RECOVERY POTENTIAL ASSESSMENT FOR THE SALISH SUCKER (*CATOSTOMUS SP*.) IN CANADA

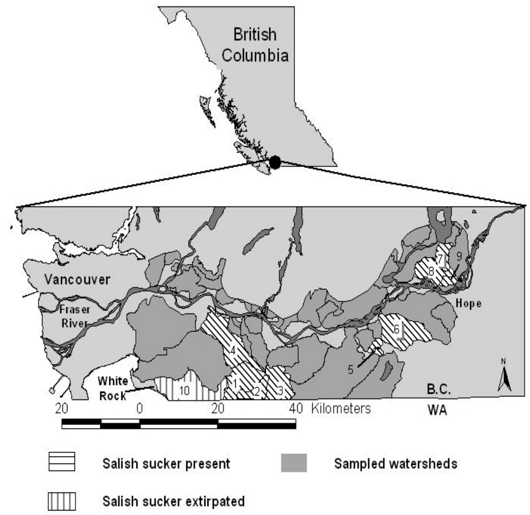

Figure 1: Location of Salish sucker populations in Canada. Source: Pearson 2007.

Context :

This Recovery Potential Assessment provides advice to the Minister of Fisheries and Oceans concerning the status, human-induced mortally, habitat threats and scenarios for mitigation for Salish sucker Catostomus sp. Salish sucker is listed as Endangered (Schedule 1) under the Species at Risk Act (SARA). The ten populations of Salish sucker in Canadian waters are presently considered a single designatable unit according to COSEWIC criteria. The species was designated Endangered by COSEWIC in 1986, with an updated status report in 2002 (COSEWIC 2002). Ideally, an RPA precedes listing of a species or population under SARA, and is used to help make the decision whether or not to list. If the species is already listed, the RPA contains information and technical advice which can be used to develop recovery plans. Salish sucker belongs to a third category: it is listed under SARA, and a draft Recovery Strategy has already been written. A DFO science peer-review was conducted April 8 2008 at Nanaimo BC.

SUMMARY

- Potential critical habitat includes all reaches in streams currently containing populations that contain more than 50 m of continuous pool that exceeds 70 cm depth at low flow. It includes all aquatic habitat and riparian reserve strips of native vegetation on both banks for the entire length of the reach. The most important riparian vegetation is mature forest to provide effective ecological function and protection to instream habitat.

- Current estimates of abundance of Salish sucker are unpublished, incomplete (some populations have not been not considered) and highly uncertain, and thus, insufficient to describe trends in abundance. For these reasons, population estimates presented in the original working paper could not be endorsed by all participants in the peer-review process.

- All estimates of current habitat capacity within individual watersheds are below the amount required to support 7000 adults, an average guideline for the minimum viable population (MVP) needed to ensure (with 99% probability) the long-term persistence of an isolated vertebrate population (Reed et al. 2003). Only 1 population (Chilliwack Delta) appears to have sufficient habitat capacity to support 4700 adults, the MVP for a 90% probability of long-term persistence. However, these estimates of habitat capacity are highly uncertain, and populations in different streams might not be as isolated from one another as the MVP guidelines assume.

- The geographic location of potential critical habitat for the known populations of Salish sucker is identified in Pearson (2007). Relationships between buffer width and maintenance of stream ecological function have not been developed that are specific to suckers. Recommended riparian buffer widths for potential critical habitat were therefore established using buffer-width ecological function relationships developed for salmonids, as described in the Riparian Areas Regulations methodology (Pearson 2007). Generalized buffer width-ecological function relationships developed for salmonids can be used for calculating biological and socio-economic tradeoffs until such time as research targeted at developing specific relationships for sucker are undertaken.

- Hypoxia, habitat loss, degradation, destruction and fragmentation are the most important factors jeopardizing survival or recovery.

