Status of the Leopard Dace, *Rhinichthys falcatus*, in Canada*

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Only in recent years, has the Leopard Dace (*Rhinichthys falcatus*) been verified as a species distinct from the similar looking Umatilla Dace (*R. umatilla*). Both species occur in the larger main rivers of the lower Columbia Basin of Washington, Oregon, Idaho and British Columbia. Leopard Dace prefer somewhat slower segments of rivers than current-seeking Umatilla Dace. Much of the original habitat of these fishes in the Columbia River is now dammed. Judging by co-occurrence of these fishes in a reservoir in the Kootenay River of British Columbia, the species can apparently survive in disturbed habitats. However, that particular reservoir does not fluctuate in level as much as do reservoirs of the Columbia River and has steady water current in upper reaches of the reservoir where these fishes occur. It is doubtful that the species occurs in numbers similar to those before reservoir flooding. Leopard Dace are restricted in numbers in Canadian portions of the Columbia Basin: namely, the lower Similkameen River (mostly below Keremeos); Kootenay River (sympatric with Umatilla Dace in the reservoir between Brilliant and South Slocan dams); Okanagan Lake and Lower Arrow Lake. Leopard Dace have dispersed since Pleistocene glaciation into the Fraser system in contrast to the Speckled Dace (*R. osculus*) and Umatilla Dace which have not dispersed north of the Columbia System. It is found in fair numbers in the lower Fraser Valley near Chilliwack and other scattered locations including the Thompson, Nicola, West Road, Stuart and Nechako rivers plus the Fraser River below Prince George. Because of its wide distribution in British Columbia in numerous river drainages, the Leopard Dace cannot be placed in any COSEWIC category.

On sait seulement depuis quelques années que le Naseux léopard (*Rhinichthys falcatus*) est une espèce distincte de *R. umatilla*, d'apparence similaire. On trouve les deux espèces dans les grands cours d'eau du bassin du cours inférieur on et du fleuve Columbia, dans les Etats de Washington, d'Oregon et d'Idaho et en Colombie-Britannique. Le Naseux léopard préfère les portions plus lentes des cours d'eau, contrairement à *R. umatilla*, qui recherche les endroits où le courant est plus fort. Aujourd'hui, la plupart des habitats naturels de ces poissons, sur le fleuve Columbia, se trouvent dans l'emprise de barrages. A en juger par la co-occurence de ces espèces dans un réservoir de la rivière Kootenay, en Colombie-Britannique, elles peuvent survivre en milieu perturbé; il faut toutefois préciser que le niveau de ce réservoir ne varie pas beaucoup comme les autres de la rivière Columbia, et la circulation y est assez régulière. On ne sait pas si ces espèces se présentaient en quantités comparables, avant le remplissage du réservoir, mais on est en droit d'en douter. Des populations restreintes Naseux léopard habite certaines parties canadiennes du bassin du fleuve Columbia, notamment le cours inférieur de la rivière Similkameen (surtout en aval de Keremeos); la rivière Kootenay (en situation sympatrique avec *R. umatilla* dans le réservoir situé entre les barrages Brilliant et South Slocan); le lac Okanagan et le lac Lower Arrow. Contrairement à *R. umatilla* et au Naseux moucheté (*R. osculus*), qui ne se sont pas répandus au nord du bassin du fleuve Columbia, le Naseux léopard s'est dispersé, depuis le Pléistocène, dans le basin du fleuve Fraser. On le trouve en quantités appréciables dans la vallée du cours inférieur du Fraser, près de Chilliwack, et en d'autres endroits dispersés dont les rivières Thompson, Nicola, West Road, Stuart et Nechako, y compris le fleuve Fraser en aval de Prince George. En raison de sa vaste répartition en Colombie-Britannique, dans de nombreux bassins versants, le Naseux léopard ne peut être inscrit dans aucune catégorie du CSEMDC.

Key Words: Leopard Dace, Naseux léopard, *Rhinichthys falcatus*, Cyprinidae, dace, British Columbia.

Amongst Canadian fishes, the Leopard Dace, *Rhinichthys falcatus* (Eigenmann and Eigenmann 1893), though easily identified by its general appearance (Figure 1), can be easily confused with its sympatric congeners, *R. osculus* and *R. umatilla* which have a similar spotted appearance when freshly captured. Peden and Hughes (1988) found the presence of a barbel on larger specimens which protruded well outside the maxillary groove, and pelvic stays are persistently present. In contrast, *R. umatilla* has a small barbel confined within the groove and pelvic stays are absent or weakly developed. *Rhinichthys falcatus* has a more slender appearance, larger fins with delicate appearing membranes and falcate distal margins on dorsal and anal fins (more rounded fins on *R. osculus* and most *R. umatilla*). The scales near the tail of *R. falcatus* appear larger, with 51 to 63 (mean 55) scales on the lateral line (usually more in *R. umatilla*). There is an average of 26 scales

