3.3 nʔastqʷitkʷ - Naswhito Creek

Naswhito Creek is a tributary to Okanagan Lake, flowing from the west side of the Okanagan Basin into the northwest arm of Okanagan Lake near Vernon, B.C. over a length of approximately 13 km (Eyjolfson & Dunn 2016). The Naswhito Creek watershed is approximately 87 km^2 (Associated 2016). Naswhito Creek is not lake-headed and has no developed storage; however, several wetlands are located in the headwaters. A summary of creek characteristics is found in Table 3-7 and additional stream-specific data is provided in Appendix B3.

The lower reaches of Naswhito Creek flow over an alluvial fan that has merged with the Equesis Creek fan. Paired streamflow measurements indicate streamflow losses to groundwater on the fan. Agricultural fields are located adjacent to the creek with several unrestricted livestock access points. The lowest reach of Naswhito Creek below Westside Road has some minor channelization, and excellent to high quality riparian vegetation (Eyjolfson & Dunn 2016). Instream habitat in this section is characterized by pool-riffle morphology and good quality spawning gravel for Kokanee. For many years the most downstream barrier to fish migration was an irrigation dam located below Westside Road 2.6 km from the mouth (Eyjolfson & Dunn 2016). The dam was washed out during the 2018 freshet and is now passable (Louis pers. comm. 2019). Upstream of Westside Road, substrate size increases and the creek provides high quality Rainbow spawning and rearing habitats.

Naswhito Creek is known to support populations of Kokanee spawning as well as Rainbow spawning and rearing (Associated 2016). Kokanee spawning was confined to the reaches up to the irrigation dam barrier at 2.6 km (Louis 2012) until it was washed out during the 2018 freshet; Kokanee were observed spawning in the newly accessible reaches above the washed out dam in 2019 (Louis pers. comm. 2019). Spawner enumeration reports indicate that low flows tend to create issues with Kokanee migration into the creek and passage and spawning conditions improve at higher flows (e.g., Louis 2010; Louis 2004).

A total of three riffle and two glide transects were established in Naswhito Creek. One particularly wide and shallow riffle transect near the mouth was established to determine suitable passage conditions for migrating spawners. All transects were located downstream of the fish barrier at 2.6 km from the mouth and within the documented Kokanee spawning reaches. The lowermost transect (1) had to be moved following the 2017 freshet due to extensive channel changes at the original location.

At present there are 12 points of diversion within the watershed; however, the actual volume extracted is unknown (Associated 2019). Okanagan Indian Band is the main water user. The creek is currently fully recorded for irrigation unless supported by storage (FLNRORD 2016). One hydrometric station was installed in 2016 and continues to operate presently (Figure B3-2, Appendix B3). Naswhito Creek is 'flow sensitive' during summer and winter when naturalized flows are below 20% LTMAD (Table 3-8).

Estimated naturalized, residual and maximum licensed flow data were provided by Associated (2019). A quality rating of C (data error estimated between 25% and 50%) was assigned to the data. However, the estimated naturalized flows during the late summer and early fall season were consistently below the residual flows recorded at the ONA hydrometric station near the mouth from 2016-2018. Further, WUW curves indicate that Rainbow rearing, insect production and Kokanee spawning at the estimated naturalized flows would be marginal (i.e., less than 20% of maximum WUW available), but Naswhito Creek is known to support a Kokanee population (Louis 2008-2016) and spawning and rearing Rainbow (Wightman & Taylor 1978). Therefore, the Associated (2019) naturalized flow estimates were considered relatively uncertain and summer and fall EFNs were set based on WUW curves and recent hydrometric

data. Estimated maximum licensed flows indicate that Naswhito Creek would be dry from early August to mid-September if licensed withdrawals were maximized (Figure 3-6).