- Population recovery depends on halting and reversing environmental degradation of Salish sucker habitat. The probability of recovery will be low if the impact on habitats from agricultural, industrial and urban development is not addressed through habitat protection and restoration, particularly in the presence of projected increases in human population growth in the Fraser Valley.

INTRODUCTION

This RPA for Salish sucker adheres to the revised DFO protocol for conducting Recovery Potential assessments (RPA) (DFO 2007). An RPA should provide the best advice possible with the data available, and note specific information gaps. For the Salish sucker, very little information is available on the species' natural history, abundance and habitat use. In fact, the knowledge base is limited to a few peer-reviewed papers and unpublished reports, and the first-hand experience of a small number of experts. Without more field research, our understanding of the species is not likely to increase. Uncertainties arising from this extremely limited knowledge base are noted throughout the RPA. The advice in this report was formulated at two DFO peer-reviews of Salish sucker held in Nanaimo BC. A review of potential critical habitat occurred October 25 2007. Products of that meeting included a CSAS Research Document (Pearson 2007) and a CSAS Proceedings Document (DFO 2007). A review of the recovery potential of Salish sucker occurred at a second peer-review meeting held April 8 2008 in Nanaimo. Products of that meeting will be a CSAS Research

Document (Harvey 2009), a Proceedings Document and this CSAS Science Advisory Document.

ASSESSMENT

Phase I: Assessment of Species

Range and numbers of populations

The sucker family (Catostomidae) comprises many species, most of which inhabit fresh water in North America The Salish sucker is a divergent form of the more widely distributed longnose sucker (*Catostomus catostomus*) which occurs in western Washington and also in the lower Fraser Valley, B.C. (Figure 1). Salish sucker is distinct from longnose sucker both morphologically and genetically (based on analysis of mitochondrial DNA); however, it has not been formally described as a different species. The two forms became isolated during the most recent glaciation (>10,000 years ago), which the Salish sucker survived in the non-glaciated Chehalis refugium south of the Puget ice-lobe and west of the Coast Mountains. This origin explains the present distribution of Salish suckers along the eastern side of Puget Sound and north into the lower Fraser Valley. No studies have been undertaken to determine the extent of demographic isolation or genetic distinctiveness among Salish suckers inhabiting different rivers in Canada.

Salish sucker have been extirpated from at least one small watershed in the Fraser Valley (Little Campbell River), and are presently found in ten other Canadian watersheds:

- Bertrand Creek
- Pepin Creek
- Fishtrap Creek
- Salmon River
- Salwein Creek/Hopedale Slough
- Chilliwack Delta (Atchelitz, Chilliwack and Semmihault Creeks)
- Miami Creek (Harrison Lake tributary)
- Mountain Slough
- Agassiz Slough
- Elk Creek/Hope Slough

The first three watersheds also contain endangered populations of Nooksack dace; the two species, while they do not overlap greatly in their habitat preferences, are nevertheless subject to many of the same threats. The population in Elk Creek is the most recently discovered; they appear to be thinly distributed and the abundance is not known. Populations grouped as occurring in the Chilliwack Delta occupy small creeks in the historic wetland area.

Within the above watersheds, the distribution of Salish sucker is concentrated within a few reaches that include both pool and riffle habitat features (e.g. gradient, channel form, riparian condition, etc.). A typical reach will be in the high hundreds to the low thousands of metres long. Most home ranges are small (average 170 m). Population viability will depend on the proximity of occupied habitat and the degree of fragmentation within a reach, for example whether there are any barriers between occupied pools (e.g. beaver dams). This uneven distribution has important consequences for risk assessment and recovery planning. A "rescue effect" – re-colonization of a stretch of river – is limited by the low probability of natural exchange of individuals between watersheds or sections of watersheds. It is, however, still feasible given the demonstrated ability of some individuals to range beyond a few hundred metres.

Salish sucker populations in B.C. are atypical in that they inhabit small streams rather than lakes; however, within those streams, Salish sucker do prefer deeper pool habitat. In contrast, Salish sucker populations in Washington State tend to inhabit lakes, like most longnose sucker populations.