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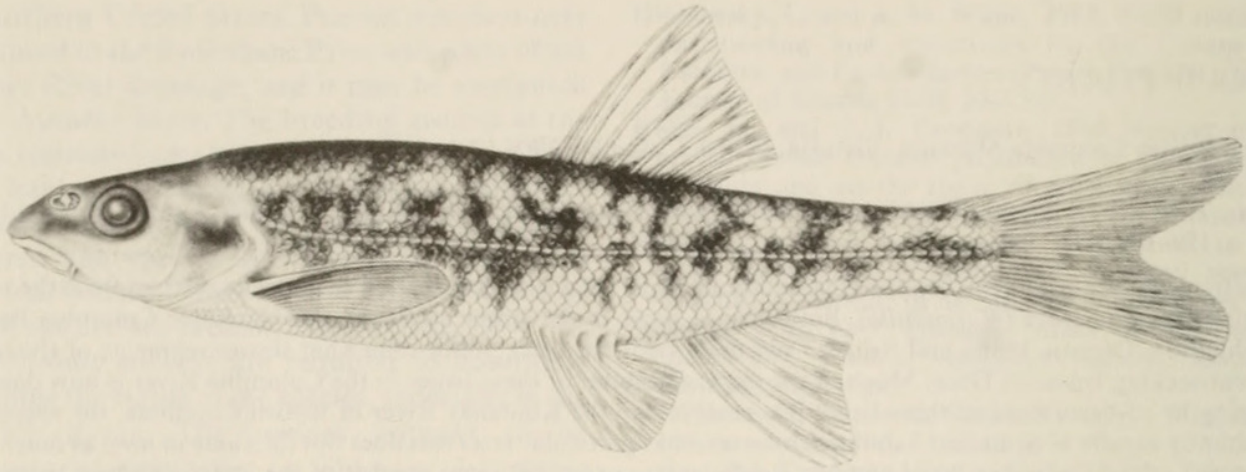

FIGURE 1. *Rhinichthys falcatus* (58 mm SL, UBC 56-573) from Nazko River, Fraser River Drainage. Drawn by Karen Uldall-Ekman.

around the caudal peduncle (average 32 to 36 in *R. umatilla*). Many *R. falcatus* have white tubercles on the head or near the tip of each scale giving an appearance of there being regular rows of tubercles along the back. Such tubercles were not observed on other species of dace that we studied.

Distribution

Rhinichthys falcatus inhabits the Columbia and Fraser systems. Distributional records are indicated in Figures 2 and 3.

United States

Washington, Oregon and Idaho: *Rhinichthys falcatus* inhabits the main stem of the Columbia drainages including the full length of the Columbia River from its estuary to the Canadian border. This includes lower reaches of the Snake, Willamette, Umatilla, John Day, Malhuer, Clearwater, Payette, Boise, Bruneau and Similkameen rivers. Simpson and Wallace (1978) and Lea et al. (1980) describe waterfall barriers (*i.e.*, Shoshone Falls, Spokane Falls) which prevent dispersal into upstream portions of the Columbia River Basin. Present day construction of dams would appear to further restrict genetic interchange between tributary drainages and prevent natural restocking of lost populations. There are records from the Cowlitz, Yakima and Walla Walla river systems (records from upstream drainages of the Deschutes River need verification).

The Similkameen River population of Washington may be of major significance to Canadian populations because the species occurs in large numbers immediately below the Canadian border and may act as a genetic reservoir for immigrants into Canada (Hughes and Peden 1985; Peden and Hughes 1988). Presently, this population is isolated from downstream populations by a dam and waterfall above Orville, Washington.

British Columbia

Columbia System: *Rhinichthys falcatus* is known from four areas within the Columbia River system (Figure 2); namely, Similkameen River, Okanagan Lake, Arrow Lakes, and the reservoir between Brilliant and South Slocan dams on the Kootenay River. Each river population occurs sympatrically with *R. umatilla*. Peden and Clermont (1989) discuss water temperature within the Columbia and its association between large lakes and rivers. The species tends to be restricted to portions of rivers with August temperatures between 15° and 18°C. Except for the Similkameen River, habitats inhabited by *R. falcatus* are modified by waters passing through large lakes and are less influenced by erratic runoff from summer snowmelt. Lake habitat complicates the issue of temperature preference, because isolated bays can warm quickly or the fish may select preferred micro-habitats. There are few data on habitat preference of *R. falcatus* in lakes.

Similkameen River: Peden and Hughes (1988) indicate that specimens of *R. falcatus* known from Canadian portions of the Similkameen River are small juveniles largely found between Keremeos and the American border. We have not located large Canadian adults to indicate significant reproductive populations. However large specimens were found with juveniles in portions of the river with reduced current above Nighthawk, Washington. Large adults, but no juveniles, were also found in faster current below Nighthawk (Hughes and Peden 1985) in sympatry with *R. umatilla* and provide evidence for each form having separate status as biological species.

Kootenay River: Peden and Hughes (1988) recently discovered sympatric populations of *R. umatilla* and *R. falcatus* in the reservoir between Brilliant and South Slocan dams on the Kootenay

