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Science Advisory Report 2009/077

RECOVERY POTENTIAL ASSESSMENT OF VANCOUVER ISLAND LAMPREY *(LAMPETRA MACROSTOMA* BEAMISH*)*

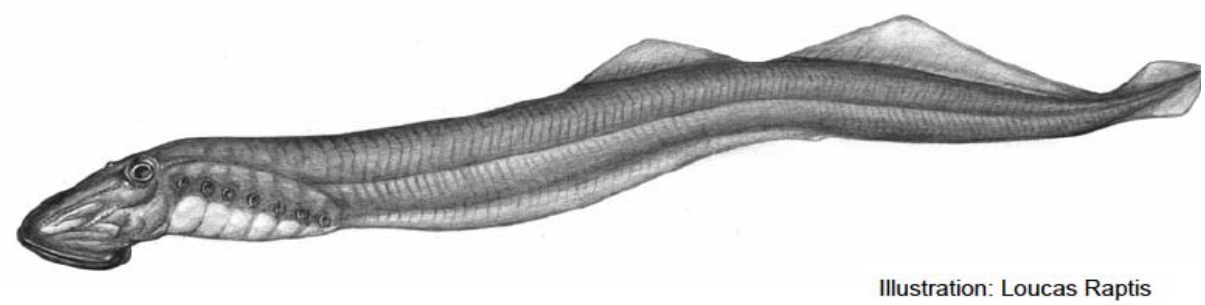

Figure 1. Vancouver Island lamprey (Lampetra macrostoma Beamish).

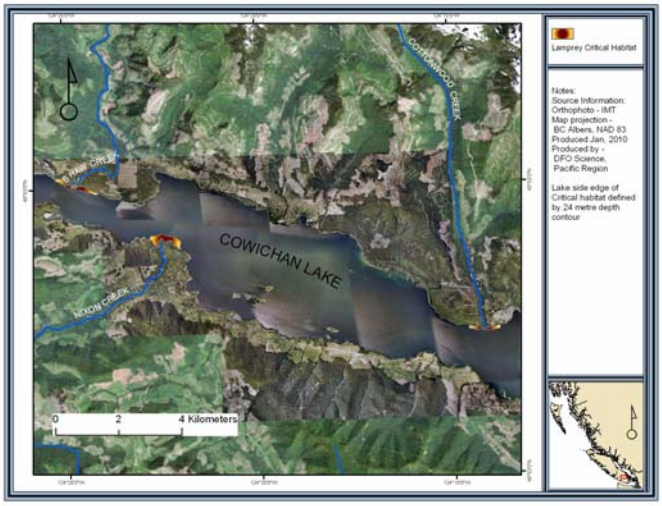

Figure 2. Cowichan Lake (west) watershed and potential critical habitat

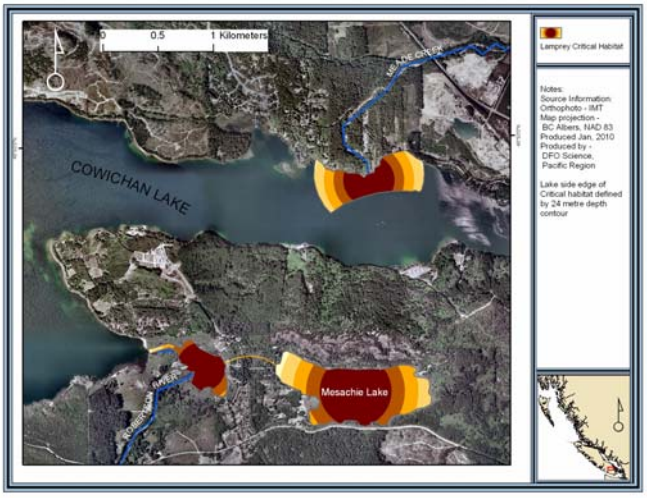

Figure 3. Cowichan Lake (east) Mesachie Lake watersheds and potential critical habitat

Context :
Vancouver lamprey Lampetra macrostoma (Beamish) was designated Threatened by the Committee of the Status of Wildlife in Canada (COSEWIC) in 2000, primarily because it is an endemic species. The species was listed under SARA in 2003. A Recovery Strategy is posted on the SARA public registry. To support decision-making, information is required on the species' biology, population trends and targets, habitat requirements, threats to the survival or recovery and allowable harm. This recovery potential assessment was developed based on a peer-review by the Pacific Scientific Advice Review Committee (PSARC).