Abundance

Current estimates of abundance from unpublished data of Salish sucker are highly uncertain, do not cover all of the ten known populations and are insufficient to describe trends in abundance (Table 1). Estimated mean abundances as of 2004, such as they are, obtained through CPUE for six of the known populations and based on a density of 0.05 breeding adults/m^2, are provided in Table 1.

Table 1. Estimates of mean abundance of Salish Sucker for six of the known populations as of 2004. Note CPUE was too low in the other four populations to allow estimation.

Watershed	Estimated abundance
Salmon River	1390
Bertrand Creek	240
Pepin Creek	2860
Fishtrap Creek	490
Salwein Creek	1290
Miami Creek	850

Given the high uncertainty in population estimates, there acceptance could not be support by all participants in the peer-review process.

Life history parameters

There are insufficient data to estimate population parameters useful for population viability analysis such as mortality and recruitment rates. Salish suckers mature at age two (earlier than longnose suckers), and live about five years.

Habitat requirements and habitat use patterns

Salish sucker are most commonly found in marshes and beaver ponds where water is deeper than 70 cm. They require extensive areas of deep water with access to spawning riffles and shallower nursery habitat. While tolerant to low oxygen, the fact that sub-lethal effects are likely between 2-4 mg/l suggests that a margin of safety can be achieved by setting the lower limit of dissolved oxygen at around 4 mg/l. The biological, physical and ecological principles used to identify aquatic and terrestrial habitat for Salish sucker are described in Pearson (2007).

Potential critical habitat has been defined for all reaches currently containing populations of Salish sucker as those with more than 50 m of continuous pool that is deeper than 70 cm at low flow. For the known populations, most of the potential critical habitat has been mapped and presently includes 141.5 km of surveyed channel (approximately 50% of the total surveyed). Deep pool habitat, most abundant in headwater ponds and marshes, is the primary habitat for most of the life cycle, and the 50 m threshold is the minimum length where CPUE is greater than 1.8 fish/trap. Riffles, which are used for spawning, are rare in such reaches; some fish may even leave their home reaches in search of them. Shallow pool and glide habitat, used by juveniles, are also included in critical reaches.

The riparian strip serves to protect the integrity of stream habitat. It helps prevent erosion and siltation, buffers water temperatures and limits nutrient input and provides a source of large woody debris that plays a signifianct role in pool formation in small coastal streams. Proposed riparian habitat is identified in Pearson (2007) and is consistent with the B.C. Riparian Areas Regulation (RAR, Reg. 837 under the Fish Protection Act). In many areas, riparian habitat is restricted by existing permanent structures (roads, dykes, buildings). A detailed discussion of the rationale for including riparian zones in potential critical habitat is found in Pearson (2007). The geographic location of potential critical habitat for the known populations of Salish sucker, reflecting survey work until 2005, is also provided in Pearson (2007).

Population and distribution targets for recovery

In a survey of population viability analyses of over 100 vertebrate species (but only 1 fish species), the minimum viable population (MVP) averaged about 7,000 breeding adults (range 2,000-10,000) where viability was defined as less than 1% risk of extinction in 40 generations; the MVP averaged 4700 if the acceptable risk of extinction was relaxed to 10% (Reed et al. 2003). Although highly uncertain, the estimated abundances of Salish sucker in Canadian streams are well below these MVP guidelines.

If all good sucker habitat were occupied at the mean density of 0.05 fish/m^2, estimated for six populations, then the estimated carrying capacity ranges between 800 and 7,000 fish per stream, with an average of 2,600 breeding adults (Pearson 2007).

Table 2. Estimates of carrying capacity of Salish sucker for nine watersheds and excluding the little-known "new" population at Elk Creek.

