The Biology and Management of the Salish Sucker and Nooksack Dace

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ABSTRACT

Salish sucker (*Catostomus* sp.) and Nooksack dace (*Rhinichthys* sp.) are undescribed and endangered members of a unique assemblage of freshwater fish that evolved in an isolated refuge in Washington State during the Pleistocene glaciations. Canadian populations are limited to a few headwater streams in the lower Fraser Valley, B.C. and are in rapid decline. This report summarizes existing knowledge of the life history and probable causes of decline of both species, and discusses research needs and management options for their conservation. Loss of riffle habitats and decreased in-stream habitat complexity are likely factors in population decline. Habitat fragmentation, sublethal temperature effects, and interactions with exotic species may also be important. Key gaps in knowledge important for management include winter habitat requirements, spawning site locations, habitat fragmentation effects, thermal tolerances, and the identification of effective habitat restoration techniques. Development of appropriate municipal policies for habitat protection are critical due to the limited spatial distribution of both species and the prevalence of land-use related causes of habitat degradation. Increased interest in these species and rising commitment to conservation of biodiversity among government agencies, municipalities, stewardship groups, and the general public provide some grounds for optimism for the survival of these species in Canada.

Key words: *Catostomus*, Chehalis fauna, Fraser Valley, Nooksack dace, *Rhinichthys*, Salish sucker, Washington State.

Salish sucker (*Catostomus* sp.) and Nooksack dace (*Rhinichthys* sp.) are the only Canadian representatives of the Chehalis fauna, a unique fish community that survived continental glaciation in an ice-free refuge in Washington State (McPhail 1967). They are nationally and provincially endangered (Campbell 1990, Cannings 1992, McPhail 1997), and within Canada are found only in a handful of headwater streams in the lower Fraser Valley, B.C. Populations are declining rapidly due to habitat loss caused by urbanization, aggregate extraction, and flood-control dredging (McPhail 1987, 1997; Pearson 1998*a*).

Although the initial description of the sucker is more than 50 years old (Schultz 1947), until this decade only McPhail (1967, 1987, 1997) had taken an active interest in either species. Since 1990, the British Columbia Ministry of Environment, Lands and Parks (MELP) has conducted a series of studies on distribution and habitat preferences (Inglis et al. 1992, 1994), population status (McAdam 1995), and habitat availability (Pearson 1998*a*,*b*). This research is continuing through the Westwater Research Centre of the University of British Columbia.

In this paper I review what is known of the origins, distribution, and life history of both species and discuss possible causes of population decline and the challenges of managing species at risk in 1 of the most rapidly developing regions in Canada.

ORIGINS

The Salish sucker and Nooksack dace recently diverged from 2 common and widespread species, the longnose sucker (*Catostomus catostomus*) and the longnose dace (*Rhinichthys cataractae*) respectively. As the range of these parental species contracted with the onset of glaciation, the fish of the Chehalis Valley were left as peripherally isolated populations (McPhail and Taylor 1996). The valley remained ice-free through all 4 major glaciations of the Pleistocene (McPhail 1967, McPhail and Lindsey 1986). Recent genetic work indicates that both species[1] have been reproductively isolated since well before the most recent glacial episode and perhaps since before the Pleistocene (McPhail 1997).

As the ice sheets withdrew, the Chehalis fauna (a number of other species share this history) dispersed into the newly exposed landscape. Salish sucker and Nooksack dace ventured further north than the others, eventually establishing themselves in the lower Fraser Valley of Canada. Their route was presumably via the temporarily freshwater Puget Sound and a series of lakes that filled the gap between the ice and the Coastal Mountains during the glacial retreat (Thorson 1980). The suckers and dace were likely among the very first species to recolonize the post-glacial streams of the lower Fraser Valley (McPhail and Carveth 1993).

DISTRIBUTION

Nooksack dace currently inhabit streams on the east side of Puget Sound and on the west side of Washington's Olympic Peninsula (Fig. 1). Oddly, they are absent from the drainages lying between these regions on the west side of Puget Sound (McPhail 1997). In Canada their distribution is restricted to tributaries of the Nooksack River: Bertrand, Cave, Pepin, and Fishtrap creeks (Inglis et al. 1994, Pearson 1998*a*).

Salish suckers are known from 6 river systems of the Puget Sound Lowlands and the lower Fraser Valley (Fig. 1). These are: the lower Fraser (Salmon and Salwein rivers, and Semiault Creek); the Little Campbell River; the Nooksack system (Bertrand, Cave, Pepin, and Fishtrap creeks, and Whatcom Lake); the Stilliguamish drainage (Twin Lakes); the Green River; and Lake Cushman of the Skokomish system (McPhail and Taylor 1996).