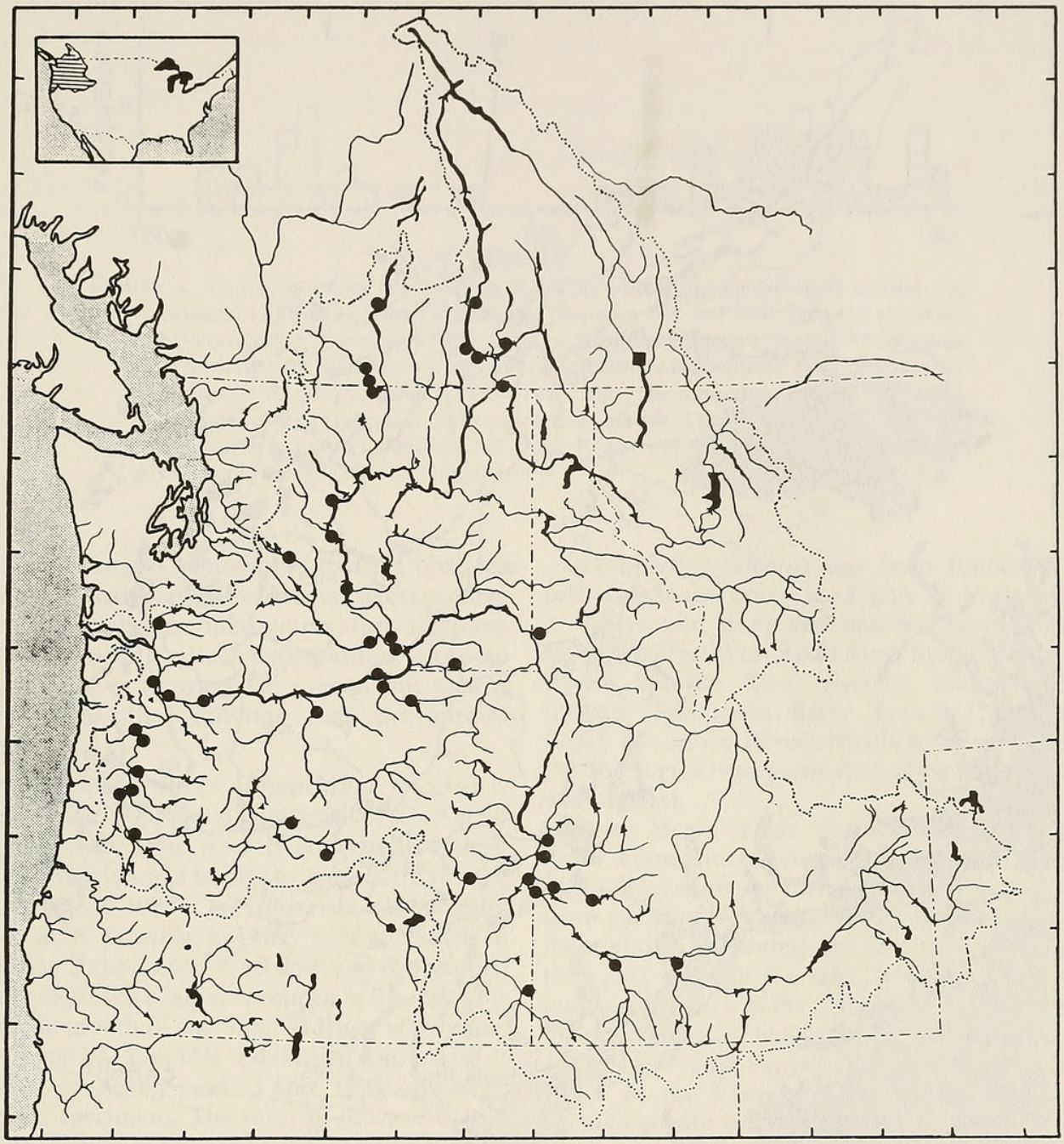

FIGURE 2. Map showing the distribution of *Rhinichthys falcatus* in the Columbia River drainage. Note: two records in the Upper Deschutes System of Oregon need verification. The darkened square shown in the upper Kootenay River represents a record shown on a distribution map by Scott and Crossman (1973), but has yet to be confirmed.

River. Peden and Clermont (1989) provided evidence that these populations are probably natural ones trapped at the time of impoundment rather than originating from other sources. A few individuals with intermediate characters may be hybrids and their existence should be studied (Figure 4). Only 15 specimens of *R. falcatus* were found after 20 hours of sampling, suggesting that this population is small.

Okanagan Lake: There have been persistent reports of *R. falcatus* from Okanagan Lake (Carl et al. 1959; Scott and Crossman 1973). We sampled both Okanagan Lake and River, but found only a few specimens in the lake, opposite Kelowna. They occurred on stoney beaches having shallow slope with beds of the water reed, *Scirpus acutus*, occurring offshore. In our judgement the Okanagan River may have been too warm for the species.

Arrow Lakes: Rhinichthys falcatus is well known from the Arrow Lakes (Carl et al. 1959; Scott and Crossman 1973). We sampled the same locations recorded for museum collections of the species and found *R. falcatus* to still be there.

