PERFORMANCE MEASURE INFORMATION SHEET #7

ARROW LAKES & KINBASKET RESERVOIRS: PHOTIC VOLUME

Objective / Location	Performance Measure	Units	Description	MSIC
Pelagic Productivity/ Arrow & Kinbasket Reservoirs	Annual Photic Volume	MMm^3-Days Cumulative over the growing season: 1 May to 31 October (Kinbasket) and 1 April to 31 October (Arrow)[1]	Product of the daily reservoir surface area and the average monthly light penetration depth summed over the year	10%

Description

Annual nutrient load and resultant pelagic productivity are the 'drivers' of annual phytoplankton carbon production cycles upon which kokanee populations are dependant. For Arrow Reservoir, there is a large extant database on phytoplankton production and biomass, as well as light, temperature and mainstem and tributary flow data, but for Kinbasket Reservoir, there is a paucity of data with which to evaluate the potential impacts of the NTS scenarios. Through the Kinbasket Reservoir ecological productivity monitoring program being undertaken through BC Hydro's Water License Requirement Program, these data are now being obtained. However, this project is in its early stages of implementation. Data collected over the past two years has yet to be analyzed in conjunction with data being collected under the Kinbasket Reservoir Kokanee population monitoring study to determine the drivers for pelagic production and any links to reservoir operations. Further data collection and analysis will be required to better understand the role of nutrients, temperature and light in determining pelagic productivity of Kinbasket Reservoir.

Performance Measure

For the purposes of the NTS analysis, the pelagic euphotic zone is used as a measure of pelagic productivity for the two reservoirs. The euphotic zone is a relatively thin layer (10–100 m) near the water surface where there is sufficient light for photosynthesis to occur. For practical purposes, the thickness of the euphotic zone is typically defined by the depth at which light reaches 1% of its surface value. Light is attenuated down the water column by its absorption or scattering by the water itself and dissolved or particulate matter.

Plant growth is dependant on the amount of photosynthetically active radiation (PAR). The light data used in this analysis measures depth of 1% light transmission based on PAR readings. Data for Kinbasket Reservoir were collected from the main pool, located in the middle of the main pool, centred among the forebay, Canoe, Wood, and Columbia reaches from April through October (2008-2010) (K Bray, BC Hydro, pers. correspondence). PAR data for Arrow Lakes Reservoir were collected from one station located in the Lower Arrow and one station located in the Upper Arrow from April through October (2000, 2001, 2004) (S. Harris, MoE, pers. correspondence).

[1] Subsequent to the November 2010 NTSA meetings, new PAR data for May and October were included in the Kinbasket Reservoir photic volume PM calculations.

This PM is based on empirical data but does not account for many variables that are known to be important in predicting pelagic productivity (e.g., nutrient availability, thermal stratification). However, light data available for Kinbasket and Arrow Lakes Reservoirs can be used to provide a relative comparison of the NTS scenarios and their impact on primary production.

Calculations

For each scenario:

1. Assemble the simulated results for month-end reservoir elevations over 60 years (1940-2000; Figure 1).
2. Assemble reference tables for a) elevation and surface area for Arrow and Kinbasket reservoirs, and b) monthly 1% light penetration (PAR) depths for each reservoir.
3. For each daily time step, use the reservoir elevation to calculate the surface area and multiply that by the average monthly euphotic depth (PAR) light penetration depth to produce a daily pelagic volume (MMm^3).
4. Volumes are summed from 1 April to 31 October over each year to produce annual results in MMm^3-Days.
5. Summarize all statistics (Figures 2 and 3).