SUMMARY

- The species has been reported in Cowichan Lake and Mesachie Lake, in south-central Vancouver Island. Neither total abundance nor abundance specific to the various habitats have been reliably estimated. COSEWIC (2000) provides a population abundance estimate of 1,000-2,000 adults.

- Results of a trapping study in Mesachie Lake suggest the population may have declined in the last fifteen years. Thirty years of informal records from an annual fishing derby on Mesachie Lake suggest decreased catch-per-unit-effort in recent years.

- Adults are not believed to guard their egg nests but they expend energy in creating spawning nests by carrying gravel in their mouths. Spawning nests should thus be considered short-term residences. The ammocoete stage has a residence requirement for silty substrate in which to construct burrows.

- Threats to survival or recovery from human impacts include incidental angling mortality in the recreational fishery, residential development and recreation, forestry, water withdrawal and prey availability.

- The low and highly uncertain population abundance estimates, the noted reports of a recent decline in catch indices and the restricted, endemic population range of the species indicate that there is no scope for human-induced mortality.

- The locations of principal spawning and ammocoete rearing sites have been identified in the better studied Mesachie Lake population. It is recommended that these areas be identified as potential critical habitat. Similar habitat types in the less studied Cowichan Lake are likely important but where there is uncertainty in the use and specific boundaries of the habitat, they are not recommended as critical habitat at this time.

INTRODUCTION

The knowledge base for Vancouver lamprey (Figure 1) is limited and first-hand experience remains confined to a small number of experts. The species is presently considered to be a single population. Vancouver lamprey is a presumed freshwater derivative of the anadromous Pacific lamprey *L. tridentata*, isolated when lake drainage patterns changed around 10,000 years ago. The two species are genetically indistinguishable based on mitochondrial DNA. McPhail (2007) describes its taxonomic status as “unclear.”

ASSESSMENT

PHASE I: assessment of status

Abundance and range

The species has been reported in Cowichan Lake and Mesachie Lake (Beamish 1982), in south-central Vancouver Island (Figure 2 and 3). Larvae have also been reported in Bear Lake, a small body connecting Lake Cowichan and Mesachie Lake (Harris 2007). Cowichan Lake is approximately 30 km long and 3 km at its widest point, with an area of about 6,200 ha. Much of

what we know about the species has come from studies in Mesachie Lake, which is much smaller (approx. 1.4 km and 59 ha) and drains into the southern end of Cowichan Lake. While there are no barriers to the sea, the species is non-anadromous.

Neither total population size nor abundance specific to the various habitats have been reliably estimated. COSEWIC (2000) provides an estimate of 1,000-2,000 adults, a number that was not based on systematic sampling. Results of a trapping study in Mesachie Lake suggest the population may have declined in the last fifteen years (Beamish and Wade 2009). Thirty years of informal records from an annual fishing derby on Mesachie Lake suggest decreased catch rates in recent years (Beamish and Wade 2009).

In studies carried out for the B.C. Ministry of Environment (Harris 2007, 2008), ammocoete larvae were found to be widely distributed throughout the system suggesting that the species may be more abundant than previously assumed and that the estimate of 1,000-2,000 adults may be low. A simulation study based on a large variety of vertebrate species estimated the minimum viable population necessary for population persistence at about 7,000 mature individuals (Reed et al. 2003).

Life history parameters

Vancouver lamprey in spawning condition have been caught between mid-May and late August, with a peak in mid-June. The fecundity is unknown. Spawning is followed by death, which is the usual lamprey life history pattern. The ammocoetes lives buried in stream or lake sediment until metamorphosing into free-swimming juveniles. The amount of time between hatching and metamorphosis is unknown but it may last several years based on life history patterns of other lamprey species. Beamish and Wade (2009) estimate the time between metamorphosis and spawning to be five years and older. If the ammocoete stage can last up to several years, this suggests a total lifespan of about nine years or more. There are no estimates of productivity for the species. For a range of better studied species and assuming a life span of nine years and a maximum reported length of 25 cm, Froese and Pauly (2008) suggests that the productivity/resilience is ranked medium to high. The calculated natural mortality rate is 0.5/yr. with a minimum population doubling time of 1.4-4.4 years.