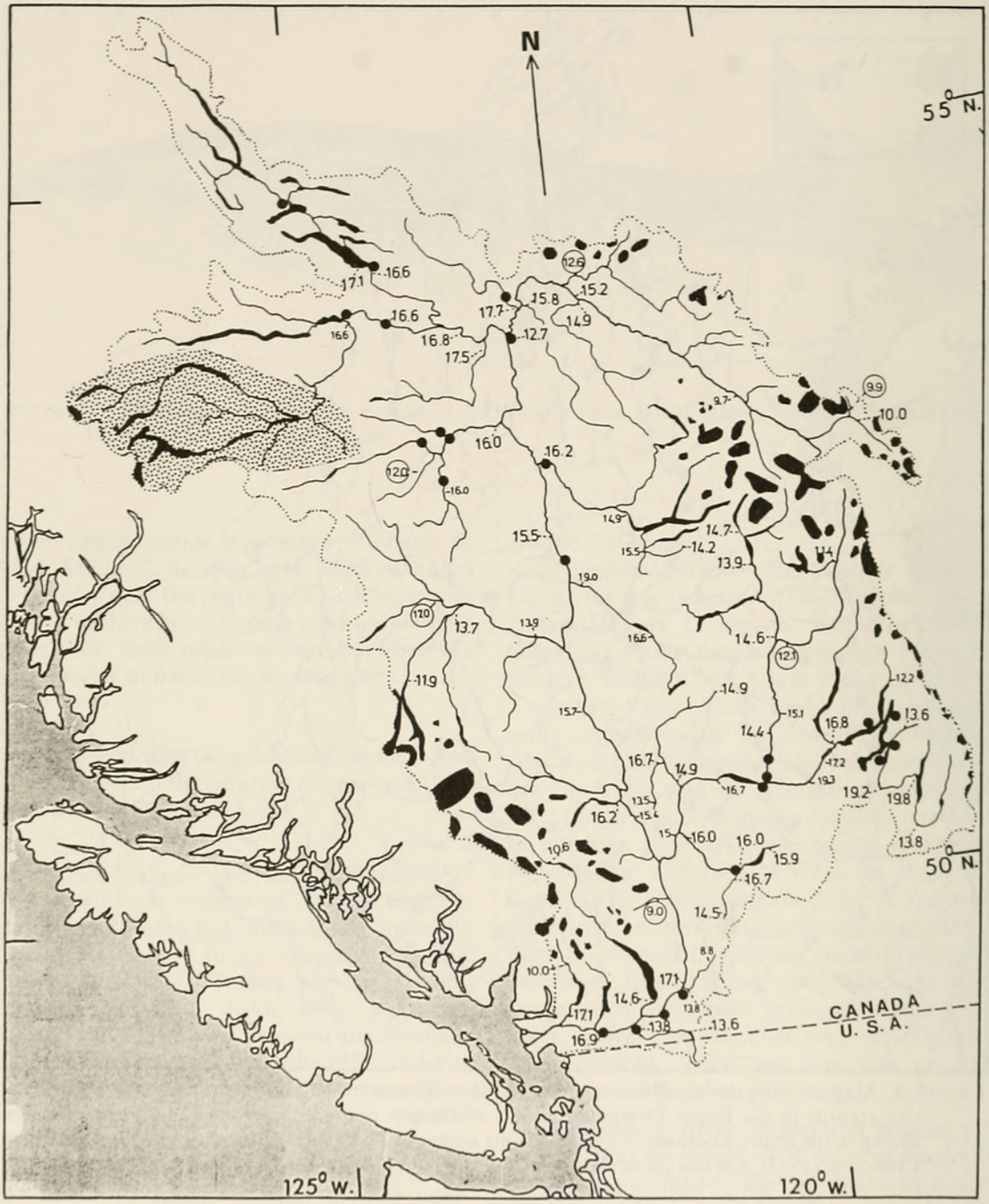

FIGURE 3. Distribution of *Rhinichthys falcatus* (darkened circles) in the Fraser River Drainage. Shaded areas indicate territory outside the drainage basin, coarse stippled area indicates portion of Nechako River drainage now diverted directly to the Pacific Coast after construction of the Kenny Dam, thickly blackened portion of rivers indicate major lakes (not named here). Numbers indicate average August spot water temperatures in °C (Environment Canada 1977). Dark patches with white stippling (not touching main rivers) indicate areas of permanent snow packs. Numbers enclosed within circles represent average temperatures based on fewer than six temperature readings.

However, the Arrow lakes are now flooded by Hugh Keenleyside Dam with an associated wide amplitude of manipulated water levels. There is much erosion of the shoreline with windswept wave-wash creating turbid inshore waters. Although there are no quantitative data for comparison, staff of the Royal British Columbia Museum sampled many sites on Arrow Lakes, but found only about a dozen specimens at four locations, suggesting the species is sparcely

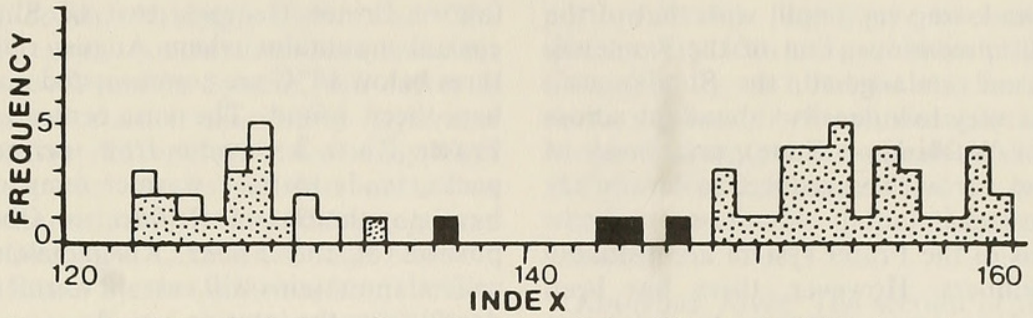

FIGURE 4. Character index representing *Rhinichthys falcatus* (individuals sorting out between 123 and 133) and *R. umatilla* (between 148 and 160) from the reservoir between South Slocan and Brilliant dams. Stippled bars are sympatric individuals of both species, solid bars are apparent intermediate individuals. The open bars are allopatric *R. falcatus* from lower Arrow Lake. The individual sorting out at 133 appears to be an atypical *R. falcatus* from the mouth of the Slocan River (indicated by coarse stippling). Data taken from Peden and Hughes (1988) where the character index is described in detail.

distributed. August temperatures of the Columbia River near Castlegar (below Arrow Lakes) average near 14.5° C; however, lake temperature upstream from here may differ. Such temperatures below the outlet of Lower Arrow Lake suggest this area is cooler than other habitats that the species occupies.