Table 3-7: Naswhito Creek description

Drainage Area	86.5 km^2
Median Elevation	1242 m
WSC station	No active stations 08NM047 (Historic) – Naswhito Creek near Ewing's Landing (1921)
ONA station	08NM586 (2016-present) – Naswhito Creek near the Mouth
LTMAD	0.363 m^3/s (Associated 2019)
Fish species expected	Rainbow, Kokanee, Prickly Sculpin (ESSA & Solander 2009)
Land use	Forestry in upper watershed, agriculture in lower watershed. The Okanagan Indian Band Reserve #1 is located on the alluvial fan of the confluence of Naswhito Creek with Okanagan Lake (Associated 2016)

Fish periodicity and flow standards described in Table 2-2 to Table 2-6 were used. Weekly Okanagan Tennant EFNs were set to the lower of the naturalized flow or flow standard. Recommended EFNs were increased from the Okanagan Tennant EFNs based on WUW information and recorded streamflow data from 2016-2018. A summary of EFNs is provided in Table 3-9 including the median EFN and the range of weekly EFNs, with weekly details in Figure 3-5 and Figure 3-6, and Appendix B3. Critical flows were calculated as described in Section 2.4. Further information regarding EFN and critical flow setting in Naswhito Creek is provided at the end of this section.

Table 3-8: Flow sensitivities in Naswhito Creek

Species & life stage	**1-in-2 yr 30-day summer low flow**		**1-in-2 yr 30-day winter low flow**	
	Flow (m^3/s)	% LTMAD	Flow (m^3/s)	% LTMAD
Rainbow rearing	0.045	12%		
Insect production				
Kokanee spawning				
Rainbow overwintering			0.038	10%
Kokanee egg incubation				

Source: Associated (2019)

Table 3-9: EFN summary table for Naswhito Creek

Species & life stage	**Time period**	**Okanagan Tennant EFN**		**WUW EFN** (m^3/s)	**Recommended EFN** (m^3/s)				**Critical flow**	
		Median (m^3/s)	% LTMAD		Median	% LTMAD	Min	Max	Flow (m^3/s)	% LTMAD
Rainbow rearing & insect production [a]	April 1 – Oct 31	0.073	20%	0.090	0.090	25%	0.090	0.259	0.031	9%
Rainbow spawning	May 20 – Jul 10	0.774	213%	0.774	0.774	213%	0.366	1.80	0.502	138%
Kokanee spawning	Sep 12 – Oct 7	0.073	20%	0.090	0.090	25%	0.090	0.090	0.060	17%
Rainbow overwintering	Nov 1 – March 31	0.073	20%	n/a	0.054	15%	0.048	0.071	0.031	9%

a while EFNs apply to the entire period, median values are presented for the summer low flow period from Jul 15-Sept 30.

