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Recovery Potential Assessment for the Nooksack Dace (*Rhinichthys cataractae)*

Évaluation du potentiel de rétablissement du naseux de la Nooksack (*Rhinichthys cataractae)*

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ABSTRACT

Nooksack dace is a close relative of longnose dace, a freshwater minnow widely distributed in North America. The Nooksack subspecies is found in only four rivers in Canada, all of them in the Fraser Valley. Three of these rivers are in the Nooksack River basin and flow south into Washington State; the fourth (Brunette River) is a tributary of the Fraser River. Most Nooksack dace habitat is in the United States.

The Nooksack subspecies was designated *Endangered* by COSEWIC in 1996, with an updated status report in 2000. The B.C. Conservation Data Centre classifies the subspecies as S1 (*Critically Imperiled*). Nooksack dace was listed as *Endangered* (Schedule 1) under the Species at Risk Act (*SARA*) in 2003. As a member of the "Chehalis fauna", a group of fishes that emerged in unglaciated areas south of Puget Sound and diverged from those in the Columbia drainage, the subspecies has considerable scientific interest for evolutionary biologists.

Nooksack dace spend most of their lives near the bottom, within restricted stretches of river, with a strong preference for riffles (areas of faster-moving water). Population sizes for Bertrand, Pepin and Fishtrap Creeks are uncertain and have been estimated using an indirect process. They are: Bertrand Creek: 5,700; Pepin Creek: 800; and Fishtrap Creek: 300. There are insufficient data to describe any trends in abundance.

Critical habitat for Nooksack dace is defined as "reaches in their native creeks that contain or are known to have previously contained more than 10% riffle by length." The human activities that most threaten Nooksack dace in Canada are those that alter, destroy or break up critical habitat. The threats to dace habitat are the result of more than a century of agricultural, industrial and urban development of the Fraser Valley. They include physical destruction, seasonal low flows, sedimentation and fragmentation. Nooksack dace habitat continues to be lost to flood control and agricultural drainage projects. Riffles and marginal pools are the most affected.

There are options not only for reducing the instances of habitat destruction and fragmentation, but also for minimizing their effects. The first approach relies on using our knowledge of the threats, their effects and the existing regulatory mechanisms to develop reach-specific best management practices. The second approach accepts that habitat loss has already occurred, and concentrates on remediation. Restoration of damaged habitat, creation of new riffle habitat and riparian planting are all technically feasible.

Alternatives to activities that affect dace habitat include removing land from agricultural production. One model is the Conservation Reserve Enhancement Program (CREP), a voluntary land retirement program administered by the United States Department of Agriculture's Farm Service Agency (FSA). A Canadian alternative that concentrates on best practices and restoration of riparian lands in the Fraser Valley could follow the lead of successful large-scale wildfowl habitat restoration projects undertaken by land trusts and their partners in B.C.

RÉSUMÉ

Le naseux de la Nooksack est un proche parent du naseux des rapides, méné d'eau douce largement réparti en Amérique du Nord. La sous-espèce de la Nooksack est présente dans quatre cours d'eau seulement au Canada, tous dans la vallée du Fraser. Trois d'entre eux se trouvent dans le bassin de la rivière Nooksack et coulent vers le sud, jusque dans l'État de Washington; le quatrième, la rivière Brunette, est un affluent du Fraser. La plus grande partie de l'habitat du naseux de la Nooksack se trouve aux États-Unis.

La sous-espèce de la Nooksack a été désignée comme *espèce en voie de disparition* par le COSEPAC en 1996, et sa désignation a été confirmée par la mise à jour de 2000. Le centre de données sur la conservation de la C.-B. (*Conservation Data Centre*) classe la sous-espèce comme S1, soit dangereusement en péril (*Critically Imperiled*). Le naseux de la Nooksack a été classé dans la liste des espèces en voie de disparition (annexe 1) de la *Loi sur les espèces en péril* (LEP) en 2003. Ce poisson fait partie de la « faune de Chehalis », un groupe de poissons qui aurait divergé de la faune du fleuve Columbia au cours des glaciations et se serait retrouvé dans un refuge libre de glace, au sud du Puget Sound. Cette sous-espèce offre donc un intérêt scientifique considérable pour les biologistes captivés par l'étude de l'évolution biologique.

Le naseux de la Nooksack passe une grande partie de sa vie près du fond, dans des segments limités de cours d'eau, affichant une forte préférence pour les rapides (zones d'eau vive). La taille de la population des ruisseaux Bertrand, Pepin et Fishtrap est incertaine, et a pu être estimée seulement à l'aide de processus indirects : ruisseau Bertrand : 5 700; ruisseau Pepin : 800; ruisseau Fishtrap : 300. Les données sont insuffisantes pour décrire toute tendance de l'abondance.

