Dace as special concern. In 2010, Umatilla Dace was reassessed as threatened (COSEWIC 2010). It is reasonable to consider the reasons for the current assessment and ask what has changed since the first assessment. Umatilla Dace were assessed as threatened in 2010 due to their limited total extent of occurrence in Canada (12,400 km^2), presence at only six locations (<10 locations), and the projected decline in quality of habitat (projected to decline over 50% of their range; COSEWIC 2010).

Even if no actions are taken prior to the next assessment, substrate habitat quality may continue to improve within the 18 km of the Columbia River below Trail. Although chemical waste continues to be introduced, industrial slag ceased being deposited in this river section in 1995; as the deposited slag slowly erodes and dissipates downstream Umatilla Dace habitat should improve within this section. Also, if there is a cessation of the Shanker's Bend high dam option (intense public pressure would make this option highly unlikely) a major threat to the Similkameen River would be removed and 24 km of river would no longer be considered to be at risk. However, in spite of these two considerations it is possible that Umatilla Dace would remain at risk (threatened) as the other threats would continue.

In order to examine the assumptions made in COSEWIC, a comprehensive survey is required to establish the number of existing dace locations throughout the dace range but especially; in tributaries to the Similkameen River, smaller watercourses entering the main Columbia, Salmo River, reservoirs and systems above the dams, and the Kettle River below Cascade falls. Comprehensive surveys for a similar species (speckled dace) have found much larger numbers of dace over an expanded range than previously thought (M. Bradford, DFO, 2010, pers. comm.). If, for example, surveys establish that Umatilla Dace populations exist in some of the Similkameen tributaries and that these populations would respond independently from the threat of low flow conditions in the main river, then the number of locations could increase to ten or more. Based on COSEWIC assessment criteria, this would change the risk status to special concern. Also it is important to identify and estimate the uncertainties around the threats and levels of future habitat loss.

The reduction or mitigation of the threats outlined below in this report should improve the status of Umatilla Dace and other at-risk species. Threat reduction is watershed-specific. The reduction or mitigation of these threats may have associated economic and social costs.

August-September water levels in the Similkameen River may continue to decline due to withdrawals and climatic changes. Total annual water yield has not declined, but late summer discharge has. Small scale water storage options that augment low flows may be possible. Augmented late summer flows may actually increase available habitat or improve habitat quality of existing habitat.

The permanent removal of invasive fish, especially northern pike, walleye and bass is viewed as impossible. However, all the introduced fish species have a high recreational fishery value and it might be possible to increase fishing pressure on these fish. A reduction in the number of predators could reduce their impact on dace and sculpins and thus improve the quality of certain habitats. However, the continued recreational catch of these species also has a social and economic value.

Ramping of flows refers specifically to the rate of change of discharge rather than to the actual volume of water discharged. Ramping is a function of flow management to meet hydroelectric generation requirements contained in domestic and international agreements; changes in flow management may be expected to have socio-economic consequences. Ramping was considered by COSEWIC (2010) to be a threat to Umatilla Dace in the Columbia River. Some aspects of ramping or rapid changes in flow rate may be mitigated in the Columbia and Kootenay Rivers (ramping rates can be altered and known stranding sites might be contoured); this could reduce the suspected harmful impacts. Research is ongoing and the results from that research may provide some future options. Golder Associates (2011a;b) and Golder Associates Ltd. and Poisson Consulting Ltd. (2010) provided evidence for the relative health of the Umatilla Dace population(s) in the Columbia River. Although stranded fish (including larval fish) were found mainly in pools, they did not find significant stranding relative to ramping rates for natural channel areas.

3.2 MAGNITUDE OF EACH MAJOR POTENTIAL SOURCE OF MORTALITY

The list of threats that follows is intended to be specific to the species' occurrence in Canada, rather than a generic listing of potential threats to aquatic species such as "industrial development" or "climate change". Population sensitivity models for mountain sucker, have shown that anthropogenic impacts that reduce survival in the first three years may be the biggest concern. The reason for the present Threatened designation is continued habitat loss projected into the future.

The lack of census data means that different authors have reached different conclusions; these conclusions vary by watershed. McPhail (2007) considered some populations of Umatilla Dace to be 'vulnerable' as a result of 'spotty distribution, relatively low abundance, and range fragmentation.' He felt the Similkameen population was "in trouble." COSEWIC (2010) as well as McPhail (2007) suggested that recruitment "appears to have been successful" and that Columbia and Kootenay populations are stable.

The Columbia River Integrated Environmental Monitoring Program (CRIEMP) is a multi-stakeholder group formed in 1991 to assess the status of ecological health of the Canadian portion of the Columbia River between HLK Dam and the US border. Periodic CRIEMP reports provide a valuable episodic look at many of the threats discussed in this RPA, including hydroelectric development, resource extraction and agriculture, and include reference to relevant environmental monitoring programs. Water quality issues in the same geographic region are discussed by Hatfield Consultants (2008).

3.2.1 Threat 1: Hydroelectric development and dams

3.2.1.1 Columbia, Kootenay and Pend d'Oreille Rivers Dams

Dam and powerhouse location and operations

Dam construction within the Columbia basin has been extensive, but new dams have not been built since the 1980s. A number of alterations to existing structures, including new generation facilities, have occurred or are proposed (Table 1). These changes are designed to utilize water which currently does not generate electricity, and may improve downstream water quality (i.e., reduce gas supersaturation levels in the lower Kootenay and Pend d'Oreille rivers). Expansions and upgrades have generally undergone environmental reviews under the Canadian Environmental Assessment Act.

The Columbia Power Corporation (CPC) and Columbia Basin Trust (CBT) collectively purchased Brilliant Dam from Teck Cominco Ltd. in 1996, and have been responsible for expansion of the dam's generating capacity (which was completed in 2007). Another CPC/CBT Joint Venture is also responsible for construction of the Arrow Lakes Generating Station that now provides power from water stored behind upstream Columbia River Treaty dams at Mica and Keenleyside.

Table 1. Dams in the Canadian range of Umatilla Dace.

River	Dam	Built	Modified	Owner
Columbia	Keenleyside	1968		BC Hydro
	Arrow Lakes Generating Station	2002		CPC/CBT
Kootenay	Brilliant	1940s	Expanded 2007	CPC/CBT
	Upper Bonnington (1)	1907	Various, to 1995	City of Nelson
	Upper Bonnington (2)	1907	Various, to 1938	Fortis BC
	Lower Bonnington	1898	1924	Fortis BC
	Corra Linn	1932		Fortis BC
	S. Slocan	1928		Fortis BC
	Kootenay Canal	1976		BC Hydro
Pend d'Oreille	Waneta	1954	CPC Expansion in planning stage	TRL/BC Hydro
	Seven Mile	1979	Upgraded 2006	BC Hydro
Kettle	Cascade	1901	Removed 1922; new dam approved	Sea Breeze Power Corp.

CPC = Columbia Power Corporation; CBT = Columbia Basin Trust; TRL = Teck Resources Ltd

River regulation on the Columbia and Kootenay rivers is extensive. The HLK and Brilliant dams are major developments on the Canadian side of the Columbia watershed (Figure 4; Table 1) that coincide with Umatilla Dace habitat. HLK was constructed as a Columbia River Treaty storage dam, and had no powerhouse until construction of the Arrow Lakes Generating Station (ALGS) in 2002, upstream of the confluence of the Columbia and Kootenay rivers (near Castlegar). The Brilliant Expansion Project became operational in 2007 (Columbia Power Corporation 2010a), five years after CPC initiated electrical generation at ALGS. Other dams in the Kootenay River are likely to have altered dace habitat, directly or indirectly (one of these structures, the Lower Bonnington Dam, marks the likely historic upstream extent of dace distribution). The four dams upstream of the Brilliant Dam are Corra Linn, Upper Bonnington, Lower Bonnington, and South Slocan. The Kootenay Canal, built parallel to the concentration of Kootenay River Dams, diverts water along a 5 km canal to four penstocks that carry the water to four generating units, while a minimum discharge (5,000 cfs) continues to be released down the old river channel. The head-works of the canal are located on the south end of the Corra Linn Dam.