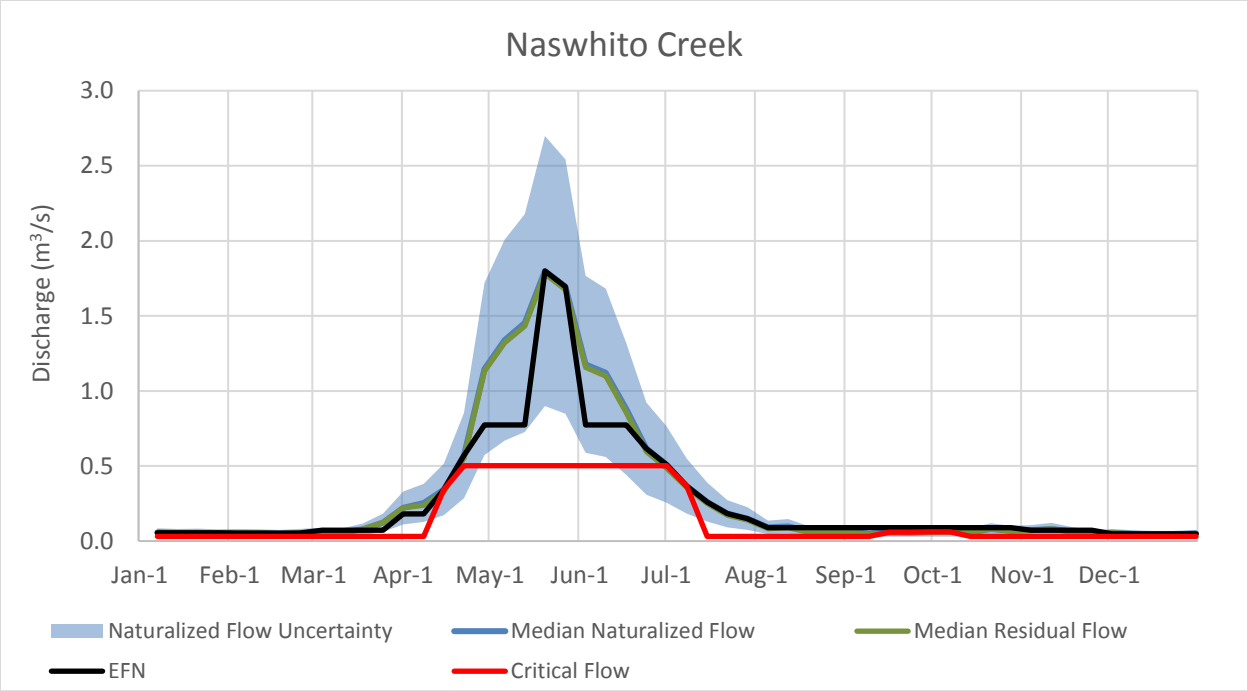

Figure 3-5: Weekly EFNs and critical flows in Naswhito Creek

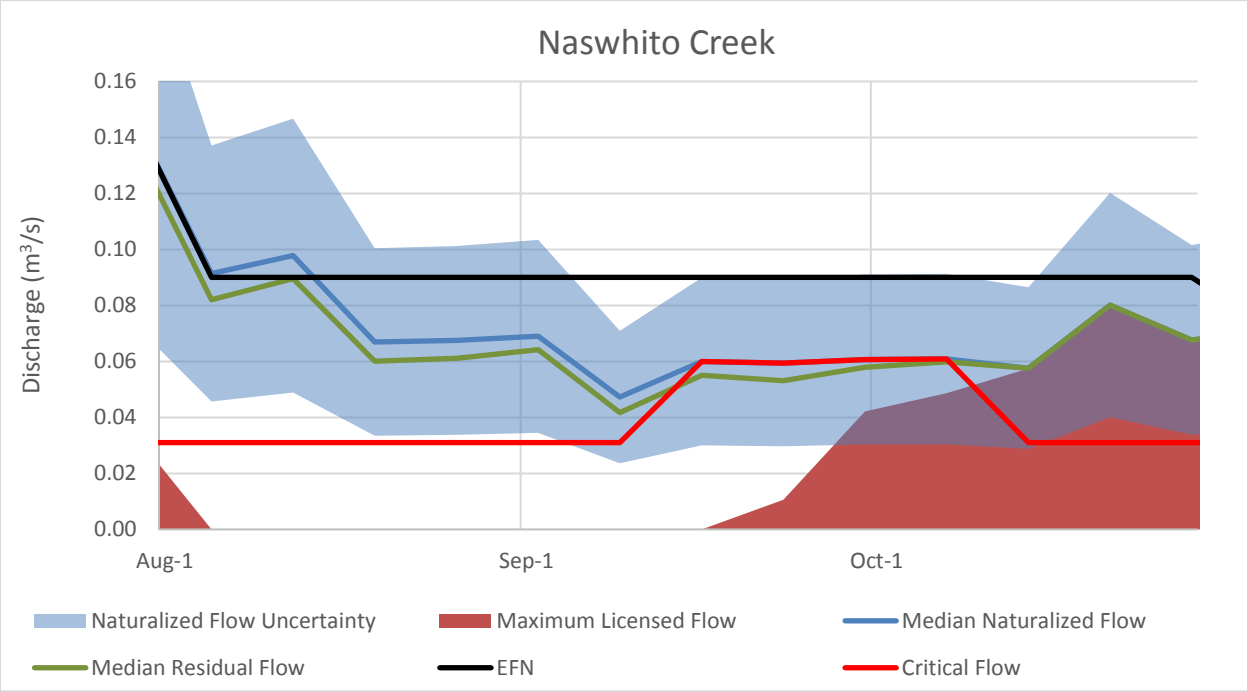

Figure 3-6: Weekly EFNs and critical flows during the summer and fall period in Naswhito Creek

Rainbow parr rearing

The recommended EFN for Rainbow Parr rearing is 0.090 m^3/s (25% LTMAD), which is greater than the Okanagan Tennant EFN (0.073 m^3/s, 20% LTMAD). The recommended EFN maintains approximately 45% of maximum WUW in glides and 20% in riffles (Figure B3-5, Appendix B3), as well as approximately 13% of maximum insect production WUW (Figure B3-6, Appendix B3). The EFN was set higher than the Okanagan Tennant EFN because naturalized summer flows provided by Associated (2019), which define the upper range of the Okanagan Tennant EFN, were implausibly low compared to measured flow data from the mouth. Further, WUW increases rapidly in this flow range. Photos of habitat conditions in Naswhito Creek at the recommended EFN flows are provided in Plate 3-5. The recommended EFN is similar to the minimum flow for Rainbow rearing recommended by the B.C. Fish and Wildlife Branch (Robertson 1983) of 0.085 m^3/s and lower than that recommended by ESSA & Solander (2009) of 0.4 – 1 m^3/s.