Figure 2 summarizes the current distribution of Salish sucker and Nooksack dace in Canada from sampling records since 1990. More detailed maps and data are provided by Pearson (1998*a*). It is important to remember in reviewing this presence/absence data, that fish density varies widely among sites and that, with very few exceptions (see below), those of suckers and dace are very low. In addition, given their rarity, the failure to collect a species at a given site does not necessarily imply absence.

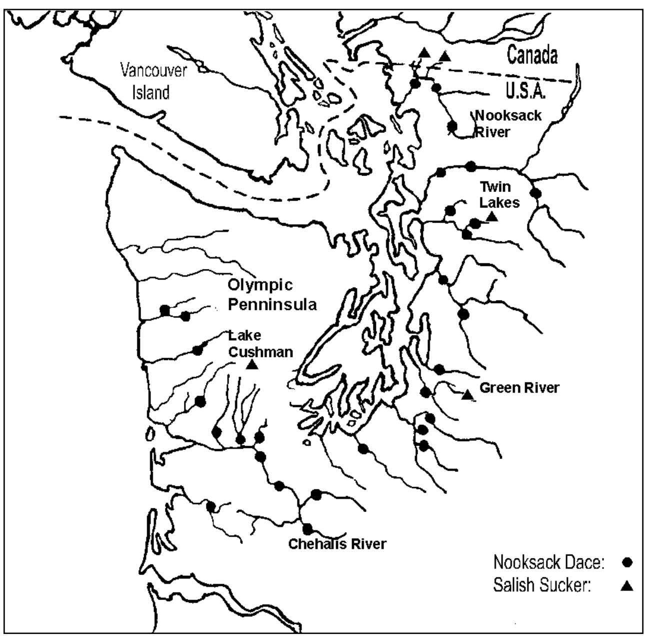

Figure 1. Current global distribution of Salish sucker (▲), Catostomus sp., and Nooksack dace (●), *Rhinichthys* sp. (adapted from McPhail 1997).

POPULATION TRENDS AND CONSERVATION STATUS

Neither species appears imminently threatened in Washington State. Two of the 4 sucker populations are located within protected areas or buffers (J. McPhail, University of British Columbia, pers. comm.), and the dace remain common in most of their native streams (McPhail 1997). In contrast, both species are in rapid decline within Canada. The Salish sucker is considered extirpated from the Little Campbell River (circa 1976; McPhail 1987) and perhaps from the Salwein River (Inglis et al. 1992). Both species have also disappeared from Howes Creek, a tributary of Bertrand

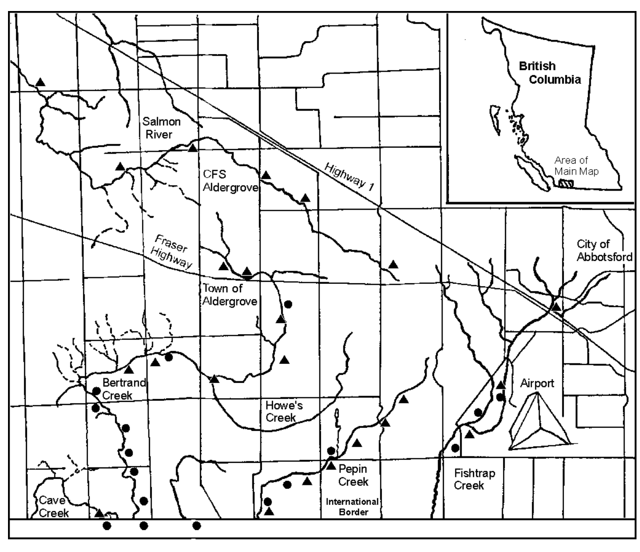

Figure 2. Current Canadian range of Salish sucker (▲) and Nooksack dace (●). A small population of suckers is also known from Semiault Creek in Chilliwack (40 km west of mapped area). The Little Campbell River, from which suckers are believed extirpated, is immediately west of the mapped area.

[1] Although the taxonomic status of neither Nooksack dace nor Salish sucker is established, there is an excellent case for granting species status to both based on their genetic and morphometric uniqueness (McPhail and Taylor 1996, McPhail 1997). I will refer to them as species in this paper for reasons of convenience.

Creek (Inglis et al. 1992, 1994). Dace remain abundant only in Bertrand Creek south of 16th Avenue (Inglis et al. 1994, Pearson 1998*a*), and only lower Pepin Creek and perhaps the upper Salmon River contain healthy numbers of Salish sucker (Inglis et al. 1992, Pearson 1998*a*).

