

PERFORMANCE MEASURE INFORMATION SHEET #11

MID COLUMBIA RIVER: VEGETATION

Objective / Location	Performance Measure	Units	Description	MSIC
Vegetation/ Mid Columbia River	Vegetation	Flooded weeks	Reports on number of flooded weeks that each 1 m elevation band is inundated	10%

Background

The depth, timing and duration of flooding of the Revelstoke Reach of the Arrow Lakes Reservoir are important factors that affect the species composition, spatial extent and diversity of vegetation in the drawdown zone. The WUP Consultative Committee focused a great deal of attention on the issue of vegetation in the mid Columbia River and the Arrow Reservoir drawdown zone since it supports a large number of other interests, including: birds and wildlife, protection of archaeological sites, dust control and aesthetic values.

The measurement of “what’s good for vegetation” is complex, and the Consultative Committee explored several different approaches to this. The development of a performance measure to track the impact of operations on vegetation was difficult due to the complexity of what drives the establishment and survival of vegetation in the drawdown zone, and significant data gaps that existed around the functioning of vegetation in a reservoir environment. A number of long-term monitoring programs are being undertaken through BC Hydro’s Water License Requirements (WLR) Program to better understand the importance of the inundation regime, specifically the timing (i.e., early vs. latter part of the growing season), and other factors that play a role in determining why and how plants can survive in the drawdown zone.

Preliminary findings from ongoing WLR work indicate that there are a number of factors that influence vegetation establishment, species composition and spatial extent, including exposure to wave erosion, substrate type, ground water availability, and slope. Further, several vegetation types are exhibiting local adaptations to environmental conditions in the drawdown zone. While the water regime is likely a key determinant of vegetation presence and composition at the lower elevations (434-436 m; 1423.5-1430 ft), other factors play important roles at mid and higher elevations. Multiple years of data will be required to sort out the all of the key drivers of change and determine the relative importance of the many environmental variables that act on vegetation in the drawdown zone.

Performance Measure

The potential impacts of the NTS scenarios on vegetation were determined based on inundation statistics for the Revelstoke Reach area, which take into account simulated reservoir elevation, local inflow and discharge releases from Revelstoke Dam for the period 1964-1973. Inundation statistics were chosen because current data suggest that the duration, depth and timing of inundation are important factors affecting vegetation establishment and composition, especially at lower elevations of the drawdown zone. While other factors may be equally, or even more important, for certain vegetation types and elevations, current research is not far enough advanced to include these data in the model.

Calculations

The most recent version of the HEC-RAS model for the mid Columbia River was used to estimate water surface elevations throughout the Revelstoke Reach¹. The model is driven by Arrow Reservoir elevations (at Fauquier), discharge from Revelstoke Dam and estimated local inflows. Water surface elevations are predicted for every week of the 10-year simulation period (1964 to 1973) based on the average local inflow by week, the average reservoir elevation by week, and the maximum hourly discharge from Revelstoke Dam by week.

The number of weeks over the growing season (April 1 to October 15 or model weeks 14-41) during which each 1 m elevation band is inundated are computed for each year. This statistic can be used to evaluate the effects of flooding on vegetation biomass and species composition at various elevations within the Revelstoke Reach. In response to a request for a more detailed model, flooding statistics were also computed for the first half (April 1- July 31) and second half (August 1 – October 15) of the growing season.

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 (1964-1973).
- Assumes frequency, duration and extent (timing, duration and depth) of inundation are the only drivers of vegetation survival/establishment.
- Assumes all vegetation types are equally affected by the three drivers.

Results

Based on the inundation statistics, there would be longer periods of flooding under Scenario D than all the “with NTS” scenarios due to increased reservoir elevations during the growing season. This is particularly evident at elevations ranging from 434-439 m (1423.5-1440 ft). This elevation zone is particularly important for vegetation, since perennial, self-sustaining vegetation communities have established here, many of which are adapted to the operating regime of the reservoir. While vegetation is present below the 434 m (1423.5 ft), these communities are affected by operations to a larger extent, and may not be maintainable over the long term.