Habitat requirements and habitat use patterns

There is enough known about the life history of the species to generally describe the physical characteristics of habitat required by its life stages. Much of what we know is based on studies in Mesachie Lake.

Adults

Adult Vancouver lamprey are presumed to feed on resident and migratory fish species in both lakes, and are believed to enter tributary streams to a short distance only, and then only to spawn. Beamish (1982) suggested that adults spawned on shallow gravel bars in the nearshore areas of the lake, constructing nests in a fashion similar to that of Pacific lamprey at depths around 15 cm (COSEWIC 2000). Gravel is assumed to provide adequate water flow. The presence of ammocoete larvae in the lower 100 m of some inlet streams also suggests that adults can spawn in these areas (Beamish 1982). In summary, adult Vancouver lamprey probably utilize the lake margin and tributary stream entries for reproduction, and the entire water column for feeding, with the major uncertainties being in identifying any preferred spawning areas and their depths, as well as a lack of knowledge of water quality tolerances.

Ammocoete larvae

Ammocoetes are presumed to burrow into fine silt in the littoral zone or in the first 100 m of inlet streams shortly after hatching, where they filter-feed on microscopic algae and organic detritus before emerging as immature adults. Ammocoetes were found in shallow areas along the shore of Mesachie and Cowichan lakes, in silt over sand or fine woody debris, as long as silt was no deeper than 10 cm. In Mesachie Lake they were mostly found along the shoreline close to the inlet stream, with very few near the outlet stream (Beamish and Wade 2009). A similar distribution picture emerges from sampling in Cowichan Lake. In a more recent study, ammocoetes were captured at 16 locations in the Cowichan/Mesachie system. The presence of ammocoetes was best predicted by areas with soft, fine sediments or sand, with an organic component such as decomposed wood and leaves. The habitat requirements of post-larval lamprey between their metamorphosis (emergence) in the fall and the beginning of feeding the following spring are uncertain.

Population and distribution targets for recovery

In the absence of quantitative life history and abundance information, a population target is a self-sustaining population within the known distribution.

Expected population trajectories

Rough comparison of trapping effectiveness in Mesachie Lake between the 1980s and studies done in 2008 suggests a decline in population. In the absence of a quantitative recovery target, however, it is not possible to describe the expected population trajectory.

Residence requirements

While adult Vancouver lamprey are not believed to guard their egg nests, they expend energy in creating spawning nests by carrying gravel in their mouths. Spawning nests should thus be considered short-term residences. An argument can also be made that the ammocoete stage has a residence requirement for silty substrate in which to construct burrows. As noted above, the depth to which these burrows are found, and any preferred locations within the lake, remain uncertain, as do any movements made by the ammocoetes.

PHASE II: scope for management to facilitate recovery

Probability of achieving recovery targets

It is difficult to make predictions in the absence of data on population size and a quantitative recovery target, and the likelihood of maintaining a self-sustaining population. The decline in abundance suggested by recent sampling warrants increased caution. The species has withstood sustained timber extraction using methods (booming in the lake; logging camps on the foreshore) that probably caused more damage than do the forestry methods used today.

Magnitude of each major potential source of mortality

Incidental angling mortality in the recreational fishery

The only known direct mortality on Vancouver lamprey occurs when anglers kill adult lamprey attached to a trout or salmon they have caught in the lake. The percentage of lamprey that are actually attached to salmonids when caught is not known, nor is the number that fall off when fish are caught. The impact of this mortality on survival is unknown. The Vancouver Lamprey Recovery Strategy considers it capable of affecting the population (Vancouver Lamprey Recovery Team 2007). The likelihood of mortality from this threat is considered high but its severity cannot be quantified until there are estimates of mortality from fishing.

Residential development and recreation

Residential development inevitably increases water withdrawal, and can also degrade water quality through addition of pollutants or changes in water chemistry. Foreshore can be disrupted by pier construction, and water quality is affected by pollution from combustion engines. There are no known water quality issues in either lake. There is uncertainty in the knowledge of lamprey use of littoral areas for spawning and ammocoete residence, and the effects of accelerated development in recent years. The threat cannot currently be quantified.