L'habitat essentiel du naseux de la Nooksack est défini comme comprenant les tronçons de ses cours d'eau d'origine qui contiennent ou sont réputés avoir contenu des rapides sur plus de 10 % de leur longueur. Les activités humaines qui menacent le plus le naseux de la Nooksack au Canada sont celles qui modifient, détruisent ou morcellent son habitat essentiel. Les menaces à l'habitat du naseux résultent de plus d'un siècle d'expansion agricole, industrielle et urbaine dans la vallée du Fraser. Elles comprennent la destruction physique, les baisses saisonnières de débit, la sédimentation et la fragmentation. Le naseux de la Nooksack continue de perdre de l'habitat à cause des projets de lutte contre les inondations et de drainage agricole. Les zones de rapides et les bassins marginaux sont les plus touchés.

Il existe des solutions permettant non seulement de réduire les occasions de destruction et de fragmentation de l'habitat, mais aussi d'en minimiser les effets. La première démarche repose sur la mise à profit de nos connaissances sur les menaces, leurs effets et les mécanismes réglementaires existants afin de mettre en application des pratiques exemplaires de gestion adaptées aux segments de cours d'eau. La deuxième démarche consiste à admettre qu'il y a déjà eu perte d'habitat et à concentrer les efforts sur la remise en état. La restauration de l'habitat, la création d'un nouvel habitat de rapides et les plantations riveraines sont toutes techniquement réalisables.

Les solutions de remplacement des activités qui ont des conséquences négatives sur l'habitat du naseux consistent à soustraire des terres à la production agricole. Le Programme américain de mise en valeur de réserves de terres sous conservation (*Conservation Reserve Enhancement Program*) est un programme de retrait volontaire des terres, administré par l'Agence des services agricoles du département de l'Agriculture américain. La solution canadienne axée sur les pratiques exemplaires et la remise en état des terres riveraines dans la vallée du Fraser pourrait suivre l'exemple des projets réussis de rétablissement à grande échelle de l'habitat du gibier à plume entrepris par des fiducies foncières et leurs partenaires en C.-B.

INTRODUCTION

A Recovery Potential Assessment (RPA) provides technical advice to the Minister of Fisheries and Oceans concerning the amount of allowable harm to an aquatic species. Ideally, an RPA precedes listing of a species or population under *SARA*, and is used to help make the decision whether or not to list. If the species is already listed, the RPA contains information and technical advice on status, threats, potential critical habitat and abundance that can be used to develop recovery plans. Nooksack dace (*Rhinichthys cataractae*) belongs to a third category: it is listed under *SARA*, and a Recovery Strategy has already been approved.

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

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

As a risk assessment, an RPA reflects the data available. In a case like that of the Nooksack dace, where there are limited data on the species’ natural history and habitat use, an RPA can only provide the best advice with the information available, while noting specific information gaps that need to be filled.

This Recovery Potential Assessment was written for DFO by Brian Harvey under contract to the Science Branch of Fisheries and Oceans Canada. The author is grateful for helpful comments and advice from Mike Pearson (Pearson Ecological Services, Vancouver) and Neil Schubert and Chris Wood (DFO). Formal reviews provided by Mike Bradford (DFO) and Don McPhail, as well as the many constructive comments of participants in the PSARC review process, were also incorporated into the document.

PART 1: CURRENT STATUS

BASIC BIOLOGY AND TAXONOMY

In older texts such as the authoritative Scott and Crossman (1973), *Rhinichthys cataractae* is simply called “longnose dace;” its distribution in North America is the widest of any minnow, and the species is not in danger anywhere in Canada. Today, several candidate subspecies are recognized; Nooksack dace is one of these, and it may coexist with longnose dace in some areas. It is well described in a factsheet from the Government of B.C. (B.C. Ministry of Environment undated). Nooksack dace is related to speckled dace (*Rhinichythys osculus*), another freshwater minnow that is also COSEWIC-listed (COSEWIC 2006b; Harvey 2007). The ranges of the two species do not overlap in Canada, although overlap is extensive in Washington (where most of the Nooksack dace range lies).

Appearance

Scott and Crossman (1973) describe *Rhinichthys cataractae* as a typical minnow about 76 mm long, whose mouth is overhung by the long snout for which the species is named. The Nooksack subspecies has some slight morphological differences, including fewer scales along the lateral line (B.C. Ministry of Environment undated). The recent Ph.D. dissertation of Pearson (2004) provides a wealth of further morphological and behavioural data on Nooksack dace, including the size of the largest recorded Canadian specimen (114 mm), and the existence of large, paddle-shaped pectoral fins that are slightly bigger in the male. Both Pearson and Scott and Crossman note an unusually small swim bladder.