There are only negligible differences across the “with NTS” scenarios (A, B and C) in terms of number of weeks that elevations between 430-440 m (1410-1444 ft) are flooded during the early part of the growing season (Table 1, Figure 1). However, on average, Scenarios A and B perform consistently better than Scenario C at elevations 434-437 m (1423.5-1433 ft) during the fall period (Table 2, Figure 2).

¹ As there is no HEC-RAS model available for Arrow Lakes Reservoir proper, inundation statistics were only generated for Revelstoke Reach. Although the high level messages from the NTS analysis are likely to be applicable to the entire reservoir (i.e., higher water levels for longer periods during the growing season is “bad” for vegetation), results of the WLR monitoring programs are indicating that vegetation communities between Revelstoke Reach and Arrow Reservoir are distinctly different in terms of species composition, species richness and abundance, and are likely to respond differently across elevation bands to the inundation regime due to difference in environmental conditions.

Table 1. Statistics on Weeks Flooded for the Early (Apr 1 – Jul 31) Part of the Growing Season (1964-1973) by 1-m elevation Band in Revelstoke Reach across the NTSA scenarios

Elevation (msl)	Average				Minimum				Maximum			
	A	B	C	D	A	B	C	D	A	B	C	D
430-431	14.0	14.4	14.0	15.7	11.8	11.8	11.8	13.1	18.0	18.0	18.0	18.0
431-432	12.6	12.8	12.6	13.1	11.2	11.0	11.3	11.4	18.0	18.0	18.0	18.0
432-433	12.0	12.2	12.0	12.2	10.3	10.4	10.3	10.3	18.0	18.0	18.0	18.0
433-434	10.8	10.9	10.8	10.9	8.8	8.9	8.8	8.7	18.0	18.0	18.0	18.0
434-435	9.8	9.8	9.8	9.8	7.9	7.5	7.9	7.8	18.0	18.0	18.0	18.0
435-436	9.2	9.2	9.2	9.1	7.1	7.0	7.0	6.0	18.0	18.0	18.0	18.0
436-437	8.4	8.4	8.4	8.4	5.6	5.6	5.6	4.8	17.8	18.0	17.8	18.0
437-438	7.1	6.8	7.0	7.3	3.7	3.5	3.9	3.6	14.4	14.5	14.1	16.8
438-439	4.3	3.7	4.5	5.3	1.2	0.1	1.0	2.1	8.1	6.0	8.0	10.6
439-440	1.5	0.9	1.7	2.0	0.0	0.0	0.0	0.0	5.3	2.3	5.4	5.2

Elevation (msl)	Median				10th Percentile				90th Percentile			
	A	B	C	D	A	B	C	D	A	B	C	D
430-431	13.2	13.3	13.2	16.0	11.9	11.9	11.9	13.1	17.8	18.0	17.8	18.0
431-432	12.0	12.2	12.0	12.8	11.2	11.1	11.3	11.4	17.5	17.6	17.5	17.6
432-433	11.4	11.5	11.4	11.7	10.4	10.5	10.3	10.4	17.4	17.5	17.4	17.5
433-434	10.0	10.0	10.0	10.4	8.9	8.9	8.8	8.7	17.3	17.3	17.3	17.3
434-435	9.0	9.0	9.0	9.3	7.9	7.6	7.9	7.8	17.2	17.2	17.2	17.2
435-436	8.5	8.6	8.5	8.7	7.1	7.0	7.1	6.1	17.1	17.1	17.1	17.1
436-437	7.7	7.8	7.7	8.0	5.7	5.6	5.7	4.9	16.9	17.0	16.9	17.0
437-438	6.8	6.4	6.7	7.0	3.8	3.5	4.0	3.7	13.7	13.8	13.5	15.9
438-439	5.0	4.2	5.3	5.1	1.3	0.2	1.0	2.2	7.9	5.9	7.8	10.1
439-440	1.4	0.8	1.4	1.6	0.0	0.0	0.0	0.0	5.0	2.3	5.2	5.1