Watershed	Carrying capacity
Bertrand Creek	800
Pepin Creek	1200
Fishtrap Creek	4700
Salmon River	1800
Salwein Creek/Hopedale Slough	2700
Chilliwack Delta	7000
Miami Creek	1500
Mountain Slough	2300
Agassiz Slough	2000

All of these habitat capacity estimates are below the average MVP required to ensure a 99% probability of long-term persistence (7000 adults), and apparently, only 1 population (Chilliwack Delta) could support the MVP for 90% probability of long-term persistence (4700 adults). The target population for Bertrand Creek is significantly lower than all the others and well below either estimate of MVP. This emphasizes the importance of environmental restoration to increase capacity, particularly in that Bertrand Creek. The fact that the estimated abundance for Pepin Creek appears to exceed carrying capacity underscores the limitations of the data used to estimate abundance.

The derivation of the habitat capacity estimates, in part, hinge on the assumed density of 0.05 fish/m^2 for good habitat. The density in "good" habitat might be higher if populations are currently limited by mortality factors unrelated to habitat constraints (i.e. toxic chemicals or invasive species), and if those factors could be remediated. If demographic isolation among streams is less than has been assumed (i.e. if the population in one stream is not completely isolated from those in other streams), then it would be misleading to apply the MVP guidelines to individual streams and perhaps be more appropriate to apply the MVP guidelines to an aggregate of neighbouring (incompletely isolated) streams. If habitat degradation is the limiting factor affecting population abundance and growth then a rescue effect is unlikely to result in population recovery until habitat degradation is reversed.

Expected population trajectories and time to recovery

The limitation of the data and lack of knowledge about key life history parameters precludes meaningful population viability analysis to project population trajectories and to assess time to recovery. It should be noted, however, that the inability to quantify population recovery will not impede recovery planning, as clearly, recovery will ultimately depend on improving and restoring the environment to increase habitat capacity.

Residence

Animals that habitually return to dwelling places (dens, nests) during some part of their life cycles are described in *SARA* as having 'residence requirements'. Salish sucker do not build nests, nor do they defend breeding territories.

Phase II: Scope for Management to Facilitate Recovery

Probability that recovery targets can be achieved

Population recovery is dependent on protecting existing habitat and halting and reversing environmental degradation of Salish sucker habitat. The probability of recovery will be low if the impact on habitats from agricultural, industrial and urban development is not addressed through habitat protection and restoration. This is a particular concern in the presence of projected increases in human population growth in the BC lower mainland and Fraser Valley watersheds. COSEWIC (2002) reports that environmental degradation has been continuing but that there are examples of habitat restoration by residents and industry in a few systems. The impact of these activities on population growth has not been assessed.

Magnitude of each major potential source of mortality

Pearson (2007) provides a qualitative assessment of impacts for each mortality source on Salish sucker habitat by population. A description of each mortality activity along with an assessment of threat severity is reproduced in Table 3.

Table 3. A description of mortality activity and qualitative assessment of the degree of threat severity.

Activity	**Result**
Over application of Fertilizer	Nutrient loading of streams through excessive application of manure is the most common cause of the chronic late summer hypoxia that affects many reaches inhabited by Salish sucker (Schreier et al., 2003).
Drainage projects	Dredging, dyking, and channelization works directly destroy habitat, cause sediment deposition in riffles, and reduce base flow,
Urban storm drainage	Storm drain systems that discharge directly to creeks are major sources of toxic contamination and sediment. They also reduce baseflow by inhibiting water infiltration to aquifers.
Riparian vegetation removal	Loss of riparian vegetation exposes a stream to increased erosion and sediment deposition, elevated water temperatures, reduced supplies of terrestrially derived food, and increased nutrient loading
Livestock access to creeks	Livestock damage habitat by trampling or causing erosion that clogs riffles with sediment. Access also contributes to nutrient loading.
Excessive water withdrawal	Water extraction (surface or ground) during dry periods reduces flows, which may contribute to hypoxia and drying of riffles needed for spawning.
Excessive sediment releases	Sediment deposition in spawning substrate and inhibition of the flow of oxygen-rich water to eggs and larvae during incubation.