Life history

Nooksack dace live four to six years and become sexually mature in their second year. They spawn at night at the upstream ends of riffles (shallow, fast-water sections of the river) from April to July (Pearson 2004; McPhail 1997). The number of eggs varies from around 200 to 2,000; these do not appear to be deposited in a nest, but are nevertheless guarded by the male until hatching. Fry appear in quiet pools at the downstream end of riffle areas in mid-summer; they feed at the surface on zooplankton and midge larvae for around four months before returning to the faster-flowing bottom habitat where they will spend the rest of their lives (McPhail and Lindsay 1970). As a bottom-living fish, adult Nooksack dace appear to subsist mainly on aquatic insect larvae, foraging at night. Their small swim bladder is probably an adaptation to life near the bottom.

Physiology and ecology

Pearson (2004) describes foraging as occurring when water temperatures reach 20°C or higher, with minimal activity below 11°C. Given the geographic location of the streams where Nooksack dace lives in Canada, foraging is probably simply most visible at temperatures over 20°C, but in fact occurs at lower temperatures as well. Nooksack dace live in ecological communities that include the native predators cutthroat trout (*Oncorhyncus clarkii clarkii*), rainbow trout (*O. mykiss*), prickly sculpin (*Cottus asper*), as well as introduced ones that may include bullfrog (*Rana catesbeiana*), bullhead (*Ameiurus nebulosus*), pumpkinseed (*Lepomis gibbosus*) and largemouth bass (*Micropterus salmoides*). None of the introduced species are riffle specialists; their impact on Nooksack dace is unknown. As is the case in many shallow streams, avian and terrestrial predators are probably important too. The main competitors for food are juvenile cutthroat and rainbow trout, which do forage in riffles (Pearson 2004).

Nooksack dace have small home ranges (less than 200 m of stream length) and do not appear to migrate (Pearson 2004).

Taxonomy and evolutionary significance

The taxonomy of Nooksack dace – the scientific description of its place on the evolutionary tree – is still a matter of discussion and research (COSEWIC 2007). While the genetic structure of the Canadian population is still unclear, it is nevertheless distinct from longnose dace. (Individuals in the Alouette and Coquitlam Rivers, both tributaries of the Fraser, seem to be a special case, and may carry either the Nooksack or the longnose genome, which may reflect ancient or contemporary hybridization (McPhail 2007 pers. comm.). There are also smaller but measurable genetic differences between different populations of Nooksack dace (for example, between those in the Fraser Valley, with which this report is concerned, and those on the Olympic Peninsula). Sorting out these and other genetic relationships of the Nooksack dace is a high research priority. As a member of the "Chehalis fauna", a group of fishes that emerged in unglaciated areas south of Puget Sound and diverged from those in the Columbia drainage, the subspecies has considerable scientific interest for evolutionary biologists.

Listings and protection

The four populations of Nooksack dace in Canadian waters are presently considered a single designated unit according to COSEWIC criteria (COSEWIC 2006a). The subspecies was designated *Endangered* by COSEWIC in 1996, with an updated status report in 2000 (COSEWIC 2000). The B.C. Conservation Data Centre classifies the subspecies as S1 (*Critically Imperiled*).

Nooksack dace was listed as *Endangered* (Schedule 1) under the Species at Risk Act (*SARA*) in 2003. *SARA* prohibits the alteration of habitat identified as critical in an approved recovery strategy. A final recovery strategy pursuant to *SARA* was completed and approved in 2007 (Pearson et al. 2007). It provides detailed criteria for habitat critical to the subspecies, but does not specifically identify that habitat.

Approximately 10% of the habitat currently occupied by Nooksack dace in Canada is part of a regional or municipal park. The remaining 90% has the legislative protection afforded by the federal Fisheries Act, although there are also a number of provincial and municipal statutes intended to protect stream and riparian habitat (Pearson 2004).

RANGE AND RESIDENCE

Range

While longnose dace are very widely distributed in Canada and the United States, the Nooksack subspecies is found in only four rivers in Canada, all of them in the Fraser Valley. These rivers are: Bertrand, Pepin and Fishtrap Creeks (which are in the Nooksack River basin and flow south into Washington State), and Brunette River, a tributary of the Fraser. The population in Brunette River was discovered in 2004 and is less well known than the other three; other populations may come to light. The area occupied in Canada is a small fraction of the total: 95.7% of Nooksack dace habitat is in the United States.

Distribution within the Canadian range has been studied for Bertrand, Pepin and Fishtrap Creeks. Based on trapping experiments in different stretches of the three streams, Pearson (2004) concluded that Nooksack dace were concentrated in small sections of the total area: seventy percent of the dace sampled were found in 12.5% of the mainstem length of these rivers. McPhail (1997) suggests that the distribution of dace in the headwater tributaries of these rivers has contracted since the 1960s. This uneven distribution has important consequences for risk assessment and recovery planning, because it implies that any "rescue effect" – re-colonization of a stretch of river by individuals from another section of the river or from a neighbouring watershed– is unlikely. One should not, however, rule out rescue completely, as larvae that drift from spawning sites may colonize downstream areas, and the very low recapture rate of tagged adults reported by Pearson (2004) suggests there may in fact be extensive redistribution of individuals.

