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Assessment of Fluctuating Reservoir Elevations Using Hydraulic Models and Impacts on Larval Pacific Lamprey Rearing Habitat in the Bonneville Pool

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Background

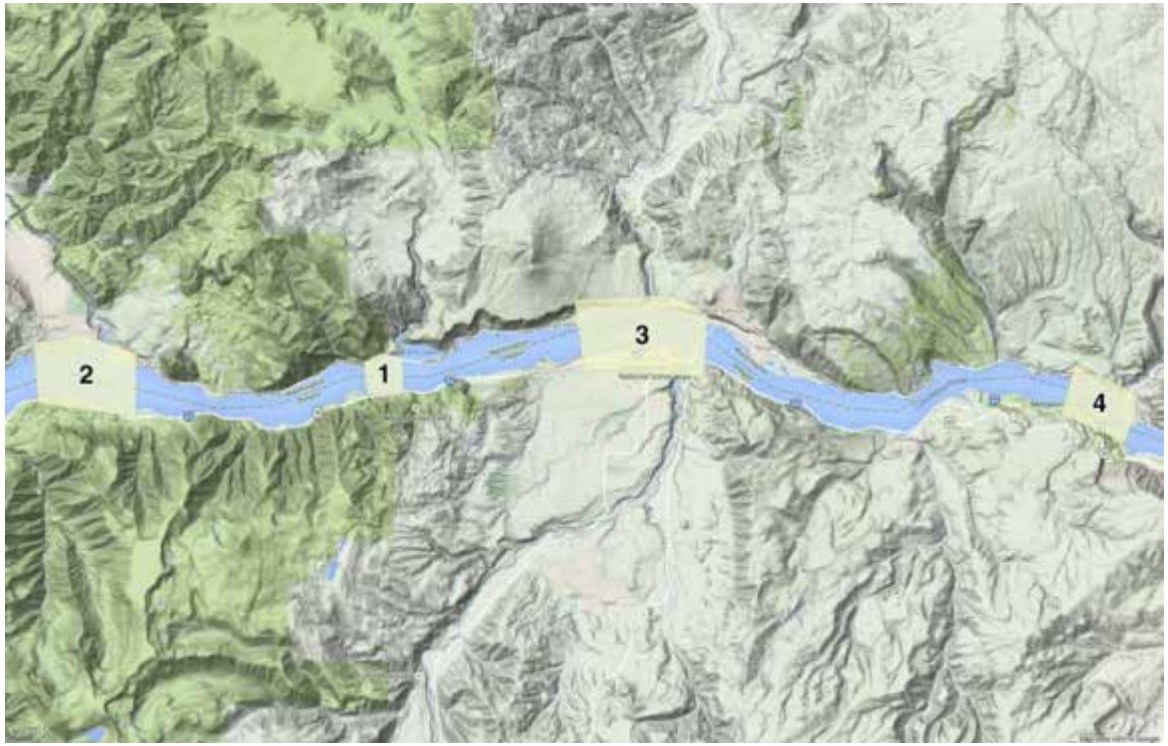
- Rearing larval Pacific lamprey are strongly associated with stream and river sediments.
- The timing, duration, and habitat use of the larval life stages are poorly understood.
- Reservoir levels fluctuate through year and larval lamprey can become exposed and potentially cause mortalities.
- Unknown whether larval lamprey vacate their burrows and move to deeper water as the water level recedes.
- Potential harm to rearing lampreys may include desiccation, forced movement to deeper water, and exposure to bird and fish predation.
- Previous surveys indicate that larval lamprey inhabit these regions.

Objectives - Methods

- PNNL's MASS2 2D numerical model to determine regions of riverbed which will be exposed during MOP, MOP+1-ft, MOP+2-ft and high pool at Bonneville Dam.
- Modeled (steady-state) exceedance flows (10, 50 and 90%)= flow rates of 291, 135 and 97 kcfs from USGS gage downstream of The Dalles Dam. 10 year period June-November.
- Model unsteady water surface fluctuations to understand how inundation may change on daily and hourly basis.