Activity	**Bertrand Creek**	**Pepin Brook**	**Fishtrap Creek**	**Upper Salmon River**	**Salwein/ Hopedale Slough**	**Atchelitz/ Chilliwack/ Semmihault**	**Miami Creek**	**Mountain Slough**	**Agassiz Slough**	**Elk Creek/ Hope River**
Over application of fertilizer	+++	++	+++	+++	++	+++	+++	+++	++	+++
Drainage projects	++	+	+++	++	++	+++	+++	+++	+	+++
Urban storm drainage	+++	-	+++	-	-	+++	++	-	+++	++
Riparian vegetation removal	++	+	+++	++	+++	+++	+++	+++	++	++
Livestock access to creeks	+	+	+	++	++	++	++	++	+	++
Excessive water withdrawal	+++	+	++	+++	+	++	++	++	++	++
Excessive sediment releases	+	+++	++	+	+	++	+	+++	+	+

+++	major concern	+	minor concern
	moderate concern	-	not a concern

Hypoxia

No single threat predominates in all population, however, hypoxia, an effect resulting mainly from pollution by agricultural fertilizers and manure, is the most serious threat in most populations. Primarily a result of excess nutrients in the form of fertilizers, hypoxia happens when algae and plant growth explode, and subsequent decomposition of organic matter uses up oxygen. If riparian vegetation is reduced, the effect is compounded by high daytime temperatures, because warmer water holds less oxygen. Reduced water movement from ponding, channelization or low flows can be an aggravating factor.

Habitat destruction and fragmentation

The effects of human activities on stream and riparian habitat in the systems that support Salish sucker generally extend beyond the high water mark into the riparian buffer zones. The likelihood of this threat is high, and its consequences severe.

The course, structure and flow characteristics of many streams in the Fraser Valley have been drastically altered by draining, dredging, building dikes, infilling and channelization for flood control, agricultural drainage, and construction projects. Marshes and beaver ponds, where Salish sucker density is highest, are often targeted for drainage in the “improvement” of agricultural land, which makes them very vulnerable to this threat. Salish sucker habitat continues to be lost to flood control and agricultural drainage projects; not all of these are done under legal permits.

Physical structures like culverts and weirs, if improperly designed, can become impassable barriers between sections of habitat (beaver dams, which are not discussed here because they are not man-made, have the same effect, although they can also create habitat for Salish sucker and other small fish species). Habitat destruction and fragmentation can have the following effects on Salish sucker:

Isolation: Because Salish sucker populations are spatially clumped, each watershed is probably inhabited by core subpopulations that are occasionally connected by migrations that would likely occur during transitory periods of high water. Habitat fragmentation would eliminate these migrations, thus reducing the ability to colonize new habitat, often a key factor in the viability of populations.

Sedimentation: Often caused by bank erosion from loss of riparian vegetation or direct discharge from runoff, excess sediment can smother riffles that Salish sucker need for spawning. An extreme case is Pepin Creek, where chronic sediment from gravel operations has filled in pools in some reaches and coated the stream bed with deposited fines. Sediment erodes naturally from banks and stream beds that may be many kilometers upstream, and streams are the conduits for its redistribution. Their capacity to handle sediment can be overwhelmed either by the addition of sediment from outside sources by way of storm drain runoff, or by any action that increases bank scouring and associated sediment inputs, such as removing riparian vegetation or increasing peak flow. Urban development, agriculture and mining can all trigger increased sedimentation.

Water withdrawal

Agricultural and domestic water demand tends to peak when supplies are the most scarce. Actions that exacerbate seasonal low flows include impermeable structures (buildings, parking lots) that reduce aquifer recharge, gravel mining that reduces the size of aquifers, and drainage of wetlands. Especially in summer, water demands for agriculture, domestic use and gravel mining can dewater streams whose only source of replenishment in a time of low rainfall is ground water. The effect of water withdrawal is mainly to exacerbate the problems caused by hypoxia, habitat loss, pollution and introduced species, although the deep pool habitats preferred by Salish sucker provide some buffer assuming that the pool habitat is not stagnant and biological oxygen demand is low.