Pend d'Oreille River: Rhinichthys falcatus is reported from the Pend d'Oreille River (Carl et al. 1959); however, this river is completely altered near the international border by large dams (Peden and Clermont 1989). We observed old samples labeled as *R. falcatus*, but they were too small to determine if they were *R. umatilla* or *R. falcatus*. We also captured a larger specimen in the reservoir below the mouth of the Salmon River which may have been *R. umatilla* (identified on basis of number of scale pockets on this otherwise damaged specimen). The survival of these fish in the Canadian portion of the Pend d'Oreille River is uncertain. Future work is needed to verify if *R. falcatus* or *R. umatilla* are still present (and if so, where?).

Fraser River System: Although the only Fraser River populations that we have sampled are those from the area between Chilliwack and Hope, British Columbia, we have also had reports of *R. falcatus* from other areas of the Fraser Drainage where the species was previously known to occur. Given that public pressure from the salmon industry has discouraged building of hydro-electric dams, and therefore much of the Fraser River is relatively unmodified compared to the Columbia River, we have no reason to suspect that the overall distribution of *R. falcatus* to be greatly altered during historic times. Obviously, local changes can be expected.

Rhinichthys falcatus has been found in the following major areas (*see* Figure 3): Fraser River — Mission to Hope and near Williams Lake to Prince George; West Road River System; Nechako River; Stewart River System; Salmon River System; Thompson River System (North and South Thompson River); Nicola River system, and the Shuswap River system (including Shuswap and Mara lakes).

These localities are characterized by August water temperatures between 15° and 18° C (Figure 3). Such areas are separated by long distances from snow pack areas, or as in the case of Shuswap Lake populations, the waters are obviously warmed as they pass through the lake. We do not know if major rivers such as the Chilcotin River have been properly sampled, but August temperatures in the 13° to 14° C range suggest exclusion of *R. falcatus*. Much of the Fraser and Thompson rivers are deeply cut into their valley floors. Consequently, many secondary rivers and streams may have impassable rapids that impede dispersal of the species onto the plateaus along the sides of the main rivers.

Protection

There is no special protection for *R. falcatus* other than existing federal and provincial regulations governing environmental quality. The species does not occur in existing parks, or in ecological or other forms of protective reserves. (*See* Peden and Clermont (1989) regarding a general discussion of protective measures in the Columbia System.)

Population sizes and trends

Few data are available on population sizes and trends for *R. falcatus*. My impression for the Canadian portion of the Columbia Drainage is

that populations are very small, with that of the Pend d'Oreille precarious, that of the Kootenay River small and endangered, the Similkameen population at very low density (abundant across the border in Washington State), and those of Okanagan and Arrow lakes reduced in density but probably persistent.

Populations of the Fraser system are probably stable in numbers. However, there has been virtually no long term sampling to determine population sizes and trends. Gee and Northcote (1963) found *R. falcatus* numerous in a field study during 1961 and 1962 in the area of the Fraser River between Chilliwack and Hope, British Columbia. Staff from the Royal British Columbia Museum visited the same area in the summer of 1988 and found the species still abundant. Given the large areas of known habitat in the upper drainages of the Fraser River and the fact that environmental consultants have reported the species in the area of the Thompson River system at least, I suspect the species continues in satisfactory numbers. Obviously, long term monitoring of *R. falcatus* should be encouraged.

Habitat

Rhinichthys falcatus occurs in rivers with slow or weak current [less than 0.5 m/sec (Gee and Northcote 1963)]. It is associated with rivers, but occurrences in Okanagan, Arrow and Shuswap lakes are exceptions. Potential habitat in the Fraser system is widespread, provided that conditions of temperature, bottom substrate, water flow, and absence of pollutants are met. In the United States, the species' habitat is unavoidably associated with dams and reservoirs that are different in character to its oligotrophic lake habitat in Canada.

Because I have captured the species mostly in the southern parts of its range in British Columbia, and each location where they were found differs greatly, I shall describe each separately after treating some general environmental parameters.

Summer Temperature: Peden and Clermont (1989) describe temperatures of the Columbia System in detail. Although average spot August temperatures where *R. falcatus* occurs average near 15° to 18°C, rivers such as the Similkameen with direct runoff from mountain peaks may have tremendous variation depending on weather conditions. Rivers such as the lower Kootenay and Columbia have consistent temperatures which are moderated as water flows through large lakes. Rivers of the Fraser System probably act similarly, (Figure 3; *see also* Peden and Clermont 1989). Most interestingly, snow packs dominate in the upper Columbia, upper Kootenay, upper Fraser (above Prince George), east of Shuswap, and coastal mountains where August river temperatures below 14°C are common and no *R. falcatus* have been found. The vast central area of the Fraser River is remote from permanent snow packs, tends to have warmer temperatures, and have populations of *R. falcatus*. Obviously, the portion of the Fraser River passing through coastal mountains will entrain warmer water (and dace?) from the interior.