Declines are almost certainly due to progressive habitat loss. The human population of the lower Fraser Valley is 1 of the most rapidly growing in the country. Riffle habitat is quickly disappearing through ponding, siltation, and dredging. Summer flows are decreasing or stopping altogether as surface runoff associated with deforestation, urbanization, and agricultural drainage increases. Dace, for example, were very common in Fishtrap Creek south of Echo Road until virtually all the riffle habitat was eliminated by municipal dredging for flood control between 1989 and 1991, and headwater regions of the Salmon River that once supported healthy populations of sucker now run dry every summer (J. McPhail pers. comm.). The situation of the Canadian populations is exacerbated by their isolation. The dace are separated from the Washington Nooksack River populations by severely degraded habitat in the American portions of Bertrand and Fishtrap creeks (McPhail 1997), and the nearest sucker populations lie 100 km and 2 drainage basins to the south (McPhail and Carveth 1993).

Both species are Red-listed in British Columbia (Cannings 1992) and designated Endangered by the federal Committee on the Status of Endangered Wildlife in Canada (COSEWIC; Campbell 1990, McPhail 1997). Neither is protected in the United States.

LIFE HISTORY

Nooksack Dace

Nooksack dace are benthic riffle specialists as adults. Inglis et al. (1994) used multivariate regressions to generate habitat suitability curves. They found that adults prefer water depths of 10–19 cm at velocities of 25–30cm/sec over gravel, cobble, or small boulders. Winter habitat use has not been well studied. McPhail (1997) suggests that they probably inhabit riffles year-round in the Fraser Valley, but may shift to pools in more severe environments. The author has collected adults from cobble riffles in Bertrand Creek during November and January.

Dace spawn at night during April and May near the upstream end of riffles, with females depositing 200–2,000 eggs depending on body size (McPhail 1997). There is no information on courtship, parental behaviour, or incubation periods. Young-of-the-year dace aggregate in shallow, marginal pools over mud or sand substrates near the downstream ends of riffles. They feed on chironomid larvae and ostracods (McPhail 1997). Aggregations break up in late summer (J. McPhail pers. comm.), and have been observed as late as 8 September by the author.

Both sexes reach maturity at the end of their second summer and spawn for the first time in their third spring. There are generally 4 year-classes present (Inglis et al. 1994) and the oldest known individual was a female in her sixth summer (McPhail 1997). Individuals exceeding 100 mm in fork length are rare.

The few gut contents examined indicate that adult dace feed primarily on riffle-dwelling insects, including caddisfly and mayfly nymphs, dytiscid beetle larvae, and adult riffle beetles (McPhail 1997). They have been observed foraging both at night (J. McPhail pers. comm.; Pearson 1998*a*) and during daylight hours (Pearson 1998*a*). Individuals collected at mid-morning have empty stomachs, but full intestines, suggesting that feeding is nocturnal (McPhail 1997).

Nooksack dace typically occur with cutthroat trout (*Oncorhynchus clarki*), prickly sculpin (*Cottus asper*), rainbow trout (*O. mykiss*), juvenile steelhead (sea-run *O. mykiss*), and juvenile coho salmon (*O. kisutch*), all of which are potential predators. Indeed, cutthroat have been observed feeding on young dace (Inglis et al. 1994).

Salish Sucker

Adult Salish suckers use a variety of habitat types. In Canada they are found in small headwater streams and associated ponds; in Washington, however, several lake populations exist (McPhail 1987). They are caught in a variety of water velocities and depths, but are most often found in slow currents over sand or silt substrate in areas with in-stream vegetation and over-stream cover (Inglis et al. 1992). Young-of-the-year Salish suckers are found in habitats similar to those used by adults, but seem to prefer more overhanging vegetation (Inglis et al. 1992). Winter habitat remains unknown, but it seems likely that they require off-channel refuge to escape from the frequent high flows associated with winter rains in Fraser Valley creeks.

Suckers spawn in riffles over fine gravel at current velocities of up to 50 cm/sec (McPhail and Taylor 1996) beginning in March or April, when water temperatures reach 7–8°C (McPhail 1987). The period is very protracted and individuals in spawning condition have been captured throughout the summer, even in late July at water temperatures in excess of 20°C (Inglis et al. 1992, McAdam 1995, McPhail and Taylor 1996). Fecundity is unknown, but preserved females contain "large numbers of small eggs" (McPhail 1987). Like other species in the genus, Salish suckers are broadcast spawners. No nest is built and the adhesive eggs stick to gravel and rocks. Those on top are usually consumed by predators, but the current carries many under gravel and cobble where they are more protected (J. McPhail pers. comm.). No information is available on incubation period.