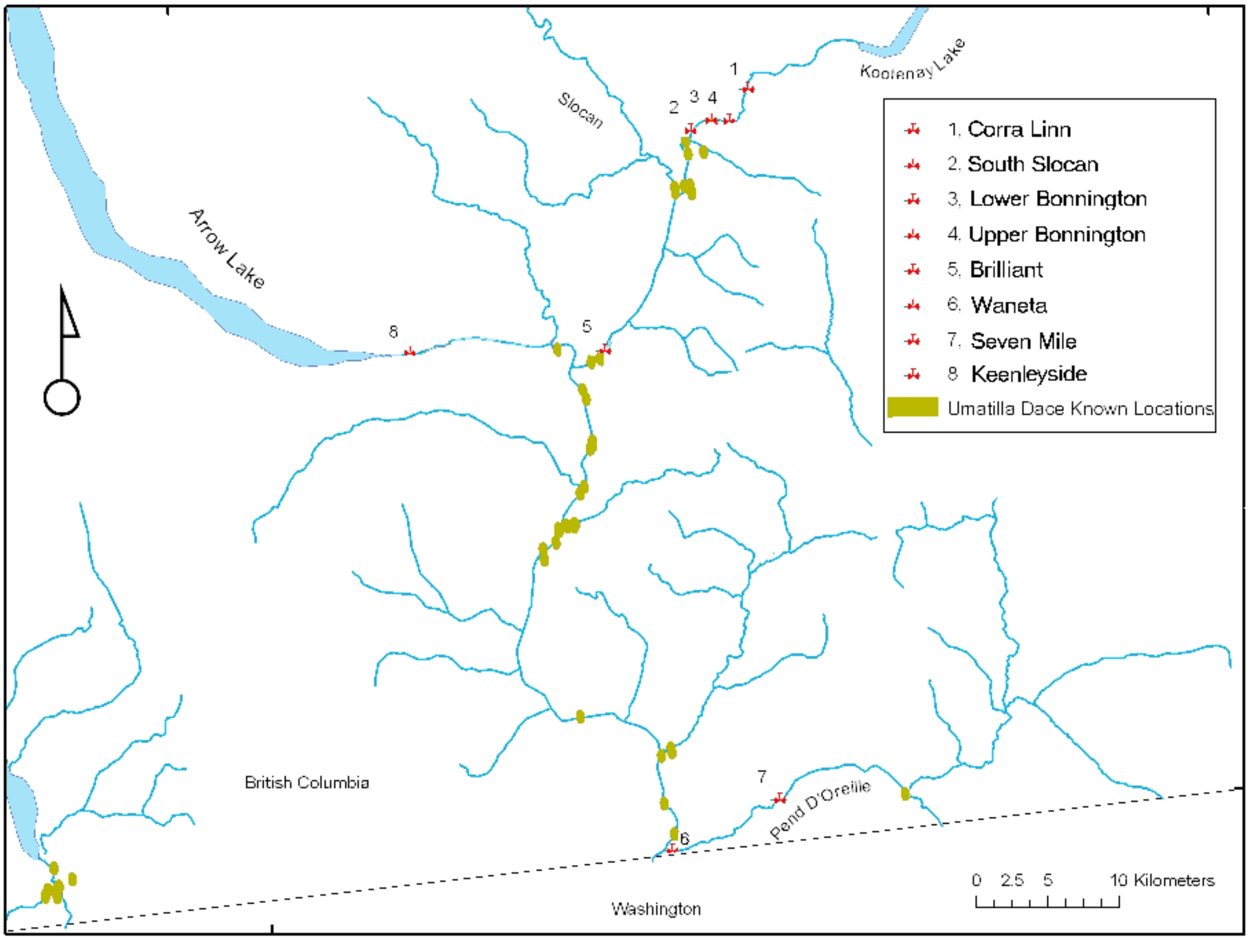

Figure 4. Known locations of Umatilla Dace in relation to hydroelectric dams (Courtesy Sean MacConnachie)

Treaties and agreements

Under the Columbia River Treaty (CRT), Canada and the U.S. jointly regulate and manage the Columbia River as it flows from Canada into the U.S. Water management priorities under the CRT include flood control and power generation, although other interests are also considered and acted upon if and when the parties agree. Because storage space is available in Canada in excess of the 15.5 million acre feet controlled by the CRT, BC Hydro and the Bonneville Power Administration (BPA) have also entered into a Non-Treaty Storage Agreement (NTSA) to provide further coordination benefits above and beyond those provided by the CRT. The NTSA is less prescriptive (more flexible) than the CRT, but mutual agreement is also required. The NTSA is currently scheduled to expire in June 2011. A renewed NTSA agreement is expected to be delivered in October 2011.

Due to the number of hydroelectric facility owners in the Canadian portion of the basin, a further coordination agreement was developed to manage water flows in the Canadian sections of the Kootenay and Pend D'Oreille Rivers (the Canal Plant Agreement, CPA).

A Water Use Plan (WUP) for BC Hydro's Columbia River facilities was made a requirement of a conditional water license by the BC Comptroller of Water Rights in 2007. WUPs were designed to help clarify how rights to provincial water resources should be exercised and to re-align water management with current public values. Under the Columbia WUP, additional operating constraints were ordered that impose regulatory obligations to manage flows over and above the requirements in the CRT and the CPA.

Responsibility for environmental consideration under the CRT rests with the Canadian and US entities. Environmental strategies can be incorporated into the Detailed Operating Plans that are developed each year, and other supplemental operating agreements, when mutually agreed by the parties. Since altering flow regimes for single species may have unknown consequences for other species, agreement can be difficult to obtain. It is not in the scope of this document to address multiple species needs relative to seasonal flows. Nevertheless, where mutual benefits are clearly provided, such environmental flow agreements have been negotiated.

Supplemental operating agreements have been made on an annual basis for rainbow trout, where releases are maintained at levels that protect redds and alevins until July, and for mountain whitefish, where spawning flow control is provided during winter. In addition, and in partnership with federal and provincial regulatory agencies (under agreements such as the WUP), BC Hydro has also agreed to undertake measures to benefit species at risk, including culture, monitoring, research and mitigative pilot projects for white sturgeon, as well as studies assessing shallow water habitat use by dace and sculpins.

In general, treaties and agreements tend to limit Canada's operational flexibility to change flow regimes to address environmental concerns for species such as Umatilla Dace. Achieving SARA compliance for existing facilities thus presents unique challenges for both industry and government because mitigation options are already limited. Such actions as shutting down facilities or altering existing flow regimes may be technically difficult or economically unfeasible; they may also run counter to an international treaty and/or other long-standing legal agreements and regulatory obligations.

Kinds of effects

Assessing the risk of hydroelectric development for Umatilla Dace is made exceptionally difficult by two things: the almost total lack of reliable census data and the apparent persistence of the species in locations downstream of major facilities that have been operating for many decades. Does the continued persistence of the species mean it is not especially sensitive to habitat changes of the kind caused by hydro development?

In general, dams cause major alterations to freshwater habitat and have many environmental effects on fish (Baer 2007; Burt and Mundie 1986). Actual conditions at any given dam however, vary from situations where several impacts are found to those where few or no significant impacts are observed. For a river-dwelling species like Umatilla Dace, hydroelectric facilities are most likely to affect populations through impoundment (reservoir formation), habitat fragmentation (where a river is broken up into isolated sections), changes in water temperature, changes in water quality (gas supersaturation and turbidity conditions) and changes in seasonal hydrograph.

Habitat related changes have been associated with dams and river regulation on the Columbia, Kootenay and Pend D'Oreille Rivers. A COSEWIC status report on the leopard dace noted the significant effects on the Kootenay and Arrow Lakes populations caused by dam construction and operation (Peden 1991) before the addition of the Arrow Lakes Generating Station and the Brilliant Dam expansion. COSEWIC (2010) reported that approximately 41% of the stream length containing Umatilla Dace habitat in the Kootenay and Pend D'Oreille Rivers had been altered by hydroelectric development (S. Pollard, unpublished data).

