Observed Reductions in Spawning and Rearing Habitat Availability for Cowichan Lamprey (*Entosphenus macrostomus)* During Drought Conditions

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Les numéros 1 à 25 de cette série ont été publiés à titre de Records statistiques, Service des pêches et de la mer. Les numéros 26-160 ont été publiés à titre de Rapports statistiques du Service des pêches et de la mer, ministère des Pêches et de l'Environnement. Le nom de la série a été modifié à partir du numéro 161.

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OBSERVED REDUCTIONS IN SPAWING AND REARING HABITAT AVAILABILITY FOR COWICHAN LAMPREY (*Entosphenus macrostomus)* DURING DROUGHT CONDITIONS

by

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ABSTRACT

Wade, J., Lovestrom, N., and MacConnachie, S. 2017. Observed reductions in spawning and rearing habitat availability for Cowichan Lamprey (*Entosphenus macrostomus*) during drought conditions. Can. Data Rep. Fish. Aquat. Sci. 1269: v + 10 p.

A habitat survey using an aerial drone was conducted in June, July, and August 2016 in Cowichan Lake at locations identified as possible spawning locations for Cowichan Lamprey (*Entosphenus macrostomus*). Aerial photographs of the sample locations were taken each month to document the available spawning and rearing habitat for the species during drought conditions. No surface water was observed flowing from Meade Creek (north), Cottonwood Creek or Robertson River throughout the survey. The deltas of Cottonwood Creek and Robertson River were almost all dry by June 2016. The small proportion that was wetted in June was reduced as lake levels decreased throughout the summer. It is during this time, and earlier, that Cowichan Lamprey are spawning, eggs are incubating and hatching, and young ammocoetes are developing in the areas around the outlets of rivers and streams. The effects of regular drought conditions on the species are unknown but it is reasonable to assume there may be population level effects resulting from multiple years of possible recruitment failure. This preliminary survey demonstrates the importance of managing the weir not only according to Cowichan River flows but also taking into consideration Cowichan Lamprey and its habitat in Cowichan Lake.

RÉSUMÉ

Wade, J., Lovestrom, N., et MacConnachie, S. 2017. Réductions observée de la disponibilité de l'habitat de frai et d'élevage de la lamproie du lac Cowichan (*Entosphenus macrostomus*) durant les épisodes de sécheresse. Can. Data Rep. Fish. Aquat. Sci. 1269: v + 10 p.

Des relevés de l'habitat ont été effectués à l'aide d'un drone en juin, en juillet et en août 2016 dans le lac Cowichan à des endroits reconnus comme étant des lieux de frai pour la lamproie du lac Cowichan (*Entosphenus macrostomus*). Des photographies aériennes des emplacements échantillonnés ont été prises chaque mois pour documenter l'habitat de frai et d'élevage accessible pour l'espèce durant les épisodes de sécheresse. Aucune eau de surface n'a été observée partant du ruisseau Creek (nord), du ruisseau Cottonwood ou de la rivière Robertson pendant le relevé. Les deltas du ruisseau Cottonwood et de la rivière Robertson étaient presque tous secs en date de juin 2016. La faible proportion qui était mouillée en juin s'est réduite à mesure que les niveaux des lacs diminuaient tout au long de l'été. C'est avant et durant cette période que la lamproie du lac Cowichan est en reproduction, que l'incubation et l'éclosion des œufs se font, et que les jeunes ammocètes se développent dans les zones entourant les décharges des rivières et des cours d'eau. Les effets d'épisodes réguliers de sécheresse sur l'espèce sont inconnus, mais il est raisonnable de supposer qu'il pourrait y avoir des effets à l'échelle de la population advenant plusieurs années d'échec en matière de recrutement. Ce relevé préliminaire démontre l'importance de gérer le barrage non seulement en fonction des débits de la rivière Cowichan, mais également en tenant compte de la lamproie du lac Cowichan et de son habitat dans le lac.