Only 2 current spawning sites are known: Pepin Creek at 0 Avenue, and Pepin Creek at Bradner Road. Previously used sites include the Salmon River at 256th, 272nd, and 280th streets, and at 40^{th} and 48^{th} avenues, but these have not been monitored in more than 20 years, and most have been severely degraded since then (J. McPhail pers. comm.). Recruitment appears sporadic and is effectively zero in many years (J. McPhail pers. comm.).

There appear to be 5 year-classes in British Columbia populations (McPhail 1987, Inglis et al. 1992) although older individuals are known from Washington (McPhail 1987). Males are sexually mature in their second year and females in their third year, with the minimum size of spawners being 87 mm for males and 95 mm for females (McPhail and Taylor 1996). The largest individual known from Canadian waters (244 mm fork length) was captured in Pepin Creek in 1992 (Inglis et al. 1992).

Dietary information is limited to gut content analysis of 10 adults, all of which contained primarily detritus and large numbers of chironomid head capsules. The diet of the young is unknown (McPhail 1987). Salish sucker fry and juveniles are probably preyed upon by many of the species with which they share their habitat, including various salmonids, prickly sculpin, and introduced species (see below).

POSSIBLE FACTORS LIMITING POPULATIONS

Populations may be limited by a variety of factors, both abiotic and biotic. These include loss of physical habitat, elevated temperatures, water quality degradation, changes in flow regime, competition, predation, and food. Given the magnitude of alteration and degradation these streams have endured over the past 200 years (Healey 1997), it seems likely that a number of factors are acting in concert to limit populations. The following is a brief discussion of some likely candidates.

Loss of Riffle Habitat

Dace spend virtually their entire adult lives in riffles, and both suckers and dace require gravel or cobble riffles for spawning. A large proportion of riffle in their native streams has been lost to the dredging, siltation, and ponding associated with urbanization, agricultural drainage, and aggregate extraction operations. Increased runoff rates (and consequent lack of groundwater recharge) caused by these developments have also reduced summer discharge levels in many reaches. Surface flow ceases for up to 2 months during most summers in Cave Creek, the upper Salmon River, and many small tributaries across the species range (Pearson 1998*b*). This, in effect, eliminates riffle habitat at the most productive time of year for dace (McPhail 1997).

Loss of In-stream and Over-stream Cover

Channel simplification and loss of riparian vegetation has impacted many reaches, particularly in pasture lands and urban areas. Inglis et al. (1992) demonstrated a marked preference for such cover in suckers, particularly juveniles. Many reaches also lack significant off-channel habitat, which may provide important refuge areas during high flows, particularly for the suckers.

Stream Temperatures/Low Oxygen

Temperature preferences and lethal limits for Nooksack dace and Salish sucker remain unknown, but circumstantial evidence suggests that both species can survive at least short-term exposure to relatively high temperatures (Pearson 1998*a*). Although acute mortality of suckers or dace is unlikely in most reaches at the present time, there are localized areas of concern (Pearson 1998*b*). Sublethal effects, including reduced growth and fecundity and increased susceptibility to disease may also be important.

Hypoxia is commonly associated with high water temperatures and nutrient loading, both of which affect numerous reaches within the study area during late summer (Pearson 1998*b*).

Habitat Fragmentation

All of the factors listed above are likely to reduce populations by decreasing the total area of suitable habitat. Their spatial distribution may also, however, have major impacts by restricting movements and dispersal of suckers and dace, at least seasonally. In addition, dams and poorly designed culverts can block fish passage under some conditions. The effects of such anthropogenic habitat fragmentation on fish is virtually unstudied, but likely to be very important. Many studies of terrestrial habitat fragmentation, which has been a major research focus in conservation biology over the past decade, have demonstrated that habitat fragmentation can accelerate rates of population declines over those produced by area loss alone (Saunders et al. 1991, Andren 1994, Gonzalez et al. 1998). Organisms near the edges of fragments are also exposed to influences from the adjacent hostile habitat. Although such “edge effects” are generally accepted to be deleterious, there is little agreement on definitions, how harmful they are, or even how to measure them (Murcia 1995).