Impoundment effects
A dramatic reduction in abundance may have historically occurred when dams changed lotic (riverine) to lentic habitats (reservoirs) within the range of Umatilla Dace. Water levels with reservoirs created by impoundment may either fluctuate or remain relatively stable. The report of Umatilla Dace by Hughes and Peden (1989) in the Brilliant Dam reservoir (which fluctuates only slightly), does suggest that the species may have some capability to persist despite major changes in habitat. Follow-up studies are needed to verify Umatilla Dace persistence in the Brilliant Reservoir.

There is no evidence of Umatilla Dace upstream of the HLK dam, based on BC Hydro studies to date (G. Birch, BC Hydro, 2010, pers. comm.). Since impoundment, the natural habitat below the HLK Dam has changed, although not as much as the sections above the dams. The area immediately downstream of the HLK Dam is naturally impounded by the gravel bar at the mouth of Norn's Creek (7.5 km downstream) and creates a lake-like habitat which is probably not used by dace. However, a Umatilla Dace was recently captured near the HLK Dam, in fast-flowing water, directly downstream of the Arrow Lakes Generating Station, along riprap placed there by Columbia Power Corporation (G. Birch, BC Hydro, 2010, pers. comm.).

Hydrograph and water quality effects
Changes in the hydrograph resulting from daily operations at HLK, Brilliant, and other dams upstream of the confluence of the Columbia and Kootenay Rivers have been recognized as a possible threat to spawning and egg survival of flow-dependent species downstream (McPhail 2001). Relatively sudden flow changes may also strand adult and juvenile fish along the river margins (COSEWIC 2010). Stranding may result in increased risks from predation or possible desiccation as individuals become trapped within interstitial spaces and drying water pockets. A recent study of the effects of flow changes on fish downstream of the HLK and Brilliant facilities found that Umatilla Dace were at risk of stranding due to night-time low flows in winter and early spring. Exposure of penned fish to low flows for more than five hours increased mortality significantly (Golder Associates Ltd. 2005). The authors of this study noted that most of the stranded fish were young; if populations of Umatilla Dace are susceptible to mortality as young fish and juvenile recruitment limits the population, stranding of this age group would represent a major threat to the species.

COSEWIC (2010) considered stranding a threat to Umatilla Dace downstream of hydro facilities on the Columbia and Kootenay Rivers, and provided additional details on the effects of multiple discharge schedules at the different facilities. BC Hydro currently operates HLK according to preferred time of day and ramping rates to limit the risk of stranding. BC Hydro also coordinates, whenever possible, the timing of flow changes in the Kootenay and Columbia systems with CPC, FortisBC, USACE and BPA to mitigate the risk of stranding (Maureen DeHaan, BC Hydro, 2010, pers. comm.). Via the annual operating agreements, discharges are designed to maintain water levels that facilitate rainbow trout egg and fry survival in shallow habitats and protect trout spawning sites at Norn's Creek fan, the lower Kootenay, and downstream areas of the Columbia. Discharges are designed to maintain water levels that facilitate rainbow trout egg and fry survival in shallow habitats and protect trout spawning sites at Norn's Creek fan, the lower Kootenay, and downstream areas of the Columbia. If Umatilla Dace spawn in similar habitat and emerge prior to July 1, the eggs would be protected by flow levels designed to protect rainbow trout. Studies on dace life history are required to verify dace spawning location, timing and emergence risk relative to discharge regimes and related water levels.

The altered hydrology of a regulated river could benefit Umatilla Dace by increasing flow during the low flow months, could potentially reduce some of the negative consequences of climatic change on flows and water temperature, and might reduce the impact of extreme precipitation events. For example, when the CRT dams were first installed, they tended to delay warming and cooling trends. In the lower Canadian portion of the Columbia basin, weather conditions appear to have been changing in the last century. In addition to higher temperatures, winters are warming faster, total precipitation has increased, and while maximum snowpack has remained relatively unchanged, snow melt now tends to occur earlier. Consequently, winters are shorter and milder and winter rain events are more common. Regulated water releases can moderate conditions by providing stored flows to the system and a more stabilized water regime. Currently, water temperatures upstream of the Revelstoke dam are cooler in summer and warmer in fall and winter when compared to pre-impoundment (McAdam 2001). Temperatures below the HLK dam are now approximately 2 to 3°C warmer from May through September (Hamblin and McAdam 2003).

Conditions downstream of the HLK and Brilliant dams appear suitable for aquatic life, in part because temperature in the lower Columbia does not appear to have increased significantly following CRT dam construction, and dissolved gas issues have improved. However, there are no population abundance data; it is thus impossible to establish risk levels. The risk-averse course is to collect abundance data where this is technically feasible, assess the effects of water release fluctuations caused by dam operations on the Columbia and Kootenay Rivers, and monitor other ecosystem impacts (COSEWIC 2010).

Effects of past dam construction on Umatilla Dace within the Pend d'Oreille River are hard to verify. While the conversion of much of this Columbia tributary to reservoir conditions has likely had serious impacts on Umatilla Dace habitat, a lack of pre- and post impoundment surveys makes it difficult to draw any conclusions. Columbia Power Corporation's expansion of Waneta Dam (a major development on the Canadian side), in which a second (downstream) generating facility would be added to the original one, has received approval (Columbia Power Corporation 2010b). There may be a beneficial effect: the Waneta expansion project will reroute water currently spilled at Waneta dam, and thereby reduce gas supersaturation during part of the year (Environmental Assessment Office 2007).

3.2.1.2 Shanker's Bend dam proposal

A proposed hydroelectric development on the U.S. side of the Similkameen River poses a significant threat to Umatilla Dace. The Okanogan County Public Utilities District has applied to U.S. regulators to build a dam at Shanker's Bend on the U.S. portion of the Similkameen River. Three configurations (dam heights) have been proposed. The lowest dam will flood an area just upstream of the dam, the second floods to the Canadian border, and the third floods over 24km of the Similkameen valley in British Columbia. This third option would flood most of the known Umatilla Dace habitat in the Canadian portion of the Similkameen River (the other two options would affect dace habitat below the international border). This would convert known Umatilla Dace riverine habitat into a reservoir. Due to the considerable alteration of the Similkameen River and flooding of both private and native lands in British Columbia, the high dam option may be considered the least likely to be permitted. However, the consequences (loss of Umatilla habitat) would be great. The province of B.C. has not applied for intervener status.

The Smillkameen and Kettle Rivers are managed by the International Joint Commission, which manages boundary waters "for the benefit of today's citizens and future generations" (http://www.ijc.org/en/background/ijc_cmi_nature.htm). Project approvals by this agency might be expected to give economic considerations more weight than environmental concerns. The International Columbia River Board of Control is a two-person board.

3.2.1.3 IPP projects

There exists the potential for independent power production (IPP) projects in a number of streams within the range of Umatilla Dace (COSEWIC 2010). As of June 2008, applications for IPP projects have been received for two locations (Similkameen River south of Princeton, and the mainstream Columbia River), and approved at three others (Kettle, Pend d'Oreille and Lower Kootenay Rivers; IPP Watch 2010). An IPP has been proposed for Koch Creek, a tributary of the Slocan River (B. Ferguson, DFO, 2010, pers. comm.).

The facility on the Kettle River (Cascade) is most likely to affect speckled dace upstream of Cascade falls, rather than Umatilla Dace; management of the risk to speckled dace has been discussed in Harvey (2007). As the area of occupancy below Cascade falls is very limited, changes upstream could influence habitat downstream. Any Umatilla Dace in the short portion of the river below the IPP facility and the international border are believed to be dependent on emigration from south of the border (Hughes and Peden 1988), suggesting that maintenance of their US habitat is important.

The Similkameen River project at Princeton was originally for a coal fired system that would draw water from the upper Similkameen River. Any additional water withdrawals from the Similkameen could exacerbate existing seasonal low flow conditions. The proponent, Compliance Energy Corporation (CEC), is considering converting its 56-megawatt Princeton power project to a 100% wood fuel mixture, which would make it eligible as Clean Electricity under current B.C. government guidelines (http://www.airwaterland.ca/article.asp?id=5256).

3.2.2 Threat 2: Alien species

The high prevalence of exotic (introduced) fish species in the Columbia River drainage has been noted by several authors (Taylor 2004; Runciman and Leaf 2009). Alien invasive species have the potential to alter native biodiversity and stress or eliminate native species, including those at risk. Alien invasive species have been described as one of the most prevalent threats for Canadian at-risk freshwater fish (Dextrase and Mandrak 2008).