INTRODUCTION

Cowichan (Vancouver) Lamprey (*Entosphenus macrostomus*) is listed as Threatened on Schedule 1 of the Canadian *Species at Risk Act* (SARA). It is a freshwater parasitic fish endemic only to the Cowichan watershed on Vancouver Island, British Columbia. The species has been found in Cowichan, Bear and Mesachie lakes and the lower parts of some tributaries to these lakes.

A one metre tall weir was constructed in 1957 between Cowichan River and Cowichan Lake to control water flow in the late summer and early fall when river discharges commonly fall below the demands downstream (Cowichan Watershed Board). The weir has two main functions 1) to maintain a flow rate or discharge rate in the river above 7 m^3/s and 2) to maintain sufficient water in Cowichan Lake as long as possible. In the late summer it is not normally possible to satisfy both objectives and operational judgement is made based on lake level, discharge rate in Cowichan River, salmon priorities and rainfall predictions (Cowichan Watershed Board). The weir is currently managed by Catalyst Paper. Specific protocols on how and when the weir is adjusted can be found in the Cowichan Weir Start-Up, Operation and Seasonal Protocols (Vessey et al 2008).

As it is currently operated, the management of the weir does not take into consideration the habitat requirements for Cowichan Lamprey; specifically, the availability of nearshore habitat for spawning and ammocoete rearing. Animals in spawning condition have been found from May to August and it is assumed that spawning would occur during this time (Beamish, 1982).

The purpose of the study was to document the habitat availability in the nearshore area of three locations previously identified as either likely spawning habitat or ammocoete rearing habitat for Cowichan Lamprey in the summer drought conditions.

METHODS

As currently available digital elevation model (DEM), bathymetry, and LIDAR datasets do not adequately cover the shoreline area of Cowichan Lake an unmanned aerial vehicle (UAV) (DJI Inspire One) was flown at three sample locations previously identified as potential spawning or rearing locations for Cowichan lamprey (Wade and MacConnachie 2016; Beamish and Wade 2008). The sampling locations were where Cottonwood Creek and Meade Creek (north) entered Cowichan Lake and where Robertson River entered Bear Lake (Figure 1).

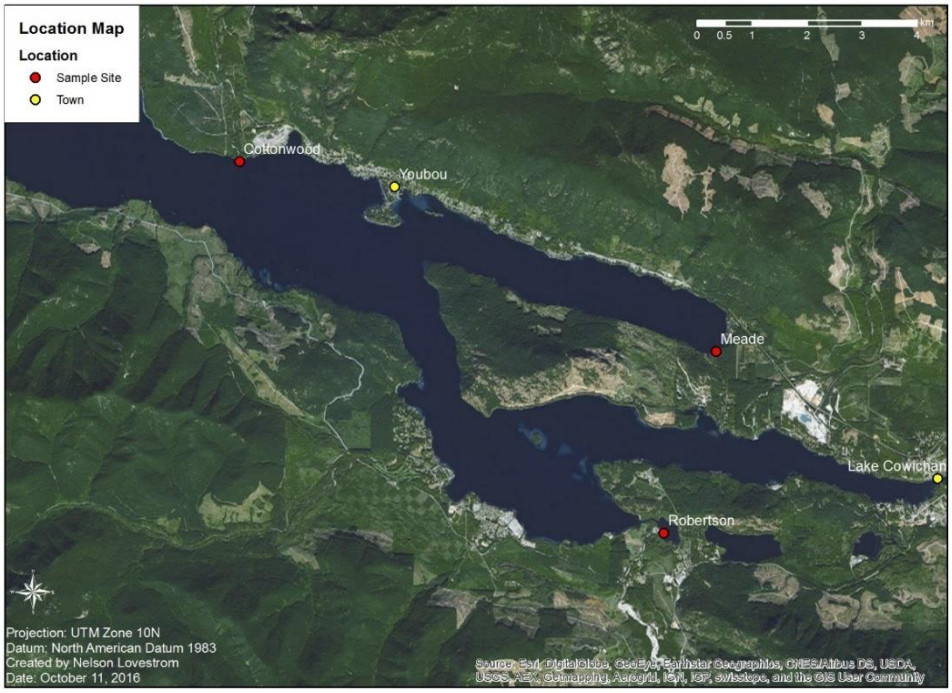

Figure 1: Map indicating sample locations for Cottonwood Creek, Meade Creek (north) and Robertson River, 2016.