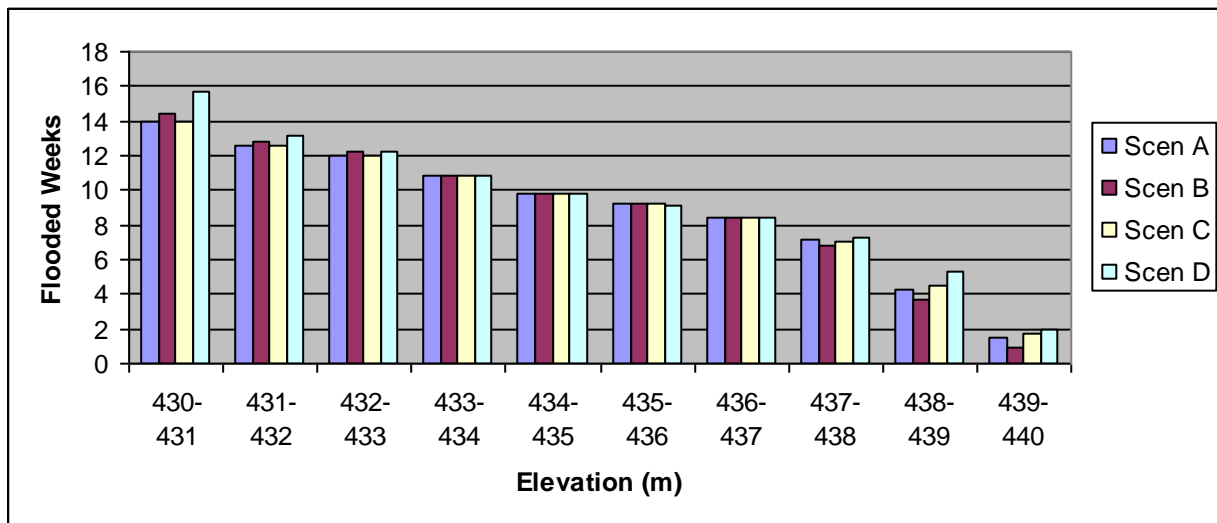


Figure 1. Average Number of Flooded Weeks by 1-m Elevation Bands during the Early Part of the Growing Season for the 10-year (1964-1973) Simulation Period

Table 1b. Statistics on Weeks Flooded for the Latter (Aug 1 – Oct 15) Part of the Growing Season (1964-1973) by 1-m elevation Band in Revelstoke Reach across the NTSA scenarios