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.' While Nooksack dace are not believed to build nests, they do defend breeding territories. Furthermore, their unusually clumped distribution, coupled with Pearson's 2004 observation that they appear to spend most of their lives within a very restricted stretch of river, argue for considering residence as synonymous with their known distribution.

POTENTIAL CRITICAL HABITAT

Identification and designation of critical habitat for Nooksack dace must reflect the species' strong preference for riffle areas, which are used for foraging by both adults and juveniles, and for reproduction by adults. Because the abundance of riffles is so strongly correlated with the abundance of dace (Pearson 2007; Pearson et al. 2007), the Nooksack Dace Recovery Team defined potential critical habitat for Nooksack dace as "reaches in their native creeks that contain or are known to have previously contained more than 10% riffle by length." Within these reaches, the definition includes "all aquatic habitat and riparian reserve strips of native vegetation on both banks for the entire length of the reach."

What is a "reach" and why is it important in identifying potential critical habitat for Nooksack dace? River scale is a nested hierarchy ranging from very large (watershed) to very small (microhabitat). The reach scale is midway along this continuum. A reach is a section of river that contains smaller habitat features like riffles and pools and is more or less homogeneous in its habitat type (Annear et al. 2004; Frissell et al. 1986); a reach will be in the high hundreds to the low thousands of metres long. The reach scale is appropriate for defining critical habitat for Nooksack dace because it contains the riffle features important to the species and is large enough to account for any seasonal shifts in their location (Pearson 2004). Riparian habitat (the land adjacent to the stream) is included in potential critical habitat because it is known to be needed to protect the integrity of aquatic habitat for many fish species. The 10% riffle threshold, while a judgment based on limited data, is chosen in order to exclude small, isolated riffles assumed to play no functional role in dace persistence. Riffle frequency was based on surveys in July, when flow would be low.

The biological, physical and ecological principles used to identify aquatic and terrestrial critical habitat for Nooksack dace are described by Pearson (2007). His report identifies 33.1 km of surveyed stream channel as potential critical habitat, and 211.9 ha of riparian potential critical habitat for Bertrand, Pepin and Fishtrap Creeks and the Brunette River. Eleven reaches containing less than 10% riffle by length in Bertrand, Pepin and Fishtrap Creeks were included based on evidence that they previously contained more riffle habitat and did in fact support Nooksack dace. Proposed riparian habitat was identified consistent with the B.C. Riparian Areas Regulation (RAR, Reg. 837 under the Fish Protection Act; B.C. Ministry of Environment 2007). The recommended width of riparian critical habitat is 30m, but is often less in practice depending on its assessed sensitivity to human-induced threats. 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 critical habitat for Nooksack dace is found in Pearson (2007).

Trends in potential critical habitat

While the availability of riffle habitat likely contributes to low abundances of Nooksack dace, it is not the only factor (see *Part 2: Threats* for a complete listing). In the Brunette River, these other factors may in fact be more important than availability of riffle habitat. Critical riffle habitat in Bertrand, Pepin and Fishtrap Creeks has been reduced by the combined effects of sedimentation, dredging, and the removal of surface and ground water for irrigation and other uses (COSEWIC 2007). Pearson (2004) estimates that around half of the riffle habitat has been lost from these three streams, mostly before 1996. The Brunette River has been considerably altered by the building of dikes and conversion of some stretches into channels (channels are engineered and relocated sections that have lost most of the characteristics of a natural watercourse). More detail on loss of habitat is provided in Part 2 (*Threats*).

Abundance

Population sizes for Bertrand, Pepin and Fishtrap Creeks have been estimated using an indirect process based on three kinds of information: the CPUE (catch per unit effort) ratio derived from trapping experiments (Pearson 2004); the amount of potential habitat in each stream (COSEWIC 2007, based on Pearson 2007); and the known density of dace in "high quality habitat" (Inglis et al. 1994).

Like many population estimates for species with no commercial importance, the abundances for Nooksack dace are extrapolations based on limited data sets, none of which were gathered for census purposes or published in the peer-reviewed scientific literature. The CPUE data are based on 24h fish-trap sets in 72 reaches of the three creeks, and corroborate the earlier electro-fishing data of Inglis et al. (1994), which showed much higher overall numbers of dace in Bertrand Creek. Methods for obtaining the second data set (amount of suitable habitat) are not clearly described. The third data set is the weakest: the dace density of 1.9 adult fish/m^2 is based on measurements in only one creek (Bertrand); neither the number of sites sampled nor how they were selected are clearly described in the cited report. CPUE estimates in Pepin and Fishtrap Creeks in fact indicate much lower densities (COSEWIC 2007); the figure of 1.9 adult fish/m^2 was nevertheless chosen by the recovery team as appropriately conservative.