The drone was flown at variable heights as to capture the outlet of each river or creek into their respective lakes. Photographs were taken using the onboard camera aimed straight down. In cases where the drone could not be flown high enough to capture the whole site, a series of images were post-processed into a composite image. Sites were sampled throughout the summer from June until the end of August (Table 1).

Table 1: Sampling dates by location (2016)

Location	Sampling dates (2016)			
Cottonwood Creek	June 17	July 1	August 8	August 27
Meade Creek (North)	June 17	July 1	August 8	August 27
Robertson River		July 1	August 8	August 27

All imagery from the UAV was georeferenced in ArcGIS 10.2 (ESRI Inc) using a series of fixed points collected using a commercial grade GPS unit (Garmin GPSmap 60Cx). After all imagery was georeferenced, the shoreline was hand digitized for each site. At Cottonwood, the furthest visible extent of the tributary delta was digitized by hand. The distance between the furthest point of the fluvial fan and the nearest intersection with the

shoreline on June 17th (initial sample date) and August 27th (final sample date) were measured using a transect line which was split by the shorelines. Length of the transect was calculated using the calculate geometry tool in ArcGIS.

RESULTS

COTTONWOOD CREEK

On June 17, 2016 no surface water was observed flowing from Cottonwood Creek into Cowichan Lake, although there were some small groundwater pools. By the second sampling date (July 1, 2016) no water was seen emptying into the Lake (Figure 2). This lower reach of the creek is part of the tributary delta but was completely dry before the survey began.

Figure 2. Aerial photograph of Cottonwood Creek at the convergence with Cowichan Lake; left: June 17, 2016 and right: July 1, 2016.

The amount of available habitat in the fluvial fan was reduced throughout the sample period (Figure 3). The distance between the June 17th shoreline and the furthest point of the fluvial fan was approximately 7.38 m, this same transect from the August 27th shoreline was approximately 5.03m (Figure 3, blue line).