Locations and size of regions within the Bonneville pool

Location	Total Area (ha)
Little White Salmon (Zone 1)	2,226
Wind (Zone 2)	10,879
White Salmon/Hood (Zone 3)	14,790
Klickitat (Zone 4)	5,546



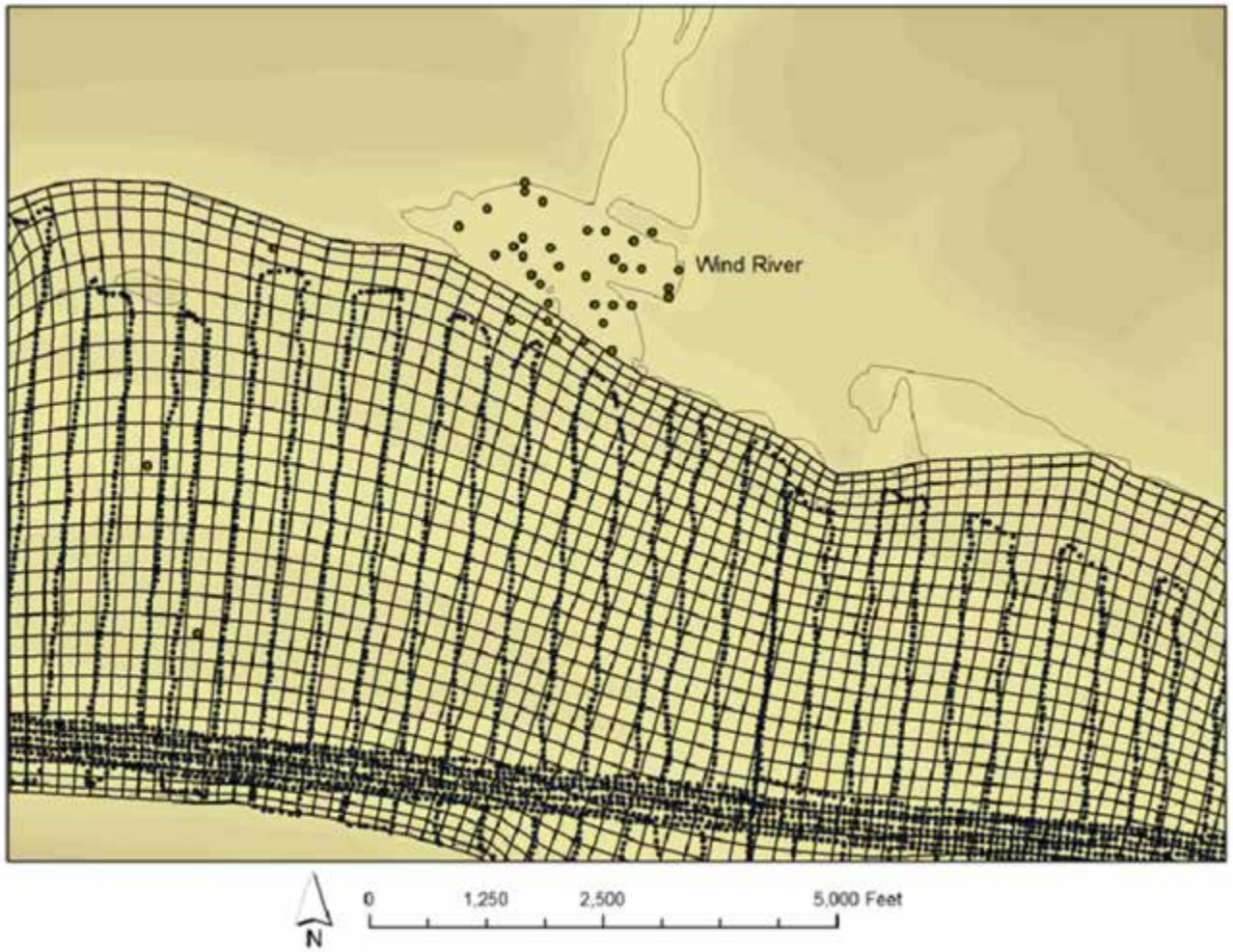
Data sources for hydraulic modeling

- Corps bathymetric survey data
  - Covers main channel but little to no coverage in shallow areas (i.e tributary river confluences).
  - 1997 navigation channel survey – 500-ft transects across channel with 100-ft spacing in navigation channel.
- Navigation charts (NOAA)
  - Out of date – In shallow areas, especially where sediment influx is significant these old data are not very reliable.
- Prior lamprey sampling depth measurements (USFWS)
  - Not an elevation, but estimate was made using 1D model (MASS1) water surface elevation during survey period.

Model improvements for shallow non-surveyed regions