Because of stratified summer temperatures according to depth, it is difficult to assess August temperature preferences of *R. falcatus* in lakes. Within the Columbia drainage of British Columbia, Okanagan Lake is undoubtedly the warmest habitat for *R. falcatus* and the Arrow Lakes are coldest. As indicated in Figure 3, the Shuswap area possesses the warmest habitats within the Fraser system where *R. falcatus* occurs. Takla, Trembluer, Stuart, Francois, Shuswap, Adams, Mara and Nicola lakes probably modify temperatures in Stuart, Nechako, Thompson, South Thompson, and Nicola rivers where *R. falcatus* is found. The West Road River was described in one set of collection data as a wide river. Numerous lakes in Tweedsmuir Provincial Park are now dammed and diverted directly to the coast (Figure 3), and probably influenced the Nechako River before impoundment. Temperatures of the Chilcotin and Lillooet rivers are apparently too cold.

Winter Temperatures: Within the Columbia River system, the Similkameen River averages 0.6°C in January where *R. falcatus* occurs and the river may freeze. In contrast, the Kootenay River averages near 3°C and the river water rarely freezes (Peden and Clermont 1989). Moreover, spring warming occurs earlier (March). Although Environment Canada (1977) data are not analyzed in detail here, upper regions of the Fraser River freeze solidly and spring warming occurs more than a month later (i.e., April or May).

Spring Flooding: The cycle of spring snow melt is more fully described by Peden and Clermont (1989). In contrast to the Kootenay River and Arrow Lakes populations where dams alter seasonal sequence of flooding and low water periods, other locations in British Columbia with *R. falcatus* have a natural cycle. Periods of high water levels will be near times of spring or summer spawning and low water periods will occur in fall and winter. Thin layers of algae on rocks along the three foot depth of shoreline where *R. falcatus* occurs support insect larvae on which the species feeds. This shallow band of productivity undoubtedly shifts as water levels lower or spring turbidity clears.

Dissolved Solids: Although Peden and Clermont (1989) were concerned about nutrient loading in the Columbia System, this factor is probably less important at this time for *R. falcatus* in the Fraser River. Except for the Kootenay River below Nelson, the species inhabits areas less subjected to municipal effluents. The exceptional situation of Okanagan Lake is discussed below.

As for the Fraser System, effluents from the City of Kamloops may affect downstream habitat of the Thompson River and that of Prince George may affect nearby Fraser habitat with *R. falcatus*. Despite these localized conditions, the species as a whole is probably less affected by municipal or industrial effluents than in the Columbia River (but see exception below). Other issues of logging or mining could have greater significance.

Northcote and Larkin (1963) characterize the turbidity of most interior lakes of the Columbia and Fraser drainages in British Columbia as being between 75 to over 300 ppm dissolved solids. Waters of coastal and high mountain areas where the species does not occur are below 75 ppm. Populations in the Fraser River near the coast are obviously influenced by waters of higher dissolved solids carried from the interior.

Columbia Habitats

Similkameen River: Similkameen River habitats are briefly described by Hughes and Peden (1983, 1984), Peden and Clermont (1989), and Peden and Hughes (1988). *Rhinichthys falcatus* was confirmed to occur with *R. umatilla* in the lower portion of the river below Keromeos. *Rhinichthys umatilla* also occurred upstream as far as Otter Creek. Numerous young-of-the-year were seined during September and October in back water pools, but no adult *R. falcatus* were captured on the Canadian side of the International Border. Immediately downstream, near Nighthawk, Washington, adult and juvenile *R. falcatus* were found in large numbers where slower river flow allowed fine sediment to settle on stones. When using an electro-shocker, we observed *R. falcatus* darting out of the fine sediment as frequently as from the stones under which the species often hides. Downstream from this location, the river bottom is much more rocky with current fast enough to remove the fine sediment. Relatively large adults were found here, but no juveniles of *R. falcatus*.

In general, this lower portion of the Similkameen is subjected to direct runoff of spring snow melt from high mountains, and has a wide flood plain on the Canadian side of the border. Except in spring flood, the water is very clear. The lower American portion of the river where *R. umatilla* and *R. falcatus* were found is rocky with some portions having bedrock. The lower Canadian portion consists largely of gravel or stoney bars that are very clean and probably shift during flood. Consequently, such habitat may be less stable for sheltering dace. I believe inflatable rafts should be used to find any pockets of habitat sheltering adult *R. falcatus* and *R. umatilla*, if we are to confirm whether sustainable populations occur within Canada.

Kootenay River: The section of the Kootenay River now possessing *Rhinichthys falcatus* is very restricted (Peden and Hughes 1988). This area below the present South Slocan Dam corresponds with the section of the river locally known as Slocan Pool. Judging by the configuration of the river and the presence of gravel bars on the river bottom when the reservoir is lowered, appropriate slow water habitat associated near the pools probably occurred here before reservoir construction. *Rhinichthys umatilla* and *Cottus bairdi* were apparently trapped above South Slocan Dam at time of river inundation (Peden and Hughes 1988; Peden and Clermont 1989). Populations of *R. falcatus* in the same area are probably indigenous. Upstream, Bonnington Falls probably acted as the prehistoric barrier to dispersal.

Today, this population of *R. falcatus* inhabits a reservoir that is designed for power generation, but it too small for significant water storage. Thus, fluctuation of water level varies up to about two meters in a 24-hour cycle depending on needs to generate power. Upstream storage reservoirs such as Cora Linn and Libby dams buffer seasonal floods.