McPhail and Carveth (1994) listed 43 fish species in Canada's portion of the upper Columbia watershed. Of these, 27 fish were native. Many exotics not yet present in Canada have been identified in the lower/mid Columbia basin. These include over 20 water-related vascular plants, 13 non-native fish species, 35 invertebrates, 2 turtles, 1 frog, and 1 mammal (Systsma et al 2004). Although many of these exotics are found only in the lower Columbia River and multiple dams do limit upstream migrations; each species has the potential to be introduced above the dams and move north into the Canadian portion of the basin that is currently occupied by Umatilla Dace.

Of the 16 non-native fish introductions, 14 fish as well as 1 shrimp have been confirmed to occupy drainages within the current range of Umatilla Dace (Table 2). Two invasive fish are outside Umatilla Dace's known distribution: a single bluegill sunfish (*Lepomisi macrochirus*) was caught in Osoyoos Lake and arctic grayling (*Thymallus arcticus*) are found in the Flathead River. While brown trout is included in the table, it is believed to be rare in the Kettle system (S. Matthews, DFO, 2010, pers. comm.).

Table 2. Alien invasive fish and crustacean species within the range of Umatilla Dace in the Canadian portion of the Columbia River basin (from McPhail 2007; Runciman and Leaf 2009)

SPECIES	HABITAT	STATUS	DISTRIBUTION
Opossum Shrimp - *Mysis relicta*	Lacustrine-pelagic/ River	Abundant	Allison, Kootenay, Christina Lake, Columbia
Walleye - *Sander vitreus*	Lake/River	Common	Columbia, Pend d'Oreille
Largemouth Bass - *Micropterus salmonides*	Lake/River	Common	Columbia and Kootenay
Smallmouth Bass - *Micropterus dolomieu*	Lake/River	Common	Kettle R., Christina Creek, Pend d'Oreille, Columbia R, Kootenay R.
Black Crappie - *Pomoxis nigromaculatus*	Lake/sluggish stream	Common	Pend d'Oreille (reservoirs)
Yellow perch - *Perca flavescens*	Lacustrine-limnetic	Common	Kettle, Kootenay, Pend d'Oreille box canyon, Koocanusa, Columbia
Northern pike - *Esox lucius*	Lake/River	Recent	Columbia (2010), HaHa Lake
Pumpkinseed - *Lepomis gibbosus*	Lake/River	Common	Kootenay , Columbia, Pend d'Oreille
Black bullhead – *Ameiurus melas*	Lake/River		Kootenay River/Kootenay Lake
Carp – *Cyprinus carpio*	Lake/River	Common	Arrow L., Kootenay R.(below Brilliant), Okanagan system
Tench - *Tinca tinca*	Lake, Reservoirs	Common	Christina L., Pend D' Oreille, Columbia
Brown trout - *Salmo trutta*	Riverine	Rare	W. Kettle (rumoured)
Brook trout - *Salvelinus fontinalis*	Mainly Lake/River	Common	Extensive (19 lakes stocked-sterile) a few established populations
Lake trout (eastern) – *Salvelinus namaycush*	Lacustrine	Common	Kootenay, Lower Columbia
Lake whitefish (eastern) – O*regonus clupeaformis*	Lacustrine-pelagic/ River	Rare	Arrow and Kootenay Lakes, Lower Columbia and Lower Kootenay rivers.

If one assumes that Umatilla Dace distribution is limited to faster-flowing riverine habitats and that they are rare or do not occupy reservoirs or lakes, this might reduce their interactions with lake-dwelling exotics. If, as some limited evidence suggests, Umatilla Dace can indeed survive in reservoirs, conversion of riverine habitat to reservoirs would enhance colonization opportunities for those species listed in Table 2 that are lacustrine. These include lake trout (introduced from eastern Canada), lake whitefish (introduced from eastern Canada but not abundant), black crappie and tench (both currently in Pend d'Oreille reservoirs) and opossum shrimp. Opossum shrimp, although a lacustrine species, often end up in back eddies in the larger rivers below reservoirs, where they may be consumed by juvenile white sturgeon (Gary Birch, BC Hydro, 2010 pers. Comm.).

3.2.2.1 Invasive species with low risk of interaction with Umatilla Dace

Salmonids
Introduced salmonids can prey on minnows, but their distribution and abundance may limit interaction. Brown trout, presumably the descendants of fish planted in the 1950-60s, are rumoured occasionally to be caught in the W. Kettle River, although these fish may have been misidentified brook trout (S Matthews, DFO, 2010, pers. comm.). There is a history of brook trout stocking in the Columbia basin, with a few wild populations now established throughout Umatilla Dace range. For the last decade, only sterile brook trout have been stocked in enclosed interior lakes. Brook trout tend to occupy lakes and have not been seen in either the Similkameen or Kettle Rivers during snorkel surveys (S. Matthews, DFO, 2010, pers. comm.).

Pumpkinseed
Little is know of the potential for interaction between pumpkinseed and other fish, but they likely compete with native minnow species for food and space. Larger pumpkinseed may be piscivorous (Jordan et al. 2009). Pumpkinseed are abundant in the Kootenay River system in British Columbia and have become one of the dominant species in Creston valley lentic habitat. Pumpkinseed habitat has been described as including ponds, bays of lakes and pools in slow-moving stream sections (Jordan et al. 2009; McPhail 2007). Assuming that Umatilla Dace occupy faster waters, there is less likelihood of direct interaction.

Common carp
Common carp have been noted below the Brilliant Dam and from the Arrow Lakes to the U.S. border (McPhail 2007). Although described as associated with lower-velocity weedy habitats (Scott and Crossman 1973), they are abundant in the Okanagan River within faster waters with gravel and cobble substrates, described as chinook spawning habitats (Davis et al 2007). Common carp are bottom-feeding omnivores; while they might consume eggs, consumption of fish is unlikely. Because both Umatilla Dace and carp consume benthic invertebrates, competitive interaction is possible, but its degree is unknown.

Yellow perch
Yellow perch is a highly adaptable species that can utilize a wide range of habitats (Brown et al 2009a). It is considered to be lacustrine-limnetic, and although it can occupy low-velocity rivers it is not found in faster-flowing ones. There should be little habitat overlap between Umatilla Dace and yellow perch, because yellow perch juveniles tend to bottom-feed; however, larger perch consume fish eggs and fish (Brown et al 2009a). Competition and predation may occur in the few locations where habitat utilization does overlap. A biological risk assessment for yellow perch in British Columbia outlines the possible consequences of their introduction (Bradford et al 2008a).

3.2.2.2 Invasive species with higher risk of interaction with Umatilla Dace

Northern pike
Northern pike are piscivorous and considered a threat to native fish species (Harvey 2009; Bradford et al 2008b). The impacts of pike introductions include decreased cyprinid and minnow densities, decreased yellow perch densities, and declines in trout and salmon abundance (Kerr and Lasenby, 2001). Northern pike have been caught in HaHa Lake (which drains into the Columbia River), an area from which the species were considered to have been eradicated (COSEWIC 2010), and from below the HLK Dam. They are currently in the US portion of the Pend d'Oreille and the Koocanusa reservoir (which is outside the known Umatilla Dace range;

Harvey 2009). Northern pike were caught in the Columbia River above the U.S. border (G. Birch, BC Hydro, 2010, pers. comm.). It is likely that pike will continue to move north through trans-boundary dispersal and will increase in abundance within the Canadian portion of the Columbia watershed (Harvey 2009; Runciman and Leaf 2009; Bradford et al 2008b).

Walleye
Of the many piscivorous fish that have found their way into Umatilla Dace habitat, walleye generate the most concern about the effects of exotics on small-bodied fish and are the invasive species most likely to be common in Umatilla Dace range. Believed to have resulted from introductions south of the international border, these visual predators have advantages in rivers from which silt has been reduced by upstream dam operations – like the lower Columbia and Kootenay portions of Umatilla Dace habitat. They may be able to pass through locks and move upstream (B. MacDonald, retired DFO, 2010, pers. comm.). The abundance of walleye has increased substantially within the Columbia River mainstream since the 1980s (R.L. & L.1995). Numbers increased significantly between 2003 and 2005 (due to a strong 2001 brood year), and now the species appears to show relatively stable annual abundance (of about 7500 adults) in the Columbia River between HLK Dam and the border (Golder Associates Ltd. 2010). Observed decreases in native prey species, including Umatilla Dace, coincide with increases in walleye populations (R.L. and L. 1999), suggesting a cause and effect relationship. Introduced piscivores like walleye can bring about significant changes in native fish community composition and should be considered a major invasive threat (Bradford et al 2008b).