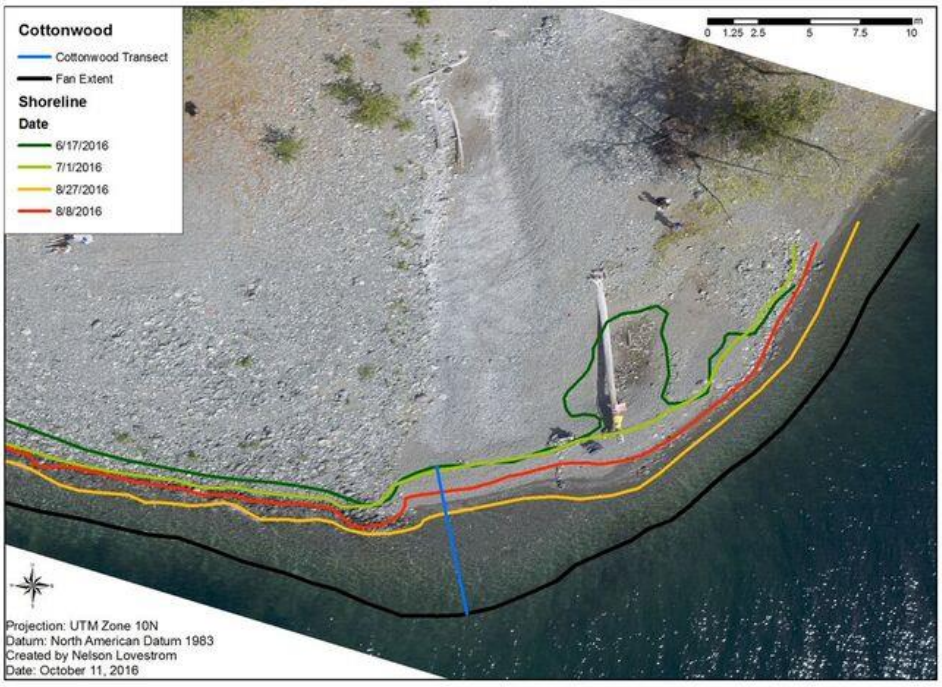

Figure 3. Visual representation of the receding shoreline at the convergence of Cottonwood Creek and Cowichan Lake on June 17(dark green), July 1 (light green), August 8 (yellow) and August 27 (red) 2016. Black line indicates the extent of the fluvial fan; blue line indicates the distance between the furthest point of the fluvial fan perpendicular to the shoreline for the first sample.

MEADE CREEK (NORTH)

The initial sample on June 17, 2016 at Meade Creek (north) (Figure 4, left) showed Meade Creek as a wetted area with no running water into Cowichan Lake. Over the sample period the wetted area dried up and on August 28th, the final sample, the area was completely dry. At no point during the study was there a direct connection of water between Meade Creek (north) and Cowichan Lake (Figure 5).

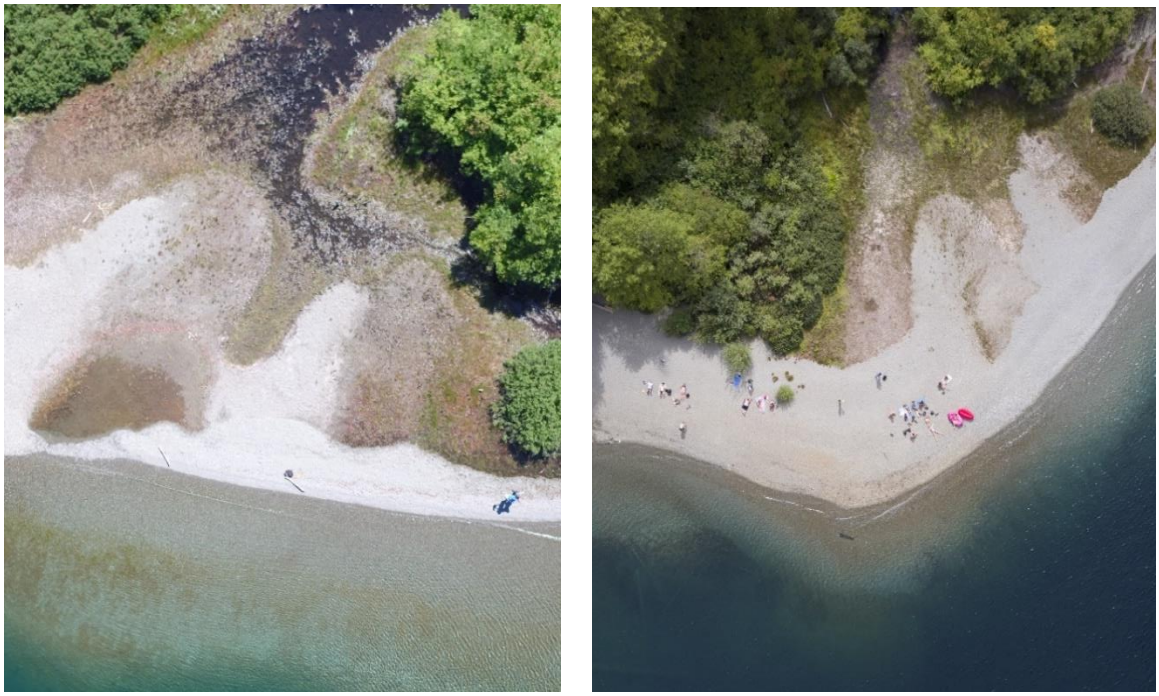

Figure 4. Aerial photograph of Meade Creek (north) at the convergence with Cowichan Lake; left: June 17, 2016 and right: August 28 2016.

Figure 5.Visual representation of the receding shoreline at the convergence of Meade Creek (north) and Cowichan Lake on June 17(dark green), July 1 (light green), August 8 (yellow) and August 27 (red) 2016.