Such caveats about uncertainty are not uncommon when trying to estimate abundance of a species on which very little research has been published. Nooksack dace are hard to sample; minnow traps are inefficient, electrofishing must be done with great care to avoid damaging fish, and "kick seines" only work if the substrate is not too big. The population estimates yielded by this process are the best we currently have. Sampling designed specifically for determining the current abundance of Nooksack dace, and that can stand up to rigorous scientific scrutiny, should be a high research priority. The current population estimates, which reflect conditions in 2004, are:

Bertrand Creek: 5,700
Pepin Creek: 800
Fishtrap Creek: 300

For the three Nooksack rivers, availability of habitat appears to limit dace abundance. This, however, does not appear to be the case for the Brunette River, where recent sampling has revealed two important findings. First, only 34% of the channel length identified as potential critical habitat is actually occupied by dace; second, in those areas that are occupied, density is only 0.5 adult fish/m^2 (Pearson 2007). Further research is needed to determine why so little of the available habitat in Brunette River is occupied. Using the available data, the current abundance in Brunette River is 3,825 adults, well below its carrying capacity.

There are insufficient data to describe any trends in abundance.

POPULATION AND DISTRIBUTION TARGETS FOR RECOVERY

The Recovery Strategy for Nooksack Dace (Pearson et al. 2007) provides population targets derived using the same data used for estimating abundance but omitting the adjustment for CPUE. In other words, population targets are obtained by multiplying the amount of suitable habitat by the density of dace believed to be supported by such habitat, so they are the same thing as carrying capacity. The same caveats about data noted in the previous section therefore apply to the population targets too. These targets, which are intended as goals to be achieved by 2015, are:

Bertrand Creek: 5,700
Pepin Creek: 4,400
Fishtrap Creek: 3,900

The target for Brunette River, based on the most recent density for that river of 0.5 fish/m^2 (Pearson 2007), works out to 10,075 adults; it is not, however, included in the Recovery Strategy.

These targets are *not* minimum viable populations (MVPs), because there are insufficient demographic data to determine such a benchmark. While they have been derived from incomplete data sets, they nevertheless have value for recovery so long as one accepts the data we have on Nooksack dace density. Even though calculated on the basis of the highest density recorded, the targets are reasonable in the light of generic guidelines based on review of the scientific literature on population viability analysis for vertebrate species, which suggest an MVP of 5,000 – 7,000 adults (Reed et al. 2003), and even more in cases where habitat is limiting. They represent what Wood and Gross (2007) call the abstract goal of preserving the maximum amount of unique biodiversity, not the pragmatic one of minimizing the loss of ecological goods and services.

Such targets are simply the best response of science to the question of extinction risk. Whether they are actually achieved depends in part on social and economic considerations. Another option for setting targets, based on the rule of thumb of an effective breeding number (N_e) of 1,000 adults and a corresponding adult census of around 10,000, would require more knowledge than we currently have about the possibility of any natural or man-made rescue effect among the four isolated populations.

By definition, these target abundances assume that all habitat with high potential productivity will be occupied by Nooksack dace. The population in Bertrand Creek thus appears to be healthy. To achieve the target abundances for Pepin and Fishtrap Creeks, riffle areas that are currently degraded and unoccupied will need to be remediated. Brunette River, with its large areas of unoccupied habitat, does not fit this pattern, and urgently requires further research to determine the cause of its apparently low population. Distribution targets for the watersheds listed above are linked to the population targets.

PART 2: THREATS

SOURCES OF HUMAN-CAUSED MORTALITY AND HARM

There are two general kinds of human-caused threat to the Nooksack dace in Canada: actions that alter, destroy or break up habitat, and actions that alter water quality. Actions that affect habitat are of the most concern; we have already noted that abundance of Nooksack dace is presently limited by habitat in three of the four rivers. The situation in the Brunette River is, however, a reminder that availability of habitat does not automatically guarantee its occupation by dace, so threats other than those to habitat must also be considered.

Increased predation or competition from introduced aquatic species is a generic threat for many native fish species but does not appear to be a serious one for Nooksack dace, with whom there is little habitat overlap. Sources of human-caused mortality are also discussed in the Recovery Strategy (Pearson et al. 2007).

Threats to habitat

The effects of human activities on instream habitat in the rivers that support Nooksack dace in Canada generally extend beyond the high water mark into the riparian buffer zones described above; for this reason, the following discussion will consider the two types of habitat together. Threats to aquatic and riparian critical habitat include (in order of severity): physical destruction, seasonal low flows, sedimentation and fragmentation.