The recommended EFN value is lower than the median weekly residual flows recorded at the ONA hydrometric station near the mouth in 2016 and 2018, and slightly higher than in 2017, which was a drought year (Figure B3-3, Appendix B3). Water temperatures in Naswhito Creek recorded at the hydrometric station were generally favorable to Rainbow rearing though approached the upper range of suitable rearing temperatures (20^oC) in late July (Figure B3-4, Appendix B3). The recommended critical flow for Rainbow rearing is 0.031 m^3/s (9% LTMAD, Table B3-2, Appendix B3) based on the riffle width criterion (Table 2-7).

Rainbow spawning

The recommended EFN for Rainbow spawning is 0.774 m^3/s, which is equivalent to the Okanagan Tennant flow standard (213% LTMAD) and slightly below median naturalized flows for the spawning period (1.00 m^3/s, 275% LTMAD). The EFN maintains 80% of maximum spawning WUW (Figure B3-7, Appendix B3) while also maintaining high (>90%) rearing WUW. Flows were above the EFN for the entire spawning period in 2017 and 2018 (Figure B3-3, Appendix B3). Photos of habitat conditions in Naswhito Creek at the recommended EFN flows are provided in Plate 3-6. A previous EFN of 1 m^3/s was recommended by ESSA & Solander (2009).

The recommended critical flow for Rainbow spawning is 0.502 m^3/s (138% LTMAD, Table B3-2, Appendix B3) based on the passage depth criterion (Table 2-7).

Kokanee spawning

The recommended EFN for Kokanee spawning is 0.090 m^3/s (25% LTMAD) and maintains 40% of the maximum WUW (Figure B3-8, Appendix B3). The EFN was set higher than the Okanagan Tennant EFN (0.073 m^3/s, 20% LTMAD) because estimated naturalized flows, which define the upper range of the Okanagan Tennant EFN, were implausibly low compared to measured flow data from the mouth. Further, WUW increases rapidly in this flow range. Recorded residual flows were greater than the EFN in 2016 and 2018, but lower in 2017 (Figure B3-3, Appendix B3). Photos of habitat conditions in Naswhito Creek at the recommended EFN flows are provided in Plate 3-5.

Passage issues for Kokanee spawners during low flows have been noted on occasion in the Kokanee enumeration reports (e.g., Louis 2010) and low flows have been identified as a limiting factor to Kokanee production by Wightman & Taylor (1978). Therefore, Kokanee in Naswhito Creek likely benefit greatly from flows higher than the recommended EFN when available. Robertson (1983) suggested EFNs of approximately 0.14 m^3/s, which may be more appropriate given higher WUW and better riffle passage,

though probably not realistically achievable for the entire spawning period during all years. ESSA & Solander (2009) recommended 0.6 m^3/s.

Critical passage flows for Kokanee estimated from riffle analysis were 0.177 m^3/s (49% LTMAD; Table B3-2, Appendix B3). Kokanee riffle passage is known to be a problem during low flows in this creek (Louis 2010). Due to these known passage issues, the recommended critical flow for Kokanee spawning is 0.060 m^3/s (17% LTMAD, Table B3-2, Appendix B3), which corresponds to the median naturalized flow during the Kokanee spawning season. Thus, any water use during Kokanee spawning has the potential to adversely impact Kokanee access and movement. It is likely that fall rain events play a critical role for Kokanee access into Naswhito Creek.

Plate 3-5: Naswhito Creek habitat conditions at flows near the recommended Rainbow parr rearing and Kokanee spawning EFNs (0.090 m^3/s)

Glide 2 at 0.093 m^3/s (26% LTMAD)

Glide 2 at 0.149 m^3/s (41% LTMAD)

Riffle 1a at 0.083 m^3/s (23% LTMAD)

Riffle 1a at 0.139 m^3/s (38% LTMAD)

Plate 3-6: Naswhito Creek habitat conditions at flows near the recommended Rainbow spawning EFN (0.774 m^3/s)

Glide 2 at 0.643 m^3/s (177% LTMAD)

Glide 2 at 1.53 m^3/s (421% LTMAD)