The likelihood of this threat is high, and its effects variable, ranging to severe if pools and riffles are strongly affected and if inadequate re-aeration in riffles associated with low discharge exacerbates hypoxia. Uncertainties derive from the amount of extraction, its location and timing.

Introduced species

Apart from direct degradation of sucker habitat, there are introduced predators in all known Salish sucker streams: they include bullfrog (*Rana catesbeiana*), bullhead (*Ameiurus nebulosus*) and largemouth bass (*Micropterus salmoides*). These species appear to have coexisted with Salish sucker for a decade in some parts of their range. Further introductions are possible. Their impacts on Salish sucker are not well known. Based on the existence of introduced species already in Salish sucker habitat and the easy accessibility of that habitat, the likelihood of further introductions is high.

Phase III: Scenarios for Mitigation and Alternatives to Activities

Inventory of mitigation measures

The human activities that most threaten Salish sucker in Canada are those that alter, destroy, pollute or disrupt potential critical habitat. These threats are the result of more than a century of agricultural, industrial and urban development in the Fraser Valley. While damage to habitat still occurs, our understanding of its effects on wildlife has grown; so too has the number of legislative and regulatory tools (including some that are rarely enforced). In the following section of this RPA, ways to minimize these effects are presented; after that, the report concludes with a consideration of ways in which some of these activities can actually be eliminated, and replaced by others that have no impact on potential critical habitat.

It is recommended that the existence of endangered Nooksack dace in Bertrand, Fishtrap and Pepin Creeks should be taken into account when developing best practices and restoration projects for these watersheds, because the two species prefer different habitats. In most cases Nooksack dace seem unlikely to be harmed by recovery activities for Salish sucker, many of which focus on creating new habitat, rather than converting existing habitat used by one species to a different type. Recovery actions that benefit two endangered species will also have a positive awareness impact.

Hypoxia

Agricultural intensification, which means getting higher production out of the same amount of land, has been going on for 10,000 years, with enormous modification of global ecosystems (FAO 2004). Agricultural practices in the Fraser Valley accounts for over half the gross farm receipts in B.C. on a small portion of the province's overall agricultural land (Fraser Basin Council 2001). Agriculture intensification involves irrigation, increased mechanization, the use of higher-yielding plant varieties and increased use of fertilizers, including manure. Minimizing hypoxia, an indirect effect of pollution to which Salish sucker are especially vulnerable, starts with reducing fertilizer input to streams.

In the Fraser Valley, using manure or fertilizer in excess of crop needs or at the wrong time increases non-point-source pollution from nutrients and other substances contained in manure. Minimizing the amount of nutrient loading in Fraser Valley streams is a challenge, and sustainable management of nutrients in the Fraser Valley is still a distant goal. The two most applicable Acts are the federal *Fisheries Act* and the provincial *Waste Management Act*. The Fisheries Act specifically prohibits entry of oxygen-depleting wastes into fish-frequented waters. The *Agricultural Waste Control Regulation*, under the *Waste Management Act*, pertains specifically to nutrient management on farms. Both Acts contain provision for enforcement and fines up to $1 million. Further legislative options include developing and implementing provincial groundwater legislation.

A Nutrient Management Planning Strategy has been developed jointly by government agencies and agricultural producers (Fraser Basin Council 2001). For much of the Fraser Valley, farms can achieve an acceptable nutrient balance, and reduce the risk of hypoxia in Salish sucker habitat, by improving on-farm nutrient management practices, reducing the use of inorganic fertilizers, improving feeding strategies and setting up manure storage. There are substantial benefits beyond the environmental ones. These include improved consumer perception, reduced fertilizer costs and health risks to cattle, reduced greenhouse gases and improved human health through better water quality.

Monitoring and awareness are critical, and there is a major role for stewardship groups working in partnership with technical and regulatory advisors from the responsible federal, provincial and municipal agencies.