ROBERTSON RIVER

The image of the initial sample on July 1, 2016 focused on the wetted area over the fluvial fan at the mouth of Robertson River where it empties into Bear Lake (Figure 6). It is evident from this photograph that there is a wetted area on the fluvial fan which in comparison to the subsequent two samples where this area is completely dry. A visual representation of this receding nearshore area has been depicted in Figure 7.

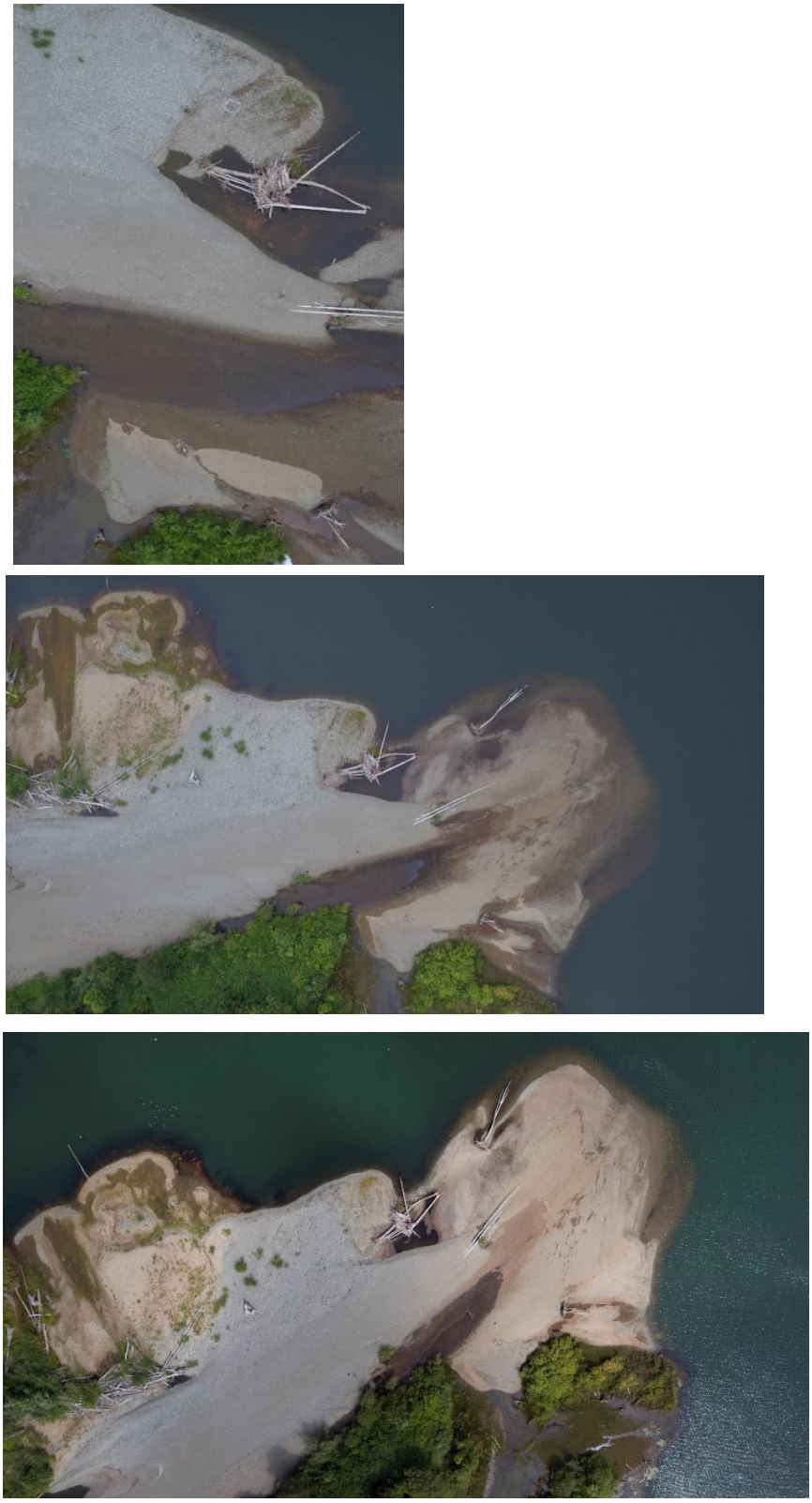

Figure 6. Aerial photograph of Robertson River at the convergence with Bear Lake; top: July 1, 2016, middle: August 8 2016 and bottom: August 28, 2016.

