PERFORMANCE MEASURE INFORMATION SHEET #20

SOFT CONSTRAINTS FOR ARROW LAKES RESERVOIR: FISH

Objective / Location	Performance Measure	Units	Description
Fish Soft Constraint/Arrow Reservoir	Tributary Access	# days above defined elevation thresholds between 25 August and 15 November: *Original threshold = 1424 ft* *Updated threshold = 1430 ft*	Sum of # days over the kokanee and bull trout spawning periods that the reservoir water level is above defined thresholds.

Description

During the Columbia WUP process, concern was expressed that seasonal changes in the elevation in Arrow Lakes Reservoir have the potential to negatively affect the ability of key fish populations (namely kokanee, bull trout and rainbow trout) to access critical spawning habitats in the Arrow Lakes tributaries. Reduced success in upstream passage can result from a variety of effects associated with the topographic configuration of the tributary fan, including gradient, channel depth and velocity, morphology (braiding), and sub-surface conveyance of tributary outflow.

While it was assumed that the effects of low spring reservoir elevation on spawning rainbow trout are, in part, mitigated by increased stream flow during tributary freshet, low reservoir levels during the fall spawning period for kokanee and bull trout was considered an issue by the WUP Consultative Committee. BC Hydro conducted several tributary access assessments in Arrow Lakes Reservoir in the fall (Bayes and Olmsted 1997, CCRIFC 2006, BC Hydro 1998, 2004-2006, and Wilson 1999). Although there were no reports of significant access issues related to low reservoir conditions, low flow access issues were observed in a small number of tributaries to the Lower Arrow.

As part of developing soft constraints for Arrow Reservoir operations, the Committee recommended an elevation target of 1424 ft over the period August 25 - November 15 to minimize potential impacts on fall spawners. This was thought to be the critical elevation below which some tributaries could become inaccessible over the kokanee and bull trout spawning periods.

The Committee acknowledged that further study would be required to resolve whether current operation of Arrow Lakes Reservoir is negatively affecting tributary access. A 5-year monitoring study (2008-2012) is currently underway to assess whether operation of the Arrow Lakes Reservoir is limiting upstream migration of spawners into tributary streams, whether there is a reservoir elevation threshold below which spawning access is affected, and to what extent stream flows mitigate low reservoir water levels in the spring. Preliminary findings from the first year (2009) of field study suggest that rainbow trout may not experience the same limitations as kokanee, as adfluvial trout spawning migrations coincide with spring freshet and periods of increased tributary discharges (Ecoscape 2010). However, operation of the reservoir can block or reduce upstream passage of kokanee during their fall spawning migration. Of the passage barriers identified in tributary streams, all of these were attributed to some combination of channel braiding, rock/debris barriers and low stream flows. In some tributaries, access was still a problem even when reservoir water levels were 4.5 ft above the elevation threshold set for the

Arrow soft constraint (1424 ft). Braided channels within many of the tributaries are highly dynamic and unstable, causing individual barriers to possibly migrate upstream/downstream as a result of bedload movement. Further surveys will be required to identify reservoir elevation thresholds above which channel stability is increased and elevational position where low flow barriers exist.

Based on the 2009 study results, seven tributaries were found to have barriers as a result of low stream flows, braided channels and or aggradation. The elevations of these obstructions ranged from 1418 ft to 1438 ft, with most occurring at or below 1430 ft. A second threshold for the Performance Measure was therefore included to report out on the number of days that Arrow Lakes Reservoir is above 1430 ft during the kokanee and bull trout spawning periods.

Calculations

For each scenario:

1. Assemble the simulated results for Arrow Reservoir elevations over 60 years (1940-2000; Figure 1).
2. Count the number of days over the kokanee spawning period that the reservoir is at or above either 1424 ft or 1430 ft in each of the 60 years.
3. Summarize all statistics (Figure 2 and Figure 3).