Elevation (msl)	Average				Minimum				Maximum			
	A	B	C	D	A	B	C	D	A	B	C	D
430-431	11.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0
431-432	10.9	11.0	11.0	11.0	10.2	11.0	11.0	11.0	11.0	11.0	11.0	11.0
432-433	10.7	10.8	11.0	11.0	8.9	9.3	10.7	11.0	11.0	11.0	11.0	11.0
433-434	9.3	10.1	9.9	11.0	6.4	8.5	8.6	11.0	11.0	11.0	11.0	11.0
434-435	7.4	8.5	8.3	11.0	3.9	5.0	4.6	11.0	10.8	10.9	10.9	11.0
435-436	5.4	6.0	6.1	10.9	2.8	3.0	2.6	10.2	8.7	8.3	8.2	11.0
436-437	3.5	3.7	3.9	10.7	1.7	1.1	1.2	8.9	5.1	5.6	5.6	11.0
437-438	1.8	1.8	2.2	8.3	0.4	0.3	0.3	7.0	3.2	3.3	3.3	10.9
438-439	0.5	0.4	0.8	5.6	0.0	0.0	0.0	4.1	1.9	2.0	2.0	6.6
439-440	0.1	0.0	0.1	1.3	0.0	0.0	0.0	0.1	0.5	0.3	0.6	2.5
Elevation (msl)	Median				10th Percentile				90th Percentile			
	A	B	C	D	A	B	C	D	A	B	C	D
430-431	11.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0
431-432	11.0	11.0	11.0	11.0	10.3	11.0	11.0	11.0	11.0	11.0	11.0	11.0
432-433	11.0	11.0	11.0	11.0	9.1	9.4	10.8	11.0	11.0	11.0	11.0	11.0
433-434	9.4	10.8	10.3	11.0	6.5	8.5	8.6	11.0	11.0	11.0	11.0	11.0
434-435	7.3	8.2	8.2	11.0	4.0	5.2	4.8	11.0	10.8	10.9	10.8	11.0
435-436	5.1	6.0	6.4	11.0	2.9	3.1	2.8	10.3	8.6	8.3	8.1	11.0
436-437	3.4	3.6	3.9	11.0	1.7	1.3	1.4	9.0	5.1	5.6	5.6	11.0
437-438	1.7	2.0	2.5	8.1	0.4	0.4	0.4	7.1	3.2	3.3	3.3	10.7
438-439	0.1	0.2	0.5	5.9	0.0	0.0	0.0	4.1	1.9	1.8	2.0	6.6
439-440	0.0	0.0	0.0	1.4	0.0	0.0	0.0	0.1	0.4	0.3	0.6	2.5

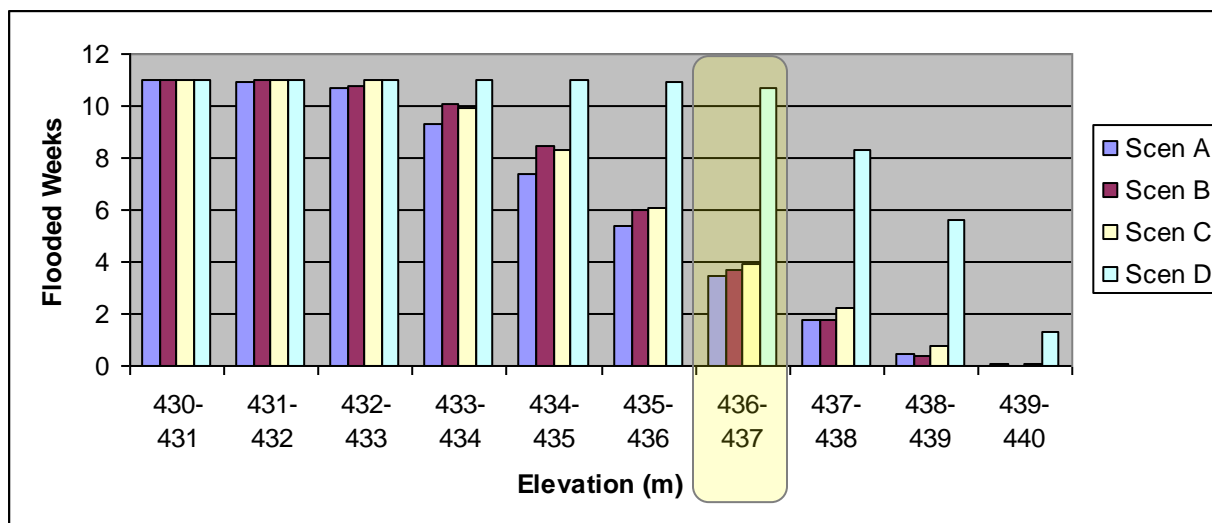


Figure 2. Average Number of Flooded Weeks by 1-m Elevation Bands during the Latter Part of the Growing Season for the 10-year (1964-1973) Simulation Period. Yellow-shaded results carried forward to Consequence Table