4.2 Summary of recommended EFNs and Critical Flows

This section provides a summary of the EFN and critical flow recommendations as well as comments on general patterns observed. Recommended EFNs for the study creeks are provided in Table 4-2 and critical flows and flow sensitivities are provided in Table 4-3. Climate change will affect both the timing and magnitude of hydrographs and stream temperatures and the EFNs and critical flows in this report apply only to current climate conditions. They should be reviewed periodically in the future and adjusted, if warranted, to reflect changing climate conditions and any other stream changes or new information.

Okanagan streams are characterized by snowmelt-driven hydrographs with a large freshet peak in the spring and early summer and comparatively low flows during the remainder of the year. As a result, flows are most limiting to fish populations in the summer, fall and winter periods. The following general observations were made:

- Naturally available streamflows during freshet are generally sufficient to produce optimum conditions for **Rainbow** and **Steelhead** that spawn during the spring freshet. Okanagan Tennant EFNs were mostly set at the presumptive flow standards and were rarely constrained by naturally lower flows, except for some smaller streams. Okanagan Tennant flow standards typically produced near optimum WUWs and as a result, final recommended EFNs were not further adjusted. Water use during this time is usually relatively low and residual streamflows typically meet EFNs and critical migration flows in most years. However, caution is advised in heavily regulated systems with large storage capacity to ensure that water storage does not reduce streamflows below spawning EFNs. Where residual flows were available they did not indicate substantial infringement by water storage activities on springtime EFNs except in one stream (Mill Creek); however, residual flows or flow estimates were unavailable for approximately 40% of the streams, some known to be heavily regulated. While some hydrometric records exist from these systems and are discussed in the body of this report, residual flow estimates will provide a better understanding of any negative impacts that water storage has on Rainbow and Steelhead spawning EFN flows in these systems. Water regulation activities during freshet should ensure that a relatively natural flow pattern is maintained with appropriate timing of high flows as specified by the recommended EFNs, and that abrupt changes in flow are strictly avoided.

  Critical riffle analysis indicates that safe riffle passage ($\geq$25% of transect with depths $\geq$0.18 m) for Rainbow and Steelhead spawners would be achieved between 18% and 129% LTMAD and the %LTMAD required declines with increasing stream size (Figure 4-2). The relationship is similar to that of the large-bodied salmonid flow standard calculation used for Okanagan Tennant flow standards (Ptolemy & Lewis 2002; Section 2.2.2. and Table 2-5), which incorporated documented fish movement data (Ptolemy pers. comm.). Critical flows for Rainbow and Steelhead spawners are usually met in the study streams due to naturally high freshet flows during their spawning period.

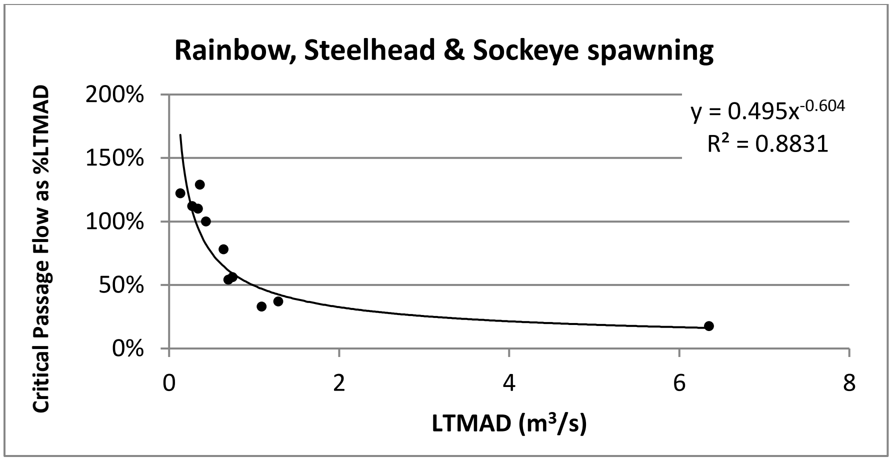

Figure 4-2: Rainbow, Steelhead and Sockeye spawner critical riffle passage flows vs. LTMAD for 11 Okanagan streams

- Streamflows are typically very low during later summer and early fall with a small increase in later fall following rain events. Thus, Okanagan Tennant EFNs for summer and early fall were generally most constrained by low naturalized flows and were mostly lower than presumptive flow standards. As a result, final EFNs were rarely further reduced based on WUW. In systems with a history of flow augmentation from storage, WUW information was used to increase EFNs from Okanagan Tennant EFNs to match residual flows to preserve the status quo. Specific observations for summer and fall EFNs include:

  - EFNs for **spring Chinook** migration and spawning in July-September were most constrained by naturally low flows during later summer as well as small stream size. The recommended EFNs were associated with relatively low WUWs (6%-28% of maximum) and riffle analysis indicated migration difficulties. Thus EFNs and, in some cases, critical flows, were set to naturalized flows in systems that are known or suspected to support spring Chinook to provide maximum available flows. Migration and spawning conditions for spring Chinook greatly improve at flows higher than the recommended EFNs.