There has been significant development on Mesachie Lake in the past fifteen years, including two new houses close to the spawning area at the inlet stream and construction of a large summer camp for children on the site of the former lumber mill. New lakeshore residents have created new beaches with trucked-in fine gravel; these areas may represent additional spawning area (Beamish and Wade 2009). On Cowichan Lake, much of the new residential development is taking place on land purchased from tree farm license-holders.

Forestry

Logging has been the main economic activity in the Cowichan Lake region since settlement in the late 1800s; the area had a ready supply of timber and a convenient river route for transport to the coast (river transport was replaced by the railway in 1912, and finally by logging roads). At one time, large logging camps occupied the lake foreshore, and much of Cowichan Lake was logged to the water. During the period of intensive timber extraction, Mesachie Lake was used as a booming ground for the nearby lumber mill. Vancouver lamprey appear to have weathered this intensive resource extraction (now somewhat reduced) for more than a century. The current threat to the population from logging is likely low and unquantifiable. The level of forestry is not expected to increase.

Water withdrawal and water quality

Outflow of Cowichan Lake into the Cowichan River is regulated by a weir to release water uniformly through the summer dry season and to facilitate operation of the Catalyst Paper pulp mill in Crofton. The Vancouver Lamprey Recovery Team (2007) analyzed the annual range in lake elevations before and after construction of the weir in 1957 and concluded that storage and diversion posed at most a minor threat to Vancouver lamprey. Neither licensed nor unlicensed water use is a substantial threat to the species in the near term in Cowichan Lake, but may be for Mesachie Lake. Increased summer drawdown of water for residential use has the potential to affect water levels on Mesachie lake.

Prey availability

The prey population size and trends in both Mesachie and Cowichan lakes are unknown. In order for this species to survive and thrive, it needs a consistent source of prey. The preferred prey species is not known. Some of this knowledge could be obtained through angler surveys. Neither Cowichan nor Mesachie Lake appears to have been stocked with salmonids although records are incomplete before 2004 (gofishbc.com).

Likelihood that the current quantity and quality of habitat is sufficient to allow population increase

The shallow, covered gravel areas near the mouths of the inlet streams to Mesachie and Cowichan Lakes serve as spawning, egg incubation and ammocoete habitat (Beamish and Wade 2009). Habitat in Mesachie Lake is better studied than in Cowichan Lake. Flow rate in the stream is probably an important habitat attribute; lower flow can result in uncovered gravel areas and restricted spawning. Because the known spawning areas are discontinuous pockets of raised gravel deposition, low lake levels may similarly restrict spawning areas.

Given the low esteem in which lamprey are popularly held and the equivocal evidence of any trends in abundance, there are no strong arguments that the population can or should increase. The factors that limit the abundance of lamprey are unknown, although one likely determinant is availability of food. COSEWIC (2000) suggests that the species coexists with its salmonid prey and that up to 50% of the salmonids caught in Mesachie Lake had evidence of non-lethal predation by lamprey. Whether habitat is a significant limiting factor is unknown.

Magnitude by which current threats to habitats have reduced habitat quantity and quality

The effects of the most significant past threat (intensive timber harvest close to the lake, and use of foreshore for logging camps and booming) are impossible to judge from today's perspective. Forestry threats are likely to have been indirect, through affecting the numbers of salmonid prey species that are more susceptible to such disturbances in the watershed. Alteration or elimination of spawning and rearing habitat as a result of increased residential foreshore development are concerns that are currently impossible to judge, because it is not known whether habitat availability limits the population. Food supply, for example, may be just as important.

PHASE III: scenarios for mitigation and alternative activities

Feasible measures to minimize/mitigate the impacts of activities that are threats to the species and its habitat

Present and future threats from forestry are likely to be lower than in the area's forestry boom years. The methods and regulations used to mitigate forestry impacts depend on the ownership of land adjacent to inlet streams in Cowichan and Mesachie Lakes. Riparian forest practices that minimize effects of logging on aquatic species are also contained in the Forest and Ranges Practices Act, which applies to Crown lands. Judging the potential effect of the provisions in the Act on lamprey would require a comprehensive inventory of spawning and rearing habitat, linked to a survey of land ownership in the identified areas.