Habitat destruction and fragmentation

There are ways not only to reduce the instances of habitat destruction and fragmentation, but also to reduce their main effects on Salish sucker, namely isolation and sedimentation. The first approach is regulatory, educational and proactive. It relies on using our knowledge of the threats, their effects and the existing regulatory mechanisms to develop reach-specific best management practices. An example would be controlling sedimentation through better management of storm drain discharge and closer control of gravel mining operations. Such practices will only work if landowners, stewardship groups, regulatory agencies and the public buy into their development and enforcement. Awareness and engagement of landowners will be especially important in cases where de facto best management practices already exist.

The second approach accepts that habitat loss has already occurred, and concentrates on remediation. Forested riparian buffers are now required on urban lands under the Riparian Areas Regulation. Moving towards establishment of forested riparian buffers on agricultural lands bordering sucker streams is also necessary to protect and restore sucker habitat. Restoration of damaged habitat, creation of new riffle habitat and riparian planting are all technically feasible and well within the interest and expertise of stewardship groups working in partnership with fisheries agencies. Restoration of habitat has the added virtue of being measurable. Public awareness materials and a participatory approach will again be crucial, especially for landowners expected to host the work of remediation. Based on results from a long history of freshwater salmonid habitat restoration in B.C., such fieldwork, combined with participatory development of agricultural and industrial best practices, can significantly minimize harm to Salish sucker habitat. Isolation of subpopulations, for example, could be minimized by removing barriers; sedimentation could be reduced by planting riparian vegetation to limit bank scouring. Both the reduction of sedimentation and the restoration of sediment-damaged riffles depend on mapping, prioritizing and working with multi-stakeholder groups.

Water withdrawal

To preserve the buffering effect of the sloughs and pools that typify Salish sucker habitat, best management practices regarding seasonal flow will need to be developed from water balance models for all watersheds where the species is found. These models will quantify current flow regimes and the extent to which drainages have been altered by surface water abstraction and groundwater removal. Minimum instream flow prescriptions (based on relationships between habitat availability and discharge) must then be developed for key reaches and harmonized with existing licenses for surface water extraction. The domino effect whereby groundwater extraction makes up for reduced availability of surface water needs also to be minimized, because the licensed withdrawal of surface water is not the only cause of decrease in flow. Withdrawal of ground water (which does not require a license in B.C.) may pose a risk in some of the watersheds occupied by Salish sucker. Current groundwater demands are likely lowering the groundwater table at critical summer low flows, and unrestricted groundwater extraction in the future will be a major cause of habitat loss and threat to population persistence. Two measures will help prevent water withdrawal exceeding any specified limits: licensing of groundwater extraction, and further research to determine the connection between surface and ground waters in the basin. Developing relationships between stream discharge and habitat availability (and by implication, a population response) for suckers is key to establishing minimum flow requirements.

Introduced species

Introductions of non-native species are usually done by the general public; some are inadvertent. The only realistic way to minimize the likelihood of further introductions is awareness, including signage at easy access points.

Alternatives to human activities and threats to habitat

The previous section discussed ways of minimizing human activities that degrade and pollute habitat; the opportunity also exists to eliminate those activities in sections of the watersheds where potential critical habitat is presently damaged. Relationships between buffer width and maintenance of stream ecological function have not been developed that are specific to suckers. Recommended riparian buffer widths for potential critical habitat were therefore established using buffer-width ecological function relationships developed for salmonids, as described in the Riparian Areas Regulations methodology (Pearson 2007). Generalized buffer width-ecological function relationships developed for salmonids can be used for calculating biological and socio-economic tradeoffs until such time as research targeted at developing specific relationships for sucker are undertaken. This would help geo-reference critical habitat in the recovery plan required under SARA based on biological and socio-economic trade offs. Some of the riparian habitat is already occupied by permanent structures (buildings, roads, trails, railways, dikes). Portions of the remainder of actively farmed riparian land could, however, be removed from production. A model is the Conservation Reserve Enhancement Program (CREP), a land retirement program administered by the United States Department of Agriculture's Farm Service Agency. The CREP program, which is available in all states, helps producers protect and restore wildlife habitat while conserving ground and surface water. Participation is voluntary; land enrolled in CREP is removed from production and grazing for a contracted period of 10-15 years. Landowners are paid an annual rent and reimbursed for buffer planting and maintenance.