    Critical riffle analysis indicates that commonly used %LTMAD-based migration (20%) and spawning (10%) critical flows do not produce safe riffle passage conditions (≥25% of transect with depths ≥0.24 m) for Chinook in smaller streams due to shallow water depths and large body sizes. Safe riffle passage would be achieved between 91%-394% LTMAD and the %LTMAD required declines with increasing stream size (Figure 4-3). Rain events and associated flow increases are likely critically important in providing spawning migration access and should be protected. Due to their typical early-summer spawning migration, spring Chinook have an extraordinarily long holding period and maintaining suitable flows throughout the summer is of critical importance to their ability to successfully spawn. Stream temperatures were not explicitly considered in this analysis but it is likely that they further constrain habitat suitability for spring Chinook spawners in some of the streams as described in Table 4-1.

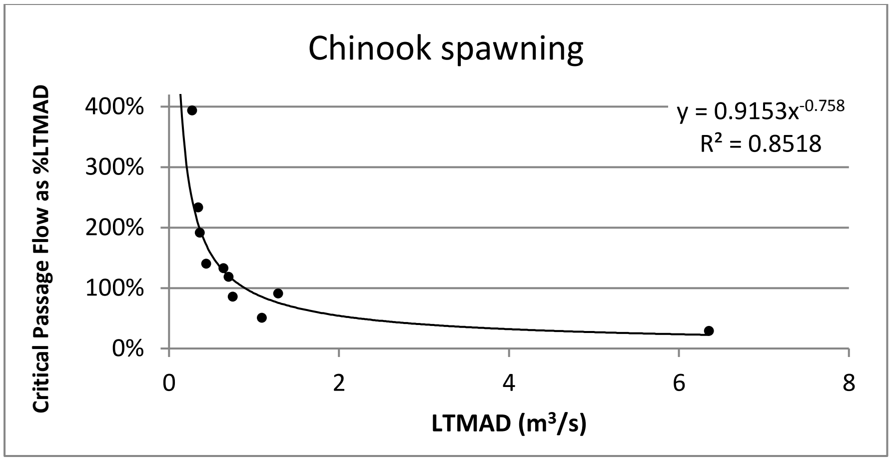

Figure 4-3: Spring Chinook spawner critical riffle passage flows vs. LTMAD for 11 Okanagan streams

- **Juvenile Rainbow and Chinook rearing** in most streams is naturally constrained by low flows through the summer and fall (July-September). As a result, many EFNs fall below the Tennant flow standard (20% LTMAD) during some portion of that period. There were a number of streams, however, with a history of flow augmentation or naturally higher baseflows, where recommended EFNs are at or greater than presumptive flow standards. WUWs at the recommended EFNs range from 25%-85% of maximum for O. mykiss parr, and from 35%-60% of maximum for Chinook fry. Optimum flows, indicated by the peak of the WUW curve, occur in all study streams at flows greater than naturally available in summer and fall. Rearing conditions improve rapidly at flows greater than the recommended EFNs. Stream temperatures were not explicitly considered in this analysis but it is likely that they further constrain suitable rearing habitats for cold water species in some of the streams as described in Table 4-1.

  Riffle width analysis (Table 2-7) produced critical flow recommendations for juvenile rearing that were slightly greater than those commonly applied by FLNRORD (5%) with a mean of 8% and a range of 3%-12% (Figure 4-4), excluding streams without WUW information and those lacking low flow measurements (Coldstream and Equesis). Recommended critical flows were always greater than or equal to 5% (Table 4-3). Unlike critical passage flows for spawners, there was no clear relationship with LTMAD.

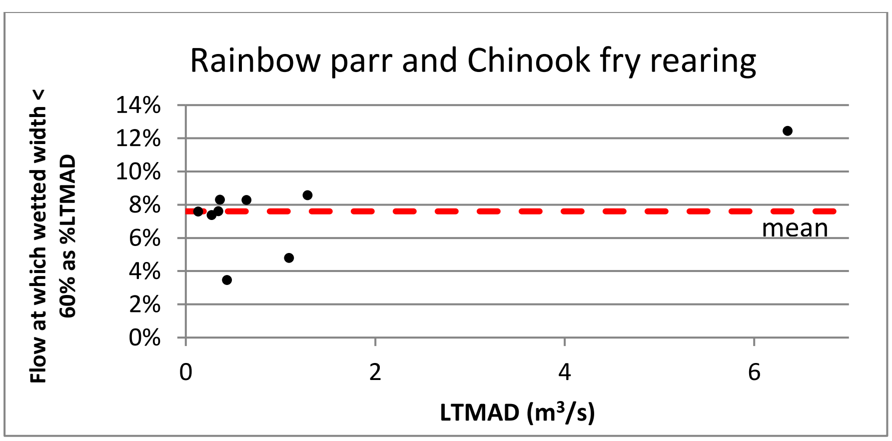

Figure 4-4: Rainbow parr and Chinook fry rearing critical riffle width flows vs. LTMAD for 11 Okanagan streams