Habitat destruction

The four rivers that support Nooksack dace in Canada are all in the Fraser Valley, an area where there has been heavy historic pressure on natural ecosystems first for agriculture, and more recently for industry and urbanization. The course, structure and flow characteristics of many streams have been drastically altered by draining, dredging, building dikes, infilling and channelization for flood control, agricultural drainage, and construction projects. Nooksack dace habitat continues to be lost to flood control and agricultural drainage projects (Pearson et al. 2007). The threat appears to be greatest for Fishtrap and Pepin Creeks, although the situation in Brunette River has not been assessed. Riffles and marginal pools are the most affected (riffles are the shallowest areas, hence the first to be removed in drainage works).

Seasonal low flows

The dependence of Fraser Valley streams on groundwater during the low-rainfall period of late summer makes riffles and shallow pools particularly vulnerable to water removal. 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 re-charge, gravel mining that reduces the size of aquifers, and drainage of wetlands. The threat appears to be greatest for Bertrand Creek, although the situation in Brunette River has not been assessed.

Sedimentation

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, such as removing riparian vegetation or increasing peak flow. Urban development, agriculture and mining can all trigger increased sedimentation. Sediment smothers riffles by filling up hiding spaces used by adult dace and restricting water flow. The threat of sedimentation is highest in Pepin Creek and unknown in Brunette River.

Habitat fragmentation

Critical habitat need not be destroyed or altered for there to be a detrimental effect on fish populations. 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 some small fish species). Most of the habitat fragmentation in Fishtrap Creek is historic (McPhail 2007 pers. comm.); because the subspecies appears to occupy very small home ranges (see Range, above), the threat from habitat fragmentation is currently believed to be lower than for habitat destruction, low flow and sedimentation.

Threats to water quality

All rivers are vulnerable to toxins that may enter them through contaminated groundwater or direct discharge. In the Fraser Valley, which is already heavily developed for agriculture and industry and is currently being rapidly urbanized, toxic chemicals include pesticides and herbicides that can also arrive from overspraying, sewage treatment effluent and storm runoff of urban and industrial wastes. Fishtrap and Bertrand Creeks and the Brunette River are the most heavily urbanized, and intensive agricultural chemical use also occurs in the Fishtrap Creek watershed (Pearson 2004). A plausible explanation for lack of dace in the Brunette River, which is highly developed, might be eradication by a toxic spill, with no chance of rescue effect from distant populations.

Hypoxia – the reduction of oxygen levels to the point where growth, metabolism and reproduction are impaired – can be fatal to fish, especially those like Nooksack dace that are adapted to fast-flowing, highly oxygenated water. Hypoxia often results from excess nutrients to the water; in the Fraser valley, these nutrients come in the form of manure and inorganic fertilizers that enter streams directly or through aquifers. The threat of hypoxia is highest for Pepin Creek.

MAXIMUM SUSTAINABLE MORTALITY

The maximum mortality sustainable by any population ideally provides decision makers with a practical benchmark that's useful for adjudicating proposed activities that can remove fish either directly (by killing them) or indirectly (by affecting habitat or water quality). Such figures are hard to arrive at for the four Nooksack dace populations in Canada, partly because each faces different challenges, and partly because estimated abundances rest on such limited data. Based on those data, the maximum population size that can be achieved in the habitat presently available is close to the minimum viable population sizes commonly accepted as generic for vertebrates when abundance data are weak (Pearson et al. 2007; Reed et al. 2003). This is the reason the Recovery Team designated all suitable habitat as critical.

Overall, there is little scope for human-induced mortality. Any contemplated increase in mortality that reduces the current abundance, however, would need to be considered in the context of the individual river. In the Nooksack drainage, for example, where habitat is limiting, the risk of losing individuals from Bertrand Creek is clearly lower than for Pepin Creek; there is thus room for some allowable harm in the Bertrand system, which currently has the most riffle habitat and the most fish. Fishtrap Creek, where dredging has already removed a large proportion of riffle habitat and the current estimated abundance is only a twentieth that in Bertrand Creek, is a much higher risk. The relative risk of removing dace from the Brunette River population is harder to judge; there may be more fish there, but the relative emptiness of so much suitable habitat is a conundrum we cannot yet explain, so the risk of losing more individuals may be at the higher end of the scale. It is also important to note that Nooksack dace occur in four separate watersheds in Canada, so extirpation from one watershed does not mean extirpation of the species. This redundancy at least reduces the risk of species extirpation from random environmental or demographic effects.

Damage to existing populations by scientific sampling can be considered allowable harm. Methods used for removing and counting fish have improved; even electro-fishing, which has the potential to damage fish, can now be done with less than 1% mortality of Nooksack dace (Pearson 2007 pers. comm.).

PART 3: SCENARIOS FOR MITIGATION AND ALTERNATIVES

The human activities that most threaten Nooksack dace in Canada are those that alter, destroy or break up critical habitat. The threats to dace habitat are the result of more than a century of agricultural, industrial and urban development of the Fraser Valley, and clearly demonstrate that eliminating the flooding to allow such development is inimical to natural stream morphology and function. The historic context for the present condition of streams in the Fraser valley is comprehensively reviewed by Rosenau and Angelo (2005), from which the following brief summary is taken.