In Canada, similar objectives can be achieved through land trusts. While most trusts work by acquiring land (hence removing the risk of development that could affect biodiversity and ecosystem processes), some operate in a way analogous to CREP. The Delta Farmland and Wildlife Trust, for example, achieves its land conservation objectives through assisted land management and stewardship on land that is owned by others. While many of its activities target farming practices in the Fraser Delta that will benefit wildfowl, the same methods (and probably even many of the same funders) will apply to Salish sucker riparian habitat. Any organization prepared to become involved in collaborative riparian restoration of Salish sucker habitat would need to be aware of potential habitat synergies and conflicts with other important species (both salmonids and the Nooksack dace have some habitat overlap with Salish sucker), and have demonstrated capacity for the long term building of landowner participation in restoration projects. Liaison with the Recovery Implementation Group for Salish sucker will also be important.

The kinds of land retirement and stewardship activities described above apply mainly to habitat degradation. Their impact on nutrient loading, which was identified by the Salish Sucker Recovery Team as the most severe threat to the species, would be limited by the amount of agricultural land included in any retirement or stewardship program.

Finally, the BC Environmental Farm Plan initiative offers some immediate opportunities for protecting fish habitat. This relatively recent voluntary program is available to agricultural producers and provides technical advice and funding for implementing approved farm plans.

CONCLUSIONS AND ADVICE

Potential critical habitat includes all reaches in streams currently containing populations that contain more than 50 m of continuous pool > 70 cm depth at low flow. It includes all aquatic habitat and riparian reserve strips of native vegetation on both banks for the entire length of the reach. Riparian vegetation in sucker reaches should be mature forest to provide effective ecological function and protection to instream habitat.

Current estimates of abundance from unpublished data of Salish sucker are highly uncertain, do not cover all of the ten known populations and are insufficient to describe trends in abundance.

All estimates of current habitat capacity within individual watersheds are below the amount required to support 7000 adults, an average guideline for the minimum viable population (MVP) needed to ensure (with 99% probability) the long-term persistence of an isolated vertebrate population (Reed et al. 2003). Only 1 population (Chilliwack Delta) appears to have sufficient habitat capacity to support 4700 adults, the MVP for a 90% probability of long-term persistence. However, these estimates of habitat capacity are highly uncertain, and populations in different streams might not be as isolated from one another as the MVP guidelines assume. In any case, restoring habitat will clearly be an important strategy to achieve the survival or recovery of the Salish sucker.

The geographic location of potential critical habitat for the known populations of Salish sucker is identified in Pearson (2007). Relationships between buffer width and maintenance of stream ecological function have not been developed that are specific to suckers. Recommended riparian buffer widths for potential critical habitat were therefore established using buffer-width ecological function relationships developed for salmonids, as described in the Riparian Areas Regulations methodology (Pearson 2007). Generalized buffer width-ecological function relationships developed for salmonids can be used for calculating biological and socio-economic tradeoffs until such time as research targeted at developing specific relationships for sucker are undertaken. This would help geo-reference critical habitat in the recovery plan required under SARA based on biological and socio-economic trade offs.

Hypoxia, habitat destruction and habitat fragmentation are the most important factors jeopardizing survival or recovery. Population recovery depends on halting and reversing environmental degradation of Salish sucker habitat. The probability of recovery will be low if the impact on habitats from agricultural, industrial and urban development is not addressed through habitat restoration, particularly in the presence of projected increases in human population growth in the Fraser Valley.

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