McPhail (2007) considered walleye to be “seasonally abundant” in the Columbia and Kootenay Rivers near Castlegar. They are also present in Christina Lake and the Kettle River north of the international boundary (Hartman 2009; Runciman and Leaf 2009). Walleye may impact native fish communities through competition and predation (Hartman 2009) and should be considered a threat to Umatilla Dace. Hartman (2009) indicated that the impacts of introduced walleye on fish communities are complex: non-native exotics such as yellow perch may also be heavily predated on, and walleye are cannibalistic. When yellow perch are absent, walleye may account for 75% of minnow mortality (Lyons and Magnuson 1987). Their continued expansion into Canada may depend on the availability of suitable spawning habitat in Canada (Bradford et al. 2008b), but it appears likely they will continue to spread into the upper Columbia system through the Arrow lakes with access through the boat lock at HLK Dam (McPhail 2009; Hartman 2009).

Largemouth bass
In the Kootenay and Columbia drainages, largemouth bass are found in 31 confirmed water bodies, mostly lakes and sloughs but also in the Columbia River and Kootenay rivers (Runciman and Leaf 2009). Largemouth bass use a variety of habitats including ponds, lakes, reservoirs, streams and vegetated slack waters within large rivers (Brown et al 2009b). They are typically larger and more aggressive than other piscivorous fish, who they tend to out-compete (Lasenby and Kerr 2000). They have been known to eliminate native species and reduce minnow populations, and must be considered a threat to dace (Tovey et al. 2008). In streams and rivers, the effects of largemouth bass on small-bodied fish such as minnows may be greater than those of smallmouth bass (Harvey et al 1988; Brown et al 2009b). Largemouth bass should be considered a threat to Umatilla Dace, although predation would be reduced if dace only occupy the faster riverine habitats while largemouth bass remain in the slower waters.

Smallmouth bass
Smallmouth bass tend to inhabit large lakes (greater than 40 ha) and wide rivers (greater than 10 m) with moderate current, and are known to congregate downstream of dams (Brown et al

2009c). They are found in the Columbia, Pend d'Oreille and Kettle rivers (including Christina Lake), and are unconfirmed in the Kootenay River (Runciman and Leaf 2009). Smallmouth bass do better than walleye when forage fish are low in abundance, the substrates are rock-boulder, and water is clear. They tend to occupy faster waters than do largemouth bass (Brown et al. 2009c) and this may bring them into conflict with Umatilla Dace. Smallmouth bass must be considered a threat to Umatilla Dace because small-bodied fish (minnows) are considered a prime forage item for the species (Tovey et al. 2008).

3.2.3 Threat 3: Water extraction

Flow is regulated throughout Umatilla Dace range on the mainstream Columbia, Kootenay, and Pend d'Oreille rivers, and seasonal low flows that would normally occur in late winter to early spring (prior to snowmelt) are augmented by water stored in reservoirs. However, Umatilla Dace have been sampled near the mouths of small tributaries to the Columbia, such as Beaver, Blueberry, and Champion creeks, (Bruce Macdonald, retired DFO, 2010, pers. comm.); these low water levels are likely associated with water withdrawals and climatic changes. Low water levels in these small tributaries could seasonally eliminate small but important habitat sites.

Water extraction is currently not considered an issue on the Canadian portion of the Columbia and Kootenay Rivers. Irrigation of gardens and hay crops accounted for less than 1/3 of the use, and domestic consumption was minimal (<0.01%). The City of Castlegar and the Celgar pulp mill take their water supply directly from the Arrow Reservoir via pipeline, as did the Westar Timber sawmill (Westar ceased production in October 2007). Although water extraction for agricultural and domestic use has increased in the last 20 years, it still represents a small percentage of the flow.

Approximately 2/3 of the withdrawn water was for industrial purposes at the Westar Timber Ltd. sawmill and the Celgar pulp mill. The Celgar mill was upgraded in the 1990s and has "undergone modernization" since 2005. In place of direct effluent discharge into the Columbia River, treatment systems have reduced pollutants (dioxins and furans) and will optimize power generation capacity. It is anticipated that Celgar's water withdrawal could double; this water will be used for cooling, with the warmed water returned to the river (Butcher 1992). Doubling the thermal effluent could be detrimental to rearing Umatilla Dace rearing in downstream habitat as the water temperatures below HLK are now approximately 2-3˚C warmer from May to September (Hamblin and McAdam 2003) as noted previously.

Water diversion, surface water withdrawal, and groundwater extractions are considered a threat to riverine species in the Kettle River, Similkameen River and their tributaries (COSEWIC 2010). The Similkameen and Kettle Rivers exhibit two seasonal peak flows. The first and largest peak flow occurs in June due to snowmelt. The second peak occurs in October and November and is due mainly to rain. Total annual discharge in recent years is highly variable but appears similar to historic annual volumes (R. Ptolemy, BC MOE, 2010, pers. comm.). Nevertheless, there have been changes to precipitation patterns, including less snowfall, earlier and quicker snowmelt, and more rain (R. Ptolemy, BC MOE, 2010, pers. comm.). The combination of changes in seasonal precipitation and increased water withdrawals has led to extreme low flows during August and September.

There was also a major increase in the amount of water that could be withdrawn by license on the Kettle River during the 1960s and 70s (Penner 2004). Increased water demand combined with lower late-summer flows has led to low water levels in both the Similkameen and Kettle Rivers. The predicted effects of future climate change in the region will increase the risk to

Umatilla Dace, because water demands are expected to increase as the human population continues to grow, agricultural lands are further developed, and the growing season becomes longer and warmer (Aqua Factor Consulting Inc. 2004a;b).

The major uses of Similkameen water have been for irrigation (59%) and domestic consumption (40% according to 1990s data; http://www.env.gov.bc.ca/wat/wq/wq_area_3.html#columbia). Industrial use, including mining, has been small to date, but may increase. When supply is limited, large and increasing consumptive water use requires the support of small water storage devices (i.e. higher elevation dams and ponds) that capture high flow in June and maintain adequate water levels through controlled releases in late summer. It appears that most of the water licenses in the Similkameen have no real storage support. A fall in mean annual discharge (MAD) rates below 20% has been assumed to cause losses in riffle quality that can affect aquatic life (COSEWIC 2010). The measurement of a summer base flow of 18% MAD at Hedley, on the mainstream Similkameen (R. Ptolemy, BC MOE, pers. comm., cited in COSEWIC 2010), would suggest that water availability has reached its limit and is barely adequate. The impact of reduced flows on smaller tributaries may be more serious than those on the Kettle River population located on the mainstream below Cascade falls and on the Similkameen River (where fish appear to be confined primarily to the mainstream).

3.2.4 Threat 4: Resource extraction

The Similkameen and Tulameen rivers have been subjected to extensive placer mining including main channel dredging along a 40-50 km stretch above and below Princeton since the 1850s. Only minor production has occurred since 1900, although placer gold claims are still available for sale on the internet (www.gpex.ca/similkameen-gold-claims-for-sale.html). Exfiltration ponds are now used to dispose of wastewater from placer mines. Seepage from these facilities may impact water quality, but the impacts are believed to be minimal because their contribution to total flow is considered insignificant relative to even the lowest recorded river flows (http://www.env.gov.bc.ca/wat/wq/wq_area_3.html#columbia). However, sediments displaced from the ponds during storm events could pose a risk for fish like the Umatilla Dace that live in substrate interstices.

Gold and platinum were discovered in the early 1980s on the east side of the Similkameen River, seven km southwest of Princeton. The Nickel Plate Mine above Hedley opened in the late 1890s and operated for over fifty years, reopening as the Mascot Mine in 1987 and closing in 1996. Horn Silver Mine near Cawston closed in the 1960s. However, the ups and downs of metal markets mean there is always the potential for old mines to reopen. All of the mining activities performed and contemplated in this area have the potential for cumulative effects such as sedimentation, temperature change, nutrient and metal loading and altered stream hydrology (COSEWIC 2010).