With regard to fishing mortality, the only known direct mortality, the Freshwater Fishing Regulations published annually by the B.C. Ministry of Environment (2008) contain an advisory on "Protected Species" (15 such species are listed in the 2008 Regulations, including Vancouver lamprey). The advisory notes that catching or killing a protected species is illegal. On its own, the advisory seems unlikely to provide much of a deterrent and should not be expected to reduce mortality significantly. Angler awareness could be substantially raised using outreach methods such as signs and leaflets, in which case a further reduction in mortality might be expected. Angler participation in a survey concerning the number of lamprey attacks on salmonids could be expected to raise awareness while at the same time contributing important insight into any population fluctuations.

Threats from residential development are difficult to quantify because of uncertainty regarding habitat use for larval and adult stages; the threats and their magnitude are different for Mesachie and Cowichan Lakes. Foreshore development could have a serious impact on spawning habitat and the ammocoete stage; mitigation could involve the design of nearshore structures to avoid destroying this habitat. The Riparian Areas Regulation contained in the Provincial Fish Protection Act, while applying only to private lands and Crown land used for private purposes, is intended to reduce the impact of residential, commercial, and industrial development, and is in force in the Cowichan Valley. Construction of new beaches near residential developments may be a form of inadvertent mitigation, but differences in gravel size between these beaches and identified spawning areas suggest caution in assuming such beaches constitute alternative spawning habitat.

Reasonable alternatives to the activities that are threats to the species and its habitat

An alternative to angling mortality in the recreational fishery is to prohibit the fishery but that would remove the opportunity to gather abundance data through cooperative programs with anglers. Reduction in fishing mortality potentially could be more easily achieved through initiates that promote awareness. Alternatives to residential development and forestry practices beyond the Provincial regulations and guidelines already mentioned are likely less feasible.

The biological feasibility of a "rescue effect" by an introduced population of Pacific lamprey is debatable. McPhail (2007) and COSEWIC (2000) mentions several naturally occurring Pacific lamprey populations that may in fact be permanent freshwater residents, including those in Sakinaw Lake, Village Bay Lake and West Lake; all are coastal lakes. But when Pacific lampreys become landlocked through human intervention, they rarely if ever establish self-sustaining populations in fresh water (Beamish and Northcote 1989). Pacific lamprey exist in Cowichan River, but it is not known if they occur in the lake.

Discussion of alternative activities and their impacts on populations must rest on adequate knowledge of the life history, habitat use, abundance and susceptibility to various causes of mortality. None of these are well enough known for Vancouver lamprey to assess the impact of alternative activities that threaten the species.

Reasonable and feasible activities that could increase the productivity or survivorship parameters

Estimates of mortality from human impacts are not available and estimates of productivity for the species are crude at best. It is therefore not possible to quantify the impact of activities on productivity. An approach to assess the sensitivity of population growth rates to mortality at specific life history stages has been applied to Laurentian Great Lakes sea lamprey (Velez-Espino et al. 2008). That assessment, termed an elasticity analysis, simulated the sensitivity of population growth rates to changes in stage-specific life history parameters. The elasticity of each of the major vital rates reportedly have a similar effect on population growth although the elasticity of ammocoete survival was higher for some variations of the simulation model. Based on their interpretation, there is no single critical stage in the life cycle of sea lamprey that is influential in determining population growth rates. It is important to note, however, that without knowledge of the actual natural range of variability for each parameter the outcome could be difficult to interpret. Until better life history information for Vancouver lamprey advances, we conclude that significant harm to any of the life stages of Vancouver lamprey may threaten the existence of the population.

CONCLUSIONS AND ADVICE

The low and highly uncertain population abundance estimates, the reported recent declines in catch rates and the restricted, endemic population range of Vancouver lamprey indicate that there is no scope for human-induced mortality. The apparent restriction of its spawning and juvenile rearing habitat to certain areas of the lakeshore and inlet streams suggest that any lethal sampling of ammocoetes or adults for research be carefully designed to limit any potential harm to the population.

Given that there is no scope for human-induced mortality, each area that each lamprey occupies is at least important if not critical habitat. Based on studies in Messachie, where specific gravel beds in and near the inlets of streams have been identified as lamprey rearing sites, they are recommended as potential critical habitat. Similar habitat types in the less studied Cowichan Lake are likely important but where there is uncertainty in the use and specific boundaries of the habitat, they are not recommended as critical habitat at this time.

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