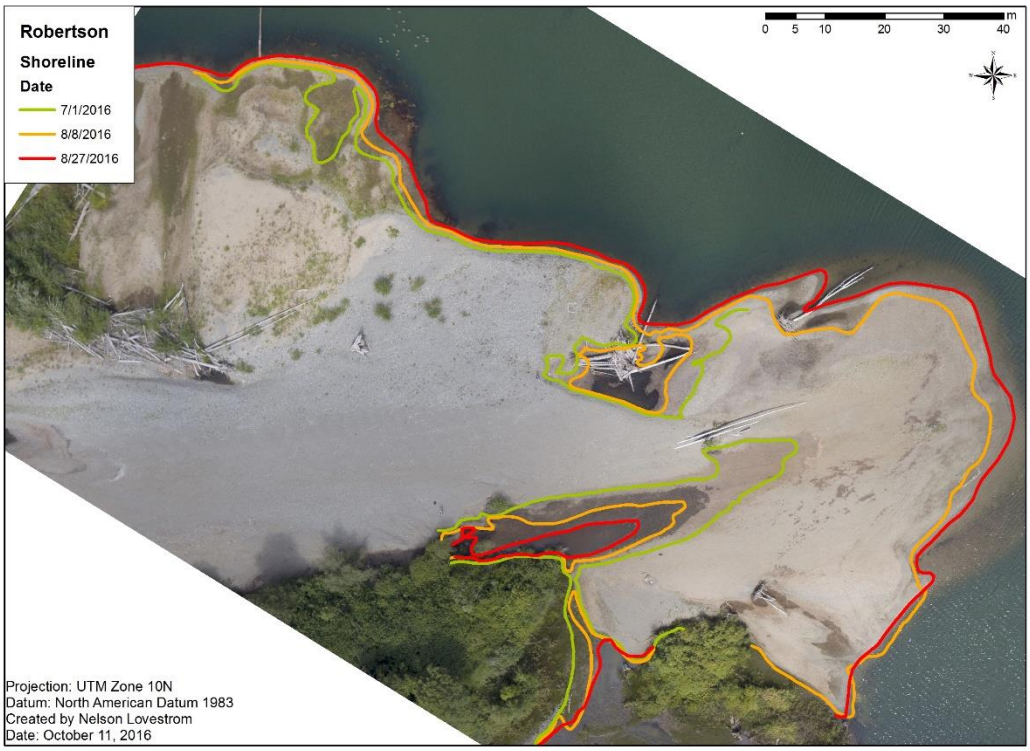

Figure 7. Visual representation of the receding shoreline at the convergence of Robertson River and Bear Lake on, July 1 (light green), August 8 (yellow) and August 27 (red) 2016.

DISCUSSION

Documenting the changes in available habitat for spawning Cowichan Lamprey and their ammocoetes are important for the management of Cowichan Lamprey and water levels in Cowichan Lake.

There was no running water in either Cottonwood Creek, Meade Creek (north) or Robertson River throughout the sample period (June to August). It is during this time, and earlier, that Cowichan Lamprey are spawning, eggs are incubating and hatching, and young ammocoetes are developing in the areas around the outlets of rivers and streams (Beamish and Wade, 2008).

The deltas of Cottonwood Creek and Robertson River were almost all dry by June 2016. The small proportion that was wetted in June was reduced as lake levels decreased throughout the summer. If there had been successful spawning in May, the amount of available nearshore habitat for young-of-the-year ammocoetes was minimal by August at both the Cottonwood Creek and Robertson River locations. Given the absence of water exiting Meade Creek (north) even in June, it would be highly unlikely that spawning would have occurred at this location. If it had, it would have been on the shore of the lake with no connection to Meade Creek (north) and not consistent with the belief that Cowichan Lamprey spawn in fluvial fans.