Mineral exploration commenced in the Copper Mountain area (10 km south of Princeton) as early as 1884, and copper and other metals have been extracted there since the 1920s (Business in Vancouver 2008). Historic mine waste has filled valleys. Granby Consolidated Mining operated the underground mine and milling facility until 1957, when the deep mine was abandoned and open pit operations were initiated by Newmont Mining Corporation. These operations ended in 1988. Cassiar Mining (Princeton Mining) continued to mine until 1996. Copper Mountain Mining Corporation purchased the Similco mine and operations in 2006, and has initiated exploratory drilling and developed feasibility studies. The company received provincial approval for reactivation in April 2010, and has plans to expand tailings pond operations and re-align the course of Wolfe Creek (J. Guerin, DFO, 2010, pers. comm.). These events are not expected to occur for about six or seven years, hence permits required to alter habitat (which need DFO authorization) have not been applied for (J. Guerin, DTO, 2010, pers. comm.).

The new Similco mine will combine the three previous pits into one large open pit. It lies within the Wolfe creek watershed, a tributary of the Similkameen River, adjacent to the east side of the Similkameen River. The new mine, scheduled for full production by June 2011, has an existing power supply, water license, and tailing ponds. Previous operation of the mine depended on extraction of water from the river and the tailing ponds have the potential to seep into Wolfe Creek and then into the Similkameen River. In 1979 there was a tailings spill into the river; however, only slight changes in water quality elements were noted at the time (http://www.env.gov.bc.ca/wat/wq/objectives/similkameen1/Similkameen1tech.pdf).

Coal was mined commercially in the Tulameen area from 1909 to 1945 (New Coalmont Courier webpage @coalmont.net). The Blakeburn mines closed with the end of demand by the Canadian Pacific Railway. Coal mining has received renewed interest in recent years. In 2002, Compliance Energy Corporation started to mine coal at the Basin Creek Project; production had increased to 42,000 tons by 2006. However the mine ceased production in 2006 (http://minfile.gov.bc.ca/Summary.aspx?minfilno=092HSE157). The Basin Coal Mine near Princeton has recently been purchased by Jameson Resources Limited, an Australian company. Coal mining has the potential to alter water quality both through the mining process itself and the washing of the mined coal.

Although the Canadian portion of the Pend D'Oreille River is only 22 km long, it contains three closed mines within this short portion of the watershed (Pommen Water Quality Consulting 2003). Reeves MacDonald Mines Ltd operated a lead-zinc mine from 1948-75 near Remac, and tailings and mine water waste were discharged into the river. Cominco operated a lead-zinc mine at Sheep Creek from 1955-78 and discharged decanted waters from tailing ponds into the Salmo River. Canex Placer Ltd extracted tungsten-lead-zinc at Lime Creek; tailing and mill effluents were discharged into Lost Creek, which flows into the Salmo River. In spite of all the tailings and historic dumping, current water quality appears to meet standards (Pommen Water Quality Consulting 2003). There have been numerous spills from these tailings ponds and there is always the possibility of a large spill such as the one that occurred in 1975 from an ice jam at Sheep Creek pond, will allow tailings to enter the river directly.

In spite of the above mining history, water quality of the Pend D'Oreille River is considered very good, with most of the water quality indicators meeting provincial criteria (http://www.env.gov.bc.ca/wat/wq/wq_area_3.html#columbia). Water quality issues originating in the U.S. portion of the Pend d'Oreille may also be a concern. Teck Cominco American Inc. has a lead-zinc concentrator in Washington State at Metaline Falls, about 10 km upstream of the Canada-U.S. border. The company has a license to dump pollutants in the river.

Several potential sources of contamination exist in the Columbia and Kootenay Rivers. These include a number of inactive and abandoned mines, a defunct smelter at Northport, and the Teck-Cominco smelter at Trail. The latter has had a history of depositing tailings and discharging waste into the Columbia River (http://www.allbusiness.com/legal/laws-government-regulations-environmental/1081003-1.html). From the 1890s to 1994, the Trail Smelter discharged over thirteen million tons of slag into the Columbia River, averaging in excess of one hundred tons per day from 1922 to 1994. In addition, the smelter and fertilizer operations discharged thousands of kilograms of pollutants each day into the Columbia River, including arsenic, cadmium, lead, zinc, and mercury. Seepage from an old landfill area flowed into Stoney

Creek and was a source of metal loadings. Historical contamination episodes in the lower Columbia River are referenced in various publications of the Columbia River Integrated Environmental Monitoring Program (for example, Columbia River Integrated Environmental Monitoring Program 2005).

A long-term program to modernize the Trail plant and reduce pollutants has taken place. As a result of facility upgrades, slag was no longer discharged into the river as of 1995, and most of the landfill drainage toward Stoney Creek is now collected and treated. However, spills have continued, for example the recent release of 950 kg of lead in acid solution in May 2008 (Spokesman Review 2008; COSEWIC 2010). There remain major concerns regarding water quality and fish health on both sides of the international border (COSEWIC 2010). In a recent aquatic ecological risk assessment developed for Teck Comico Ltd., Golder Associates (2007) noted that risk management objectives for mountain whitefish and prickly sculpin, two of the representative species selected for study, were being met in a 56 kilometre study area between the HLK Dam and the international border, while those for sturgeon were not. Umatilla Dace were not specifically included in the study.

3.2.5 Threat 5: Land use and other threats

3.2.5.1 Agriculture

Fruit and forage crops are grown extensively in the Similkameen, Kettle and Slocan valleys. In addition to water withdrawal effects (above), pollution from agricultural chemicals may also represent a threat to aquatic species. Agricultural activities have expanded over the last decade (i.e. grapes). Discharges are diffuse and crop-specific. Water quality in the Similkameen River is considered to be good, although sampling for specific pesticides in the river is limited. (http://www.env.gov.bc.ca/wat/wq/wq_area_3.html#columbia).

3.2.5.2 Transportation corridors

The development of major transportation routes, both rail and road, has occurred along the confined river valleys, especially along the Simlkameen and Slocan Rivers. Most of these routes were well established over 50 years ago. Their impact on dace populations is unknown. Umatilla Dace is considered to be a riverine species; if, however, part of the dace life cycle is reliant on habitats off the main rivers (i.e. ponds, side channels and minor drainages) then the transportation links may have restricted access to those habitats.

3.2.5.3 Timber harvest

Cumulative effects can also result from timber harvest and associated road construction. The main example, from the Similkameen, is salvage logging for timber infested with mountain pine beetle. Salvage 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). Umatilla Dace habitat would likely be affected by new roads built to service the salvage activity, because roads, ditches, and stream crossings will increase sediment loads and decrease the amount of time it takes storm and melt waters to reach the main channels.

Snow accumulation and melting dominate the hydrology of most interior British Columbia watersheds. The accumulation of snow, amount of rainfall, and rate of snowmelt vary with forest cover. Both mountain pine beetle infestation and associated salvage logging open or remove the forest canopy. Hélie et al. (2005), in a literature review, concluded that the current mountain pine beetle infestations in B.C. would kill enough trees to change interception and transpirations rates and induce changes in hydrology. Cover removal increases the net amount of precipitation reaching the forest floor, increases the snow water equivalence, and increases melt rates (Hélie et al. 2005).

Dead trees can also lead to increased subsurface storage of water. Extensive pine beetle deforestation could produce higher water tables, increased base-flow, increased low flows, greater peak flows and greater annual water yield. Uunila et al (2006) concluded that beetle-caused deforestation would increase annual water yield, increase late summer and autumn low flows, cause earlier peak flows and produce a more variable response in peak flow magnitude. The effects of deforestation could last for 60-70 years.

3.2.6 Threat 6: Scientific sampling

COSEWIC (2010) quotes McPhail (1991) to suggest that removal of Umatilla Dace for scientific research purposes could affect the viability of some populations; elimination of the Otter Creek population has been advanced as an example. Several protocols for scientific sampling exist for listed species in Canada, including Nooksack dace, Salish sucker and stickleback species pairs. Developing similar protocols for Umatilla Dace would require more knowledge of the species' behaviour, vulnerabilities and response to previous sampling (J. Rosenfeld, MOE, 2010, pers. comm.).