With the end of the Gold Rush in the last decades of the nineteenth century, clearing and draining of land in the Fraser Valley by white settlers caused a profound alteration of water dynamics. Agriculture meant dismantling the natural system of spring floods and creating rail transportation to move the products out. Natural side-channels were filled in, diked, or straightened into drainage ditches that remain to this day. Most spectacularly, the 11,000 hectares of Sumas Lake were drained in the 1920s, removing a vast aquatic habitat that must still be kept dry by automatic pumps. Farming intensified after the Second World War, and diking and drainage continued into the 1980s, accompanied by leveling of fields that removed even more wetland. In many cases, the remaining streams continue to be affected by farming right up to their banks. In the 1960s and 1970s, flood control by diking was supplemented by extensive armouring of stream banks using rip-rap. The end result of a hundred years of stream engineering was the loss of over 80% of foreshore wetlands, marshes and riparian forests in the lower Fraser River. There are now over 600 km of flood control dikes on the Lower Fraser.

Since the 1960s, many new residents of the Fraser Valley come not as farmers but to live in suburban communities. Commercial farming has amalgamated and intensified, while much of the farmland created during the last hundred years has been converted to commercial and industrial use, or used for housing. Concurrent damage to aquatic ecosystems exceeds even that caused by agriculture, because vegetation is completely eliminated (Fraser Basin Council 2007). Open pit gravel mining in the Fraser floodplain is especially damaging. The Agricultural Land Reserve, created in the 1970s to protect land for agricultural production, has not been entirely successful in preventing this shift in land use.

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. 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 critical habitat.

MINIMIZING HUMAN ACTIVITIES AND THREATS TO HABITAT

Habitat destruction and fragmentation

There are options not only for reducing the instances of habitat destruction and fragmentation, but also for reducing their effects. Both approaches depend on research that estimates the extent of habitat loss in the four rivers and identifies high priority sites.

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. These practices will only work if landowners, stewardship groups, regulatory agencies and the public buy into their development. 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. 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 measureable. Public awareness materials and a participatory approach will again be crucial, especially for landowners expected to host the work of remediation. Based on excellent 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 Nooksack dace habitat.

Seasonal low flows

Best management practices regarding seasonal flow will need to be developed from water balance models for each of the four watersheds; 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 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 Nooksack dace. Water users who turn more and more toward “unrestricted” aquifers may simply be exacerbating the overall problem. 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.

Sedimentation

Because sedimentation compromises riffle habitat, its effects can be minimized using the same two-pronged approach described above for habitat destruction and fragmentation. Both the reduction of sedimentation and the restoration of sediment-damaged riffles depend on mapping, prioritizing and working with multi-stakeholder groups.

Threats to water quality

Reducing the entry of toxic substances into streams, whether by direct run-off or through storm drains, is strongly dependent on awareness. In countless B.C. streams, contamination is addressed by stewardship groups working in partnership with technical and regulatory advisors from the responsible federal, provincial and municipal agencies. The way to minimize the effects of toxins on Nooksack dace is to ensure that such groups are aware of the issues surrounding the species, and that the awareness projects they propose are adequately funded.

ALTERNATIVES TO HUMAN ACTIVITIES AND THREATS TO HABITAT

While restoration of habitat that has already been damaged or fragmented is clearly called for in all the Nooksack dace drainages in Canada, it is a strategy that treats the symptoms rather than the disease. The previous section discussed ways of minimizing human activities that affect dace habitat; the opportunity also exists to actually eliminate those activities in sections of the watersheds where critical habitat is presently damaged.

Some of the potential riparian critical habitat is already occupied by permanent structures (buildings, roads, trails, railways, dikes); the amount varies from less than 10% for Pepin Creek to 40% for the Brunette River. Portions of the remainder of actively farmed riparian land – some 53 ha – could, however, be removed from production. A model is the Conservation Reserve Enhancement Program (CREP), a voluntary land retirement program administered by the United States Department of Agriculture's Farm Service Agency (FSA). The CREP program, which is available in all states, helps producers protect and restore wildlife habitat while conserving ground and surface water (USDA 2007). 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. The CREP program model is currently working along more than 120 km of riparian habitat in Whatcom County, Washington State – including Nooksack dace habitat in the American portion of Bertrand, Pepin and Fishtrap Creeks (Whatcom Conservation District 2007).

In Canada, similar objectives can be achieved through land trusts. While most such 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 (Delta Farmland and Wildlife Trust 2007). 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 Nooksack dace riparian habitat. Any organization prepared to become involved in collaborative riparian restoration of Nooksack dace habitat would need to be aware of potential habitat synergies and conflicts with other important species (both salmonids and the Salish sucker, another SARA-listed species, have some habitat overlap with Nooksack dace), and have demonstrated capacity for the long term building of landowner participation in restoration projects. Liaison with the Recovery Implementation Group for Nooksack dace will also be important.