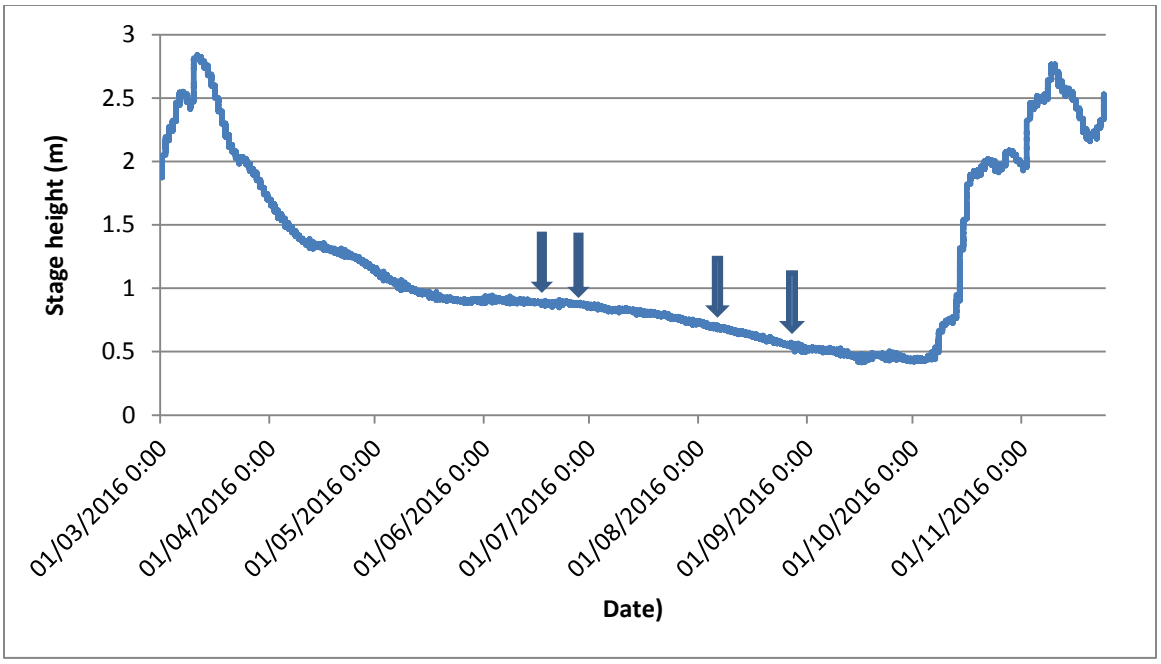

Figure 8. Stage height recorded at Cowichan Lake weir from March to December 2016. Arrows indicated dates when drone surveys were conducted.

Spawning habitat was almost completely unavailable at these three locations from at least June to August; consequently, habitat for egg incubation and rearing of young-of-the-year ammocetes was also unavailable. The stage height (Figure 8) recorded at Cowichan Lake weir during this time was below 1m. These areas have also been shown to be rearing habitat for other year classes of ammocoetes. Larger ammocoetes can move greater distances to find suitable habitat although it is unknown how far or at what depths they can survive. There is a concern that ammocoetes may not be able to survive at depth but rather require nearshore areas to obtain nutrients and grow.

It is recognized that Cowichan Lamprey must have some degree of resilience if it has survived since the last glaciation in the area. However, with very low water levels, particularly during years of drought that have been recorded for the past three summers, it is not unreasonable to speculate that this species may be experiencing recruitment failure which may have long term effects on population abundance.

A more complete picture of changing habitat would have resulted from overlaying the data presented above with nearshore bathymetry contours however, nearshore bathymetry data do not exist for Cowichan Lake. It is recommended that future studies collect the nearshore bathymetry for Cowichan Lake at high water so that similar studies may be repeated throughout the year and habitat change quantified in both "normal" years and years of drought.

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