Table 3. Summary of threats to Umatilla Dace by watershed

	Columbia and Kootenay	Kettle	Similkameen	Pend d'Oreille
Hydro dams	Stranding during ramping: loss of margin habitat and fish death. Brilliant Reservoir impoundment effect on riverine habitat. IPP proposal.	Cascade Project: Possible Impacts to upstream speckled dace.	US: Shanker's Bend: high dam option unlikely to proceed but major loss of habitat will occur in Canada if high dam option built.	Expansions: minor changes to flow and slight improvements to TGP.
Invasive species (Predation)	Predation pressure by invasive species (e.g. Pike and Walleye) could increase. New invasive species from US. may in the future enter Canada. Invasives may restrict dace habitat use.	Possibility of new invasive species from US.	Fewer listed AIS than in other systems. Predation by brook trout should decline.	Possibility of new invasive species from US.
Water Use (Seasonal Low Flow)	Not a problem; water withdrawal is a very small proportion of total flow, and flows are regulated. Minor tributaries may be impacted in late summer.	Current habitat is in main channel and flows are considered adequate for Umatilla Dace. Could become an issue if water demand increases and precipitation patterns change.	Serious concern in Aug-Sept. Will get worse as use increases and if precipitation patterns continue to change. Habitat loss of exposed riffles.	Not considered a problem: water withdrawal is perceived to be a small proportion of total flow, and flows are regulated.
Resource	Slag and effluent from Trail smelter. Although	Opening of new and old mines. Re-	Similco Mine open pit: possibility of spills from tailings	Historic tailings ponds. Spilling

	Columbia and Kootenay	Kettle	Similkameen	Pend d'Oreille
Extraction	conditions have improved during the last decade. Historic slag deposition will continue to infiltrate substrates further downstream. Reduction in water quality and possibility of decline in fish health. High possibility of smelter effluent spills.	processing of tailings at Phoenix for gold. Possible sedimentation and water quality changes if spills occur. Slight possibility of effluents from developing US mines.	ponds, re-alignment of Wolfe Creek. Increase in coal and placer mining activity will follow commodity prices. Opening of new and old mines.	sediments into river during extreme flooding events.
Agriculture	Minor (Slocan Valley). Industrial water use (Celgar Pulp and Trail smelter) has historically been larger than agricultural water use.	Increasing and will contribute to water demand.	Fruit and grape acreages are increasing with expected increases in demand for seasonally limited waters.	Not considered a threat at this time. Small portion of total water flow.
Forestry	Little to no effect on large watershed area other than possible increase in localized run-off effects	Complex hydrological considerations relative to low flows. Harvest may increase peak flow magnitude and sedimentation.	Complex hydrological considerations relative to low flow. Harvest may increase peak flow magnitude and sedimentation.	Highly regulated river; impacts from forestry impossible to measure.
Scientific Sampling	Challenges in identification may result in over-sampling.		Considered a problem on Otter creek (COSEWIC 2001).	

3.3 LIKELIHOOD THAT THE CURRENT QUANTITY AND QUALITY OF HABITAT IS SUFFICIENT TO ALLOW POPULATION INCREASE

Because most of the information on Umatilla Dace in its Canadian range is limited to presence/absence data that suffers from very low directed sampling effort, the extent to which the species utilizes the available habitat is not known. In the part of its range with the most physically "unaltered" habitat (the Similkameen mainstream), abundance appears low, to the point where McPhail (2007) considered the species to be "in trouble" there. In areas where there has been more physical habitat alteration, namely the Columbia, Kootenay and Slocan Rivers, the same author regarded the species as "locally abundant." With the limited information presently available, identifying a relationship between available habitat and abundance is impossible.

3.4 MAGNITUDE BY WHICH CURRENT THREATS TO HABITATS HAVE REDUCED HABITAT QUANTITY AND QUALITY

There is no published information on the removal or alteration of Umatilla Dace habitat by hydroelectric development that would allow us to quantify its effects. The main current and potential threats (as opposed to historical effects) are (1) the potential for inundation of parts of the lower Canadian portion of the Similkameen River if the "high dam" option for a dam at Shanker's Bend is adopted; and (2) variations in ramping rate (the rate of flow change in the river) from revised hydro-electrical generation regimes at the complex of dams near the confluence of the Columbia and Kootenay Rivers.

All three Shanker's Bend proposals would result in reduced productive habitat capacity and fragmentation of a population spanning the Canada-US border. Flooding from construction of the Shanker's Bend high dam option would be expected to extend approximately 24 km into the

Canadian section of the Similkameen, inundating a significant portion of the known dace habitat in the river (COSEWIC 2010). The other two alternatives would also be expected to have upstream effects in Canada, but these are much harder to quantify. One could be to limit or eliminate the possibility of rescue from dace moving upstream into Canada.

The amount of habitat (riffle area) lost in the Similkameen river due to seasonal drought and water withdrawals is unknown. Most of the information is based on anecdotal observations of low water levels exposing stream sections. It is known that water levels in August and September have declined over the last 50 years and do fall below levels recognized as critical.

4 SCENARIOS FOR MITIGATION AND ALTERNATIVE ACTIVITIES

4.1 FEASIBLE MEASURES TO MINIMIZE/MITIGATE THE IMPACTS OF ACTIVITIES THAT ARE THREATS TO THE SPECIES AND ITS HABITAT

One way to consider measures to reduce the impacts to Umatilla Dace is to create scenarios that consider outcomes in terms of the criteria upon which the current COSEWIC listing status is based. To review, these criteria are:

- Extent of occurrence
- Area occupied
- Number of locations
- Projected change in quality or area of habitat

While these criteria are currently applied to Umatilla Dace as though it were a single population, scenarios may be more useful for decision-making if they consider effects on listing criteria for two separate watersheds, the Similkameen and Columbia. They are considered here in no particular order and irrespective of socio-economic considerations.

4.1.1 Scenario 1: Do nothing

In this "status quo" scenario, habitat quality and quality may nevertheless improve in the Columbia basin as a result of ongoing investments in strategies that minimize the effects of flow changes on species like Umatilla Dace. Habitat use may be lost as invasive species increase in the mainstream Columbia River. Even if no actions are taken prior to the next assessment, substrate habitat quality may continue to improve within the 18 km of the Columbia River below Trail (Section 1.9). For the Similkameen population, habitat area and quality may continue to decline if late summer water flows continue to decline.

4.1.2 Scenario 2: Extensive survey

Targeted surveys for Umatilla Dace using standardized methods, sampling more extensively, and night sampling may increase the measured area of occupancy and number of known locations beyond the current six. This type of survey would improve our confidence in the COSEWIC designation. Such surveys could increase the area of occupation (currently 12,000 km^2), although it is unlikely the area can increase beyond the base line of 20,000 km^2 established by COSEWIC. An increase in the number of locations could shift the status of the species toward Special Concern.

4.1.3 Scenario 3: Mitigate and manage threats

Recommendations for research and mitigation are contained throughout this RPA. They are summarized here as:

- Rejection of the Shanker's Bend high dam option, thus eliminating the threat of loss of 24 km of known dace habitat loss in the Similkameen River
- Continuation of existing research and possibly new studies on life history, habitat use, and stranding; thus improving our understanding of Columbia River habitat use, especially margin habitat. Although considerable economic, social, and multi-species considerations might exist, it still might be possible to develop criteria for adjusting rapid water level fluctuations (ramping rates) during critical time periods in order to allow dace use of habitats and to minimize stranding.
- Cessation of new water licences on the Similkameen and building of seasonal water storage in relation to use, especially for agricultural use. Increased small project storage systems could offset low summer flows on the Similkameen River. It is hoped the new Provincial Water Act would improve water use monitoring and recognize the importance of ground water to aquatic systems.
- Increased targeted angling on high-risk introduced fish species especially walleye and northern pike in the Columbia River to reduce invasive predator numbers. This might reduce dace predation and might permit dace to continue to occupy invaded habitats. Currently considerable social pressure exists on maintaining angling opportunities for invasive fish such as walleye both in Canada and in the US.
- Continue monitoring of water quality parameters related to resources extraction and agriculture.