- **Kokanee** spawners, particularly the early fall spawning populations, are naturally constrained by low flows in September. Later spawning populations as well as **Sockeye** are less affected because flows often increase in October following rainfall events. WUWs at the recommended EFNs range from 30%-98% of maximum for Kokanee spawning, and from 30%-43% of maximum for Sockeye spawning with the exception of Shuttleworth Creek, where Sockeye access and spawning is likely limited to wet years due to small stream size and naturally low flows. Migration and spawning conditions greatly improve at flows higher than the EFNs.

  Critical riffle analysis indicates that commonly used %LTMAD-based critical flows (10%) do not produce safe riffle passage conditions (≥25% of transect with depths ≥0.12 m) for Kokanee in most of the study streams due to shallow water depths. Safe riffle passage for Kokanee would be achieved between 10%-82% LTMAD and the %LTMAD required declines with increasing stream size. Safe riffle passage for Sockeye would be achieved between 18% and 129% LTMAD (Figure 4-2) and flows are typically lower during the Sockeye spawning season. Rain events and associated flow increases are likely important in providing spawning migration access.

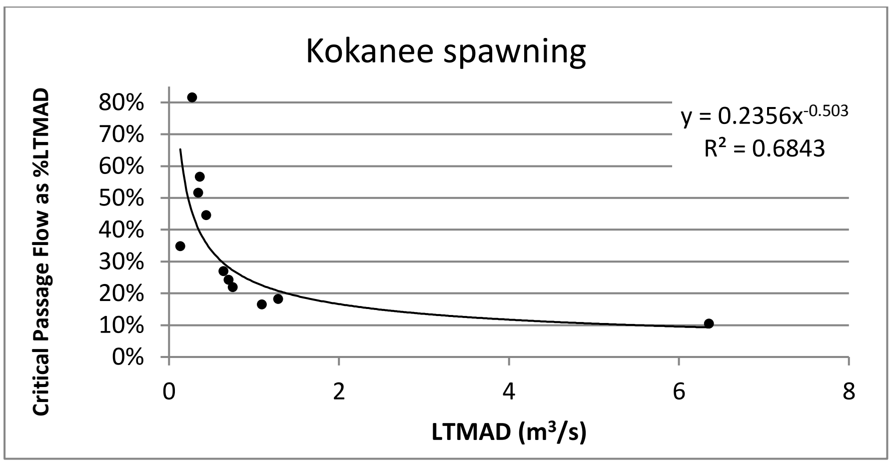

Figure 4-5: Kokanee spawner critical riffle passage flows vs. LTMAD for 11 Okanagan streams

- Most of the 18 study streams are naturally 'flow sensitive' during summer (Table 4-3) and without careful consideration of mitigation options (e.g., off-channel storage), any further water withdrawals may be detrimental to ecosystem health.

- Most of the 18 study streams are naturally 'flow sensitive' during winter (Table 4-3). Winter low flows have the potential to negatively affect egg incubation and overwintering habitats. Water demand is generally lower during the winter and streams for which maximum licensed flow estimates were produced did not indicate significant impacts on streamflows in the winter. However, care should be taken in highly regulated streams to ensure that sufficient winter flows are maintained. Measurement of flow under ice is fraught with error and introduces uncertainty in streamflow records as well as naturalized flow estimates during this period.

- In some streams, most or all migratory fish accessible low-gradient reaches are situated on valley-side alluvial fans (e.g., Shorts Creek). These transitional fan areas between steep valley side and valley bottom are naturally sensitive to low flows as they are often zones of groundwater recharge that lose some streamflow to the aquifers below. As a result, those creeks tend to experience extremely low base flows. Streams with long low-gradient valley-bottom reaches (e.g., Coldstream and Mill creeks) experience substantial groundwater inflows in those lower reaches and tend to have much higher baseflows than average.

- Streams for which maximum licensed flows were provided by Associated (2019) frequently showed extreme impacts of water use on summer and fall streamflows and five of nine creeks would dry up entirely from mid-July to mid-September under maximum licensed flow conditions. Coincidentally, the two streams showing little impact from licensed water use (Vaseux and Shuttleworth creeks) are known to dry up most summers and have large points of diversion above the dry reaches. Monitoring of actual water use is vital to understanding whether this is a natural phenomenon or whether licensed amounts are exceeded.