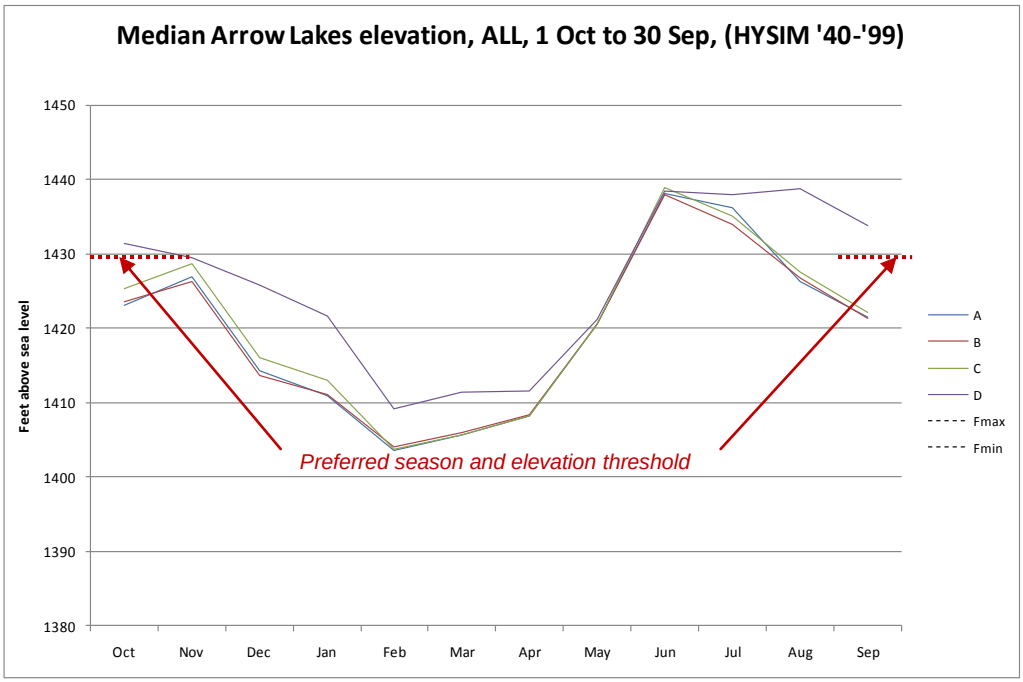


Figure 1. HYSIM Simulated Arrow Lakes Reservoir Elevations. Median result over 60 years showing the elevation target for tributary access.

Key Assumptions and Uncertainties

- Each scenario is simulated using the same set of system constraints, input assumptions (e.g., load forecasts) and historic basin inflows (1940 – 2000).
- Spawning windows do not vary from year to year either naturally or as a function of reservoir elevations and inflows.
- Uncertainty about critical reservoir elevation that limits access to important spawning tributaries.
- Factors other than reservoir elevation do not limit access of fish to tributary spawning habitats.

Results

Regardless of the statistic used, Scenario D (no NTS) would cause water levels in Arrow Lakes Reservoir to exceed the thresholds for a significantly greater number of days during the spawning period than scenarios A, B and C. All of the "with NTS" scenarios perform similarly except in dry years when B (3.0 MAF) would perform worse due to the deeper draft of the reservoir (i.e., release of an additional 0.5 MAF).

Figure 2: Tributary Access: days > 1424 ft – HYSIM Results for all NTS scenarios

	Scen A	Scen B	Scen C	Scen D
Max	83	83	83	83
90th	83	83	83	83
Mean	41	39	49	72
Med	31	30	51	83
10th	0	0	2	14
Min	0	0	0	0

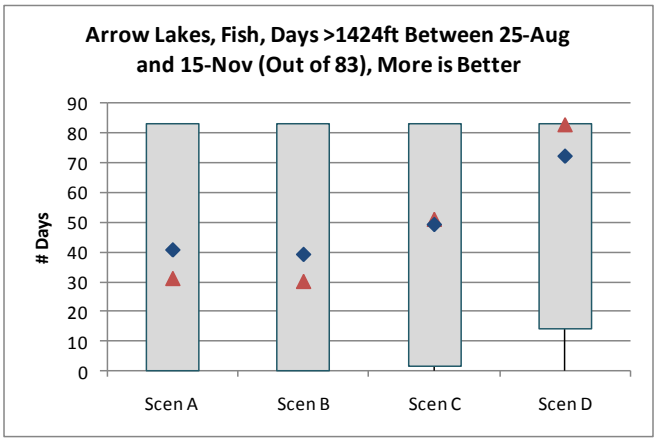
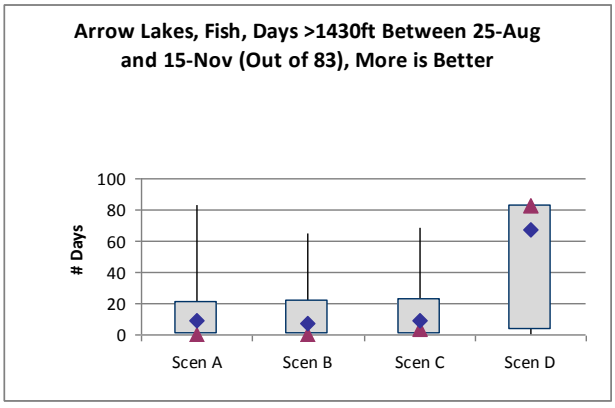


Figure 3. Fish Tributary Access: days > 1430 ft – HYSIM Results for all NTS scenarios

	Scen A	Scen B	Scen C	Scen D
Max	83	65	68	83
90th	21	21	23	83
Mean	9	8	9	67
Med	0	0	4	83
10th	0	0	0	2
Min	0	0	0	0



References

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