Two key attributes of streams are likely to alter their responses to fragmentation relative to those of terrestrial habitats: streams are linear and directional. In a linear system, fragmentation will proceed much faster than in a 2-dimensional landscape, particularly in the initial stages of habitat destruction. Unlike a 2-dimensional area, in which habitat loss initially appears as holes in intact habitat and separate patches do not form until a considerable amount of habitat is lost (Andren 1994), each unit destroyed in a linear system will either subdivide existing habitat or add to the distance between patches. Consequently the effects of reduced patch size and increased isolation are likely to appear when a

Table 1. Introduced species reported from the current Canadian range of Salish sucker and Nooksack dace (from Pearson 1998*a*).

Creek	Species	First recorded
Fishtrap Creek	Pumpkinseed (*Lepomis gibbosus*)	1995
	Black crappie (*Pomoxis nigromaculatus*)	1997
	Largemouth bass (*Micropterus salmoides*)	1997
Cave Creek	Pumpkinseed	1997
	Fathead minnow (*Pimephales promelas*)	1992
Pepin Creek	Largemouth bass	1997
Bertrand Creek	Black bullhead (*Ameiurus melas*)	1997

much smaller proportion of total habitat is destroyed than in a terrestrial system. The directional nature of stream habitats will influence edge effects greatly. For example, alterations in temperature, sediment load, and large woody debris input levels will have exaggerated impacts on downstream habitats and leave upstream habitats relatively untouched.

Reaches in which habitat has been destroyed or severely altered are unlikely to be completely hostile at all times. Seasonal changes in flow, temperature, and water quality will alter the pattern and distribution of fragmentation. A critical period for Salish sucker and Nooksack dace is likely to occur in late summer, when thermal, hypoxia, and low-flow related barriers are all most likely to occur. Currently, too little is known of movement timing or extent in either species to assess likely impacts. Other studies have shown that species with generalized habitat requirements, like the Salish sucker, are more likely to either tolerate changes within the patch or make use of "degraded" habitat than are specialists such as the dace (Andren 1992, Diffendorfer et al. 1995, Sarre 1995). Species with relatively large home ranges may also simply use several patches by moving between them, perhaps expanding the home range to accommodate habitat loss (Rolstad 1991).

Introduced Species

Exotic species are becoming established in the Nooksack tributaries in increasing numbers (Table 1), and may impact sucker and dace populations either competitively or through direct predation. Several of the introduced species are at least partially piscivorous.

RESEARCH AND MANAGEMENT NEEDS

Without significant habitat protection and restoration measures, the likelihood of the Canadian populations of Salish sucker and Nooksack dace surviving more than a few decades seems slim. Those remaining are already perilously close to extirpation, and what occurs over the next 5–10 years is likely to determine their fate. Specifically, spawning, rearing, and overwintering habitat needs to be identified and protected. Stream temperatures should be at least stabilized at current levels, and sources of siltation should be identified and reduced. In the longer term, changes in the hydrograph stemming from urbanization need to be stopped and hopefully reversed—especially decreased summer flows. All of this will require a high level of commitment and cooperation from landowners, government agencies, and local stewardship groups.

Municipal governments in particular are critical to successful conservation efforts for these and many other species at risk in heavily settled areas. A large proportion of threatened and endangered species have very restricted geographic ranges, which correspond most closely to local government jurisdictions in spatial scale. Furthermore, the majority of threats to species in these areas relate to altered land uses, which are largely under municipal control (Press et al. 1996). Powerful policy tools, including zoning by-laws, official community plans, designation of environmentally sensitive areas, and tree by-laws are available to local governments. With the necessary political commitment and some imaginative application these could become major contributors to biodiversity preservation in British Columbia. Indeed, I would argue that without their application there is little long-term hope for many species at risk, including the Salish sucker and Nooksack dace.

Fortunately, there are considerable grounds for optimism on this front. Of the 2 municipalities that contain virtually all of the Canadian range of Salish sucker and Nooksack dace, one (Abbotsford) has hired a Stream Stewardship Coordinator and has established a roundtable committee to support her work. The other (Langley) has an Environmental Coordinator and works closely with the Langley Environmental Partners Society on stream rehabilitation work. A number of local stewardship groups are active in habitat restoration. The necessary ingredients for effective action seem to be falling into place. The long-term survival of these unique species will provide a very simple test of our ability to sustainably manage watersheds with multiple and competing land uses and values.

ACKNOWLEDGEMENTS

A number of people provided invaluable assistance to this work. T. Patton was an enthusiastic and competent field assistant. K. Payette of MELP Surrey, fulfilled my many requests for maps, aerial photos, and files. J. Rosenfeld of MELP Fisheries Research, and my research supervisor, M. Healey, contributed plenty of good advice, and J. McPhail gave access to his encyclopedic knowledge of the area's fish fauna. This research is financially supported by British Columbia's Habitat Conservation Trust Fund.

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