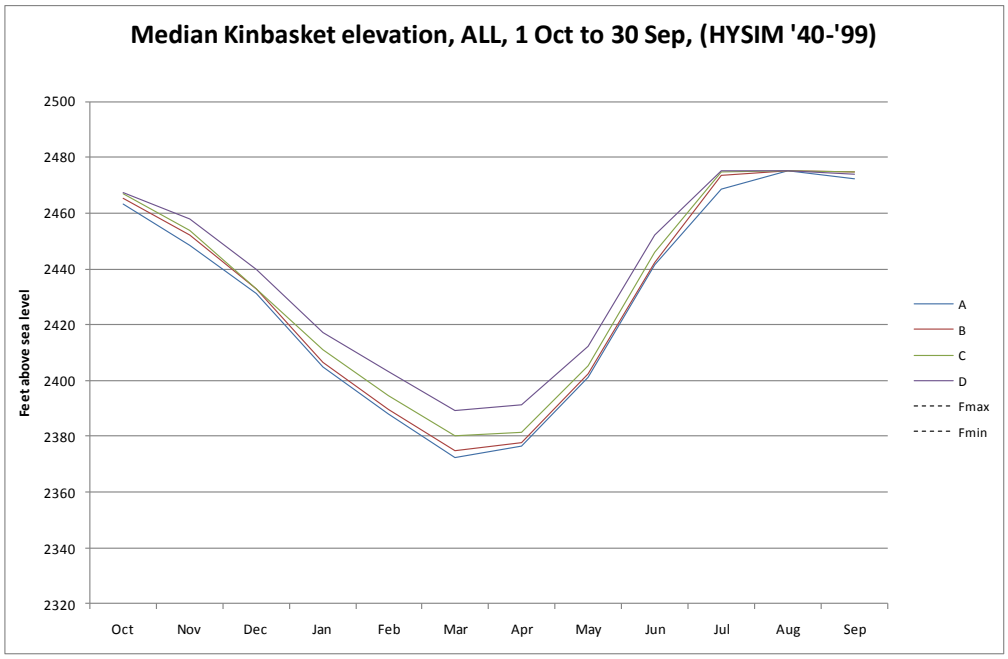


Figure 1. HYSIM Simulated Kinbasket Reservoir - Median water levels over 60 years

Key Assumptions and Limitations

- Each scenario is simulated using the same set of system constraints, input assumptions (e.g., load forecasts) and historic basin inflows (1940 – 2000).
- Assumes nutrient levels and temperature are the same across the scenarios and can be safely ignored in the analysis.
- Light is not the single driver for primary production. Temperature, nutrient availability and turbidity also play a role in determining pelagic productivity.

- PAR data are only available for the main pool in Kinbasket Reservoir from 2008-2010 sampling periods. The main pool site is generally clearer than other arms, such as Canoe or Columbia Reaches which tend to be more turbid due to depths, tributary inputs and wind.
- PAR data are considered rough estimates from point in time profiles. The 1% depth can vary from hour and day depending on cloud cover, wind, exposure, time of year, and freshet timing.

Results

Regardless of the statistic considered, none of the four scenarios perform significantly different in terms of their effects on euphotic volume in either Arrow Reservoir or Kinbasket Reservoir.

Figure 2. Kinbasket Photic Volume – HYSIM Results for all NTS scenarios

	Scen A	Scen B	Scen C	Scen D
Max	1.09	1.08	1.09	1.19
90th	1.40	1.40	1.41	1.42
Mean	1.33	1.34	1.35	1.38
Med	1.36	1.36	1.38	1.40
10th	1.20	1.21	1.23	1.30
Min	1.09	1.08	1.09	1.19

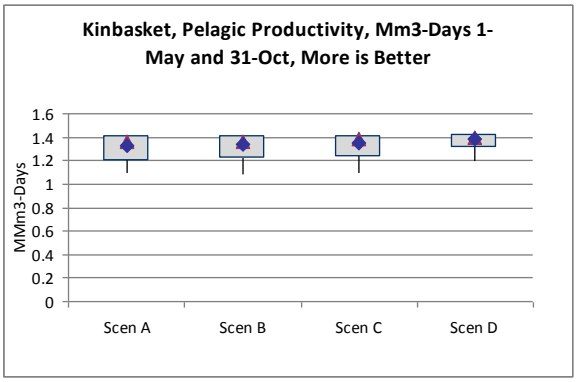
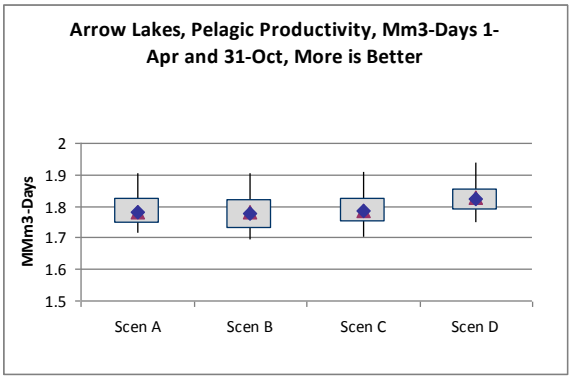


Figure 3. Arrow Photic Volume – HYSIM Results for all NTS scenarios

	Scen A	Scen B	Scen C	Scen D
Max	1.90	1.90	1.91	1.94
90th	1.82	1.82	1.83	1.85
Mean	1.78	1.78	1.79	1.82
Med	1.78	1.78	1.78	1.83
10th	1.74	1.73	1.75	1.78
Min	1.71	1.70	1.70	1.75



References

2008-2010 PAR Data for Kinbasket Reservoir collected through BC Hydro's WLR Ecological Productivity Monitoring Program

2000-2001 PAR Data for Arrow Lakes Reservoir collected through the Fish and Wildlife Compensation Program – Columbia Basin

2004 PAR Data for Arrow Lakes Reservoir collected through the Kootenai Tribe of Idaho