4.2 FEASIBLE MEASURES TO MINIMIZE/MITIGATE THE IMPACTS OF ACTIVITIES THAT ARE THREATS TO THE SPECIES AND ITS HABITAT

4.2.1 Hydroelectric threats

4.2.1.1 Stranding

Stranding of small river fish due to rapid reduction in river water levels is a well-studied problem that arises from the daily and seasonal operation of dams, and was identified as a major threat to Umatilla Dace in the lower Columbia and Kootenay rivers (COSEWIC 2010). Stranding can occur either in the pools that remain after the water level drops or in the interstices of cobble and gravel de-watered banks or bars (Bradford 1997). Factors shown to influence the rate of stranding include ramping rate (rate of flow rate change), bank contour, time of day, and species behaviours (Bradford et al. 1995).

Discharge from the Arrow Lakes Reservoir is a combination of releases through Hugh L. HLK Dam and Arrow Lakes Hydro. This combined discharge is typically confirmed or agreed to weekly by the US and Canada (BC Hydro) under the provisions of the Columbia River Treaty, resulting in weekly flow changes from Arrow Lakes Reservoir. Operating regime flow changes from the Brilliant Dam, on the other hand, are in response to more localized needs, and occur daily. The contrast between these two very different demand sources suggests that there may be some flexibility when there are no international implications.

A recent study on the effects of flow reduction rate on stranding in these locations summarizes the literature on this topic, and presents data from a three-year study that assessed the influence of several variables that could potentially be manipulated to reduce stranding (Irvine et al. 2009). Six species of fish were studied, including Umatilla Dace, and two kinds of stranding: interstitial (in the cracks between rocks) and pool (a limited area detached from the mainstream). None of the tested variables proved significant in predicting interstitial stranding. However, the likelihood of pool stranding increased with fish density, longer periods of wetted history and higher ramping rates. The report suggested that, in summer, the likelihood of pool stranding could be reduced by applying a “conditioning reduction” in flow rate before the main operational reduction. A conditioning reduction is a relatively new technique in which the main reduction is predated by a rapid, short-term one. However, tests of conditioning flows to date have provided no clear answer as to the efficacy of the technique (Gary Birch, BC Hydro, 2010, pers. comm.) Recent work has demonstrated that the viability of the method is species specific (Golder Associates and Poisson Consulting, 2010). Conditioning reductions may be efficacious for hardy fish, but results among less tolerant species show incidents of significant mortality. The method’s usefulness in reducing stranding will have to await further research into effects by species.

These results suggest several practical ways in which the threat of stranding could be reduced. At present however, formal stranding agreements (BC Hydro Lower Columbia and Lower Kootenay Fish Stranding Protocol) use two types of mitigation: bank re-contouring to facilitate limited pooling or runoff, and management of ramping rates.

4.2.1.2 Shanker’s Bend

The high dam option was one of the potential threat issues considered by COSEWIC (2010) in its risk assessment. The likelihood of the Shanker’s Bend high dam option must be considered low, due in part to the expected public outcry related to the flooding of 24 km of B.C bottomlands. If chosen, however, the high dam option would cause a major loss of known Umatilla Dace habitat. If the mid-height dam option proceeds, the Canadian portion of the Similkameen would likely lose any potential rescue effect from the downstream U.S. portion of the river because the dam would flood to the Canadian border.

4.2.2 Alien species

Evidence that a number of predatory introduced fish species have established self-sustaining populations in the Columbia and Kootenay systems has been presented earlier in this report. The threat they pose to Umatilla Dace is likely high but is difficult to quantify. There is no way to completely eliminate established invasive fish species from large rivers. However, the four species considered the greatest threat to small-bodied fish such as dace are smallmouth bass, largemouth bass, pike, and walleye and are all sought-after recreational fish. There is considerable social pressure from both Canadian and US anglers to maintain fishing opportunities and if possible enhance them.

An increase in catch through changes in targeted recreational fisheries within the mainstream Columbia could reduce the numbers of these fish, and would reduce predation on Umatilla Dace. In other areas of the province, targeted angling (fishing derbies) has been successful in reducing the numbers of aquatic invasive species. An example is the annual pike minnow derby held at Cultus Lake. In Alberta, intense angling effort has been shown to dramatically reduce introduced yellow perch numbers in a lake (M.J Sullivan, Alberta Fish and Wildlife, 2009, pers. comm.).

In the Similkameen mainstream, introduced species appear to be limited to black bullhead, brook trout, cutthroat trout, rainbow trout, kokanee salmon and common carp in the attached Wolfe Lake (Rosenfeld 1996; DFO, Okanagan Nation Alliance, BC Ministry of Water, Land and Air Protection 2005). Continuing public awareness and enforcement could reduce the spread of invasive species. Brook trout control options introduced over the last decade have the goal of preventing further spread by limiting stockings to sterile individuals in isolated lakes, and through eradication or population reduction in areas where the trout have established populations (Hatfield and Pollard 2006).

4.2.3 Water extraction

The Similkameen-Boundary Area (Ministry of Environment Regions 2, 4 and 8) is presently characterized by fish-water use conflicts resulting from seasonal over-allocation or appropriation. In a review of flow-sensitive streams in the area, Ptolemy (2009) proposed storage of snowmelt-period water behind small impoundments as a way of offsetting heavier use at what are traditionally low flow times of year. Small dams or other storage devices permit water capture at times of high flow, and controlled release later. In Similkameen-Boundary, the most consistent window that could be used for water capture excess to ecosystem needs is during April to June. Further consideration of the annual variability in water supply could also help reduce ecosystem threats, particularly in drought years. Ptolemy (2009) proposes a “healthy flow” baseline of 20% mean annual discharge.

4.2.4 Forestry

Salvage logging of trees killed by mountain pine beetle may have an incidental countering effect on low flows by causing higher water tables, increased base flow, increased low flows, increasing snow pack, greater peak flows, and greater annual water yield (see Threat 4, above). It is also possible that salvage logging may increase the rate of June snow melt, increase peak flows (because flow is channelized in ditches and along roadways), and decrease the duration of snow melt. The net effect of dead forests and salvage logging on seasonal hydrographs in water-sensitive streams is complex, and it is not clear whether the seasonal low discharge would be increased.

4.2.5 Filling data gaps

Umatilla Dace are considered in B.C. Hydro’s Columbia River water use planning process. B.C. Hydro recently started a 5-year study to monitor the life history and habitat use of six species of sculpin and dace in the Lower Columbia River. This study, the results of which are not yet available, will collect information on spawning, determine the importance of suspected nursery areas, and assess the potential risks of seasonal and daily operations on federally-listed species of sculpin and dace, particularly downstream of the HLK facility. The study will attempt to monitor sculpin and dace species in unregulated systems in the Similkameen and Slocan river systems and compare findings with those from the regulated Lower Columbia (B.C. Hydro 2009). The study will concentrate on distribution and habitat use in relation to water level fluctuations, including seasonal and diel shifts, and will examine if and how the operations at the HLK Dam increase the risk of stranding. Information on spawning habitat, spawning timing and the use of flooded areas as nurseries will be collected; these flooded areas are likely to be affected by operations of the HLK Dam (BC Hydro 2007). This study, and any similar ones contemplated for the future, should help to gather the data needed to justify allowable harm in the Columbia and Kootenay rivers (see above, *Abundance*).

4.3 REASONABLE ALTERNATIVES TO THE ACTIVITIES THAT ARE THREATS TO THE SPECIES AND ITS HABITAT

While mitigation measures are available for most of the threats to Umatilla Dace, alternatives do exist in one specific case, namely the three alternative scenarios for the Shanker's Bend storage dam on the Similkameen River below the international border. In this case, the high dam alternative clearly implies the highest threat to Canadian populations of Umatilla Dace.

4.4 REASONABLE AND FEASIBLE ACTIVITIES THAT COULD INCREASE THE PRODUCTIVITY OR SURVIVORSHIP PARAMETERS

Data gaps regarding life history and habitat use are too large to permit identifying ways of increasing survivorship.

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