Rhinichthys falcatus occurs in very reduced numbers in this section of river. We sampled with back-pack electro-shockers for 20 or more hours in the reservoir (8 hours of shocking in the Slocan Pool area) in three years but found only 15 specimens. Many more *R. umatilla* are found nearby; for example, in the mouth of the Slocan River. Because of the possibility of hybrids (Peden and Hughes 1988), there could be genetic swamping by *R. umatilla* if *R. falcatus* numbers drop too low (Figure 4).

Before construction of Brilliant and Hugh Keenleyside dams, *R. falcatus* populations of the Kootenay River may have had contact with those in the Columbia River and Arrow Lakes area. Old photographs indicate the Columbia River was relatively slow above Castlegar and Robson near the outlet of Arrow Lakes. Today, the Hugh Keenleyside Dam and pulp mills at Castlegar may have made this section of river unsuitable for *R. falcatus*.

Arrow Lakes: Rhinichthys falcatus is known largely from Lower Arrow Lake with specimens being found above Farquier, Renata and Shields,

British Columbia. The original lake is dammed and serves as a storage reservoir, with a huge amplitude of water level often out of phase with natural cycles of spring flooding and fall or winter periods of low water. During recent field trips in September and October, the lakeshore looked barren, with little vegetation. Wind swept waves on the lake disturbed silt along much of the inshore area increasing turbidity. In several of the areas where we found juvenile *R. falcatus* (near Renata and Farquier) the water was very silted from wave action so that we could not visually see the bottom (up to one meter sampling depth). Other extensive areas of steeply inclined rocks possessed clearer water from which *Rhinichthys cataractae* and *Cottus asper* were captured but no *R. falcatus* were observed.

Adult and juvenile *R. falcatus* were taken during September-October in 1987, and again in 1988, at the mouth of Shield Creek where large rocks without silt produced clearer water. Huge boulders of 0.7 to 1.7 m diameter were piled up high on the beach of the lake. The creek bed apparently was well flushed out during spring flood, however the flow was a mere trickle at the time of our October visit. In a small bay at the creek mouth where the shore was steeply piled with round rocks were a few depressions up to 1.3 to 2 m depth that possessed an accumulation of bright green algae. *Rhinichthys falcatus* was taken in small numbers at depths up to 1.3 m (maximum depth reached with electrodes and dip net).

In general, it is difficult to assess preferred habitat for this species in a natural lake so heavily impacted by a dam and because of the spotty known distribution of *R. falcatus* within the lake.

Okanagan Lake: There are no large rivers to flush Okanagan Lake similar to the situation in the Arrow lakes, since this large oligotrophic lake has a limited drainage basin. In contrast to lakes downstream with a flushing rate of one year, Okanagan Lake flushes itself every 58 years [Canada-British Columbia Okanagan-Agreement (CBCOA) 1974], therefore, the retention rate of potential contaminants in the system is much greater. The lake is controlled by a small dam that alters water level to a maximum of 1.3 m. As the lake is well studied (*see* reports of CBCOA, available from the British Columbia Water Resources Service, Parliament Buildings in Victoria, British Columbia).

During 1988, *R. falcatus* was captured at a site indicated in previous records, namely the lake shore opposite Kelowna. The species was not found in the northern portion of the lake. Except for one specimen found in a non-weedy area, the species was captured in shallow water over a stoney bottom where a band of water reed (*Scirpus acutus* Muhl.) occurred at depths greater than one meter offshore. This shallow area between the shore and *Scirpus* was washed by waves and had no sediment; the latter apparently settling in deeper water near the beds of *Scirpus*. Most of the shoreline of Okanagan Lake does not have this habitat and new development around Kelowna is destroying such areas. In particular, there is a tendency for shoreline property owners to bulldoze the beach line to push stones out of the way so as to create a sandy bathing beach.

Okanagan Lake temperatures in August probably reach near the maximum preferred by *R. falcatus*. Effects of temperature variation in inshore habitats must yet be determined. Extensive beds of *Scirpus* occur near Penticton, but whether associated stoney habitat or other requisites occur there is not known; more sampling is needed.

Fraser River Habitat

The only habitat in the Fraser River drainage where I looked for and captured *R. falcatus* is between Chilliwack and Hope (large numbers found at Herrling Island). Environmental consultants have indicated to me that they also encountered the species in numbers in the same area as did Gee and Northcote (1963). The habitat is of further significance in that it may approach conditions of large river habitats found in the Columbia River before the myriad of dams and reservoirs were constructed. In contrast, Fraser drainages could be expected to have cooler temperatures and shorter periods of warming because of their northern latitude.

We did not locate water level data in time for this report, however casual observation suggests May and June are the periods of peak flooding from snow melt, with fall and winter being periods of low water. There could be minor fluctuation of water level on the coast due to fall and winter precipitation which falls as rain on the coast but as snow in the interior. Immense gravel bars are exposed where the river spreads out below Hope to flow toward the Fraser Delta. These expansive bars become islands with small river channels separating them at low water. Because the species inhabits shorelines of one meter depth (Gee and Northcote 1963), *Rhinichthys falcatus* would have to shift up and down the banks of the river with the fluctuating water level.

Given the species preference for weaker flow (compared to *R. cataractae* and *R. umatilla*), its dominance where the river widens out is understandable. I would expect there could be pockets of the species in the river between Hope and Williams Lake; Gee and Northcote (1963) found fish upriver at MacAllister. However, the absence of literature records in sections such as the swift flowing and notorious Fraser Canyon is reasonable.