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 (B.C. Agricultural Council 2007).

REFERENCES

Annear, T., Chisholm, I., Beecher, H., Locke, A., and 12 other authors. 2004. Instream flows for riverine resource stewardship, revised edition. Instream Flow Council, Cheyenne, WY. 267 pp.

B.C. Agricultural Council. 2007. The Canada - British Columbia Environmental Farm Plan Program. www.bcac.bc.ca/efp_programs.htm

B.C. Ministry of Environment. 2007. www.env.gov.bc.ca/habitat/fish_protection_act/riparian/riparian_areas.html

B.C. Ministry of Environment. Undated. Longnose dace and Nooksack dace. B.C. Fish Facts. 2pp. www.env.gov.bc.ca/wld/fishhabitats/fishfactsheets.html.

COSEWIC. 2007. COSEWIC assessment and update status report on the Nooksack Dace *Rhinichthys cataractae* sp. in Canada. Committee on the Status of Endangered Wildlife in Canada.Ottawa. Viii + 27 pp.

COSEWIC. 2006a. Operations and Procedures Manual, April 2006. Committee on the Status of Endangered Wildlife in Canada. Ottawa.

COSEWIC. 2006b. COSEWIC assessment and update status report on the speckled dace *Rhinichthys osculus* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. 27 pp.

COSEWIC. 2000. Assessment and update status report on the Nooksack dace *Rhinichthys* cataractae sp. in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. Vii + 9 pp.

Delta Farmland and Wildlife Trust. 2007. www.deltafarmland.ca/dfwt2.html

Fraser Basin Council. 2007. www.fraserbasin.bc.ca/regions/fvr.html

Frissell, C. A., Liss, W. J., Warren, C. E., and Hurley, M. D. 1986. A hierarchical framework for stream habitat classification: viewing streams in a watershed context. Environmental Management 10:199-214.

Harvey, B. 2007. Recovery Potential Assessment for the speckled dace *Rhinichthys osculus*. Pacific Science Advice Review Committee (working paper). 32 pp.

Inglis, S., Pollard, S. M., and Rosenau, M. L. 1994. Distribution and habitat of Nooksack dace (*Rhinichthys sp.*) in Canada. Regional Fisheries Report, B.C. Ministry of Environment, Lands and Parks, Surrey.

McPhail, J.D. 1997. Status of the Nooksack dace *Rhinichthys* sp. in Canada. Canadian Field Naturalist 111: 258-262.

McPhail, J.D., and Lindsey, C.C. 1970. Freshwater fishes of northwestern Canada and Alaska. Fish. Res. Board Canada Bull. 173: 381 pp.

Pearson, M.P. 2007. An assessment of potential critical habitat for Nooksack dace (*Rhinichthys cataractae* ssp.) and Salish sucker (*Catostomus* sp.). DFO Can. Sci. Advis. Sec. Res. Doc. 2007/058. 29 pp.

Pearson, M.P. 2004. The ecology, status and recovery potential of Nooksack dace and Salish sucker in Canada. Ph.D. thesis, University of British Columbia. Xv + 239 pp.

Pearson, M.P., Hatfield, T., McPhail, J.D., Richardson, J.S., Rosenfeld, J.S., Schreier, H., Schluter, D., Sneep, D.J., Stejpovic, M., Taylor, E.B., and Wood, P.M. 2007. Recovery Strategy for the Nooksack Dace (*Rhinichthys cataractae*) in Canada. *Species at Risk Act* Recovery Strategy Series, Fisheries and Oceans Canada, Vancouver. vi + 31 pp.

Reed, M.J., O'Grady, J.J., Brook, B.W., Ballou, J.D., and Frankham, R. 2003. Estimates of minimum viable population sizes for vertebrates, and factors influencing those estimates. Biol. Conserv. 113: 23-34.

Rosenau, M.L., and Angelo, M. 2005. Conflicts Between Agriculture and Salmon in the Eastern Fraser Valley. Pacific Fisheries Resource Conservation Council. Vancouver, BC.
USDA 2007. The conservation reserve enhancement program. http://www.fsa.usda.gov/FSA/webapp?area=home&subject=copr&topic=cep

Whatcom Conservation District. 2007. The Conservation Reserve Enhancement Program (CREP) in Washington provides incentives to restore and improve salmon and steelhead habitat on private land. Fact Sheet. http://www.whatcomcd.org/CREP/Fact%20Sheet%20Brochure(8.5x11).pdf

Wood, C., and Gross, M. 2007. Elemental conservation units: communicating extinction risk without dictating targets for protection. Conservation Biology in press.