In general, the lower Fraser is much more silt laden than other localities whose habitat is described here. The cycle of spring floods with shifting currents washes away excessive silt that might have accumulated on stones, thus providing some shelter for the species.

Conclusions on Habitat

Habitats in the Fraser River are not in critical condition for *R. falcatus* as a whole, although there could be problems in localized areas. Columbia River habitats are more vulnerable, with the Kootenay and Arrow lakes populations vulnerable due to dam construction. The Similkameen population is sparsely distributed in Canada, although this could be a natural situation with the main reservoir of the gene pool across the border in Washington State. The Okanagan Lake population is also of low density and should be monitored in relationship to potential eutrophication of the habitat from towns such as Kelowna. I believe the Kootenay and Similkameen populations are most deserving of protection because of the sympatry with *R. umatilla* which provides a test for species interactions between closely related populations.

This report hinges on the assumption that *R. falcatus* tends to live in the upper meter of shoreline. On the other hand, lakes with clear water such as Okanagan Lake could also have algal production in deeper depths supporting the invertebrates on which this dace feeds. In areas such as the Okanagan Bridge causeway where algae on rocks near the surface are too thick and smother habitat, there could be optimal conditions where reduced light penetration produces less algae. *Rhinichthys falcatus* might seek cooler temperature at this depth in this warm lake. Small sized *Rhinichthys* are most easily captured in shallow water and are thus more likely to be recorded in shallow habitat. Effort is needed to confirm depth preferences, especially in unusual situations such as in Okanagan Lake.

General Biology

Reproduction and Growth: Gee and Northcote (1963) provide the only data on reproduction that we are aware of. The largest individual in their sample was 119 mm fork length. Carl et al. (1959) as well as Gee and Northcote (1963) report breeding males to have orange-red colouration on the lips and base of pelvic fins. The latter authors report the colour at all seasons. I have observed this colour on *R. umatilla* and *R. osculus* (which have it at the base of the pectoral fins as well), but believe the colouration to be most pronounced in the summer. In contrast to the other species, *R. falcatus* develops tubercles on the top of the head, body, and top surface of the pectoral rays. The body tubercles occur near the distal margin of each scale causing the tubercles to appear to be in rows. My impression is that these tubercles are less conspicuous in fall samples.

Northcote and Gee (1963) concluded that *R. falcatus* in the lower Fraser River spawn in early July, and that their young probably hatch in late July or early August.

I have no information on fecundity; however, I found a high ratio of younger fish in samples from the Similkameen and Kootenay rivers and Arrow lakes and this suggests adequate reproduction. Okanagan samples are inconclusive. In each case, more effort is needed to locate concentrations of mature adults.

Species Movement: There is little information on movements or migration. Gee and Northcote (1963) showed in the field and experimentally that *R. falcatus* prefers flow of less than 0.5 m/sec. They also showed that young fish preferred depths less than 0.3 m whereas seine caught adults were found at depths of between 0.3 and 1 m during daytime sampling. This relationship was reversed at night. Obviously there will be movements to different parts of the river when river levels fluctuate if this relationship is maintained.

Behaviour/Adaptability: Northcote and Gee (1963) indicate that *R. falcatus* in the lower Fraser River fed largely on aquatic insects at age classes 0 and I, but switched to terrestrial insects at larger sizes. In June and July, adult fish consumed primarily *Lumbricus* when water levels were high and fish could have foraged over flooded shorelines.

There is inadequate knowledge of adaptability of *R. falcatus* to change or human disturbance. The populations in Arrow Lakes, the Kootenay River, and Okanagan Lake are being severely tested by man-caused environmental change, and these populations should be monitored.

Limiting Factors

Without adequate data on abundance before reservoir impoundment, it is difficult to compare the status of *R. falcatus* before or after environmental change. The species appears to be adapted to river environments of weak current (< 0.5 m/sec.), stoney bottoms often with some silting, and August water temperatures between 15° and 18°C. The warm 20°C water of Okanagan Lake is an exception; however, temperature tolerances for the species in Washington must yet be compared. I believe hydro dams of the Columbia have had the greatest impact on the distribution of *R. falcatus*, although nutrient enrichment causing excessive algal growth could be a factor in some American waters (and possibly the Okanagan in future years). Competition with other dace may be a factor with sympatric *R.*

umatilla possibly narrowing available niche or habitat in some areas.

Special Significance of the Species

Rhinichthys falcatus is a little-studied species deserving recognition as part of the Columbia River and Fraser River fauna. Its status as a species distinct from other dace in British Columbia was clearly established by Peden and Hughes (1988). As with most of our native fish species, there is little public interest. As a unique species evolving in the Columbia Basin in sympatry with two or three other species of *Rhinichthys*, its partitioning of resources and interactions with these species should be of interest to scientist and naturalist. There have been no studies to determine genetic variation of populations from different river drainages.

Evaluation

In general, *Rhinichthys falcatus* is not a threatened species and should not be placed in any COSEWIC category at the species level. Individual populations in the Columbia system are vulnerable and require protection at the local level. Reservoir construction, and possibly nutrient loading (i.e., Okanagan Lake) are amongst the chief potential threats to the species. In the case of the Okanagan area, warm waters above 20°C could be limiting, and conditions causing excessive warming might be monitored although these are probably more important to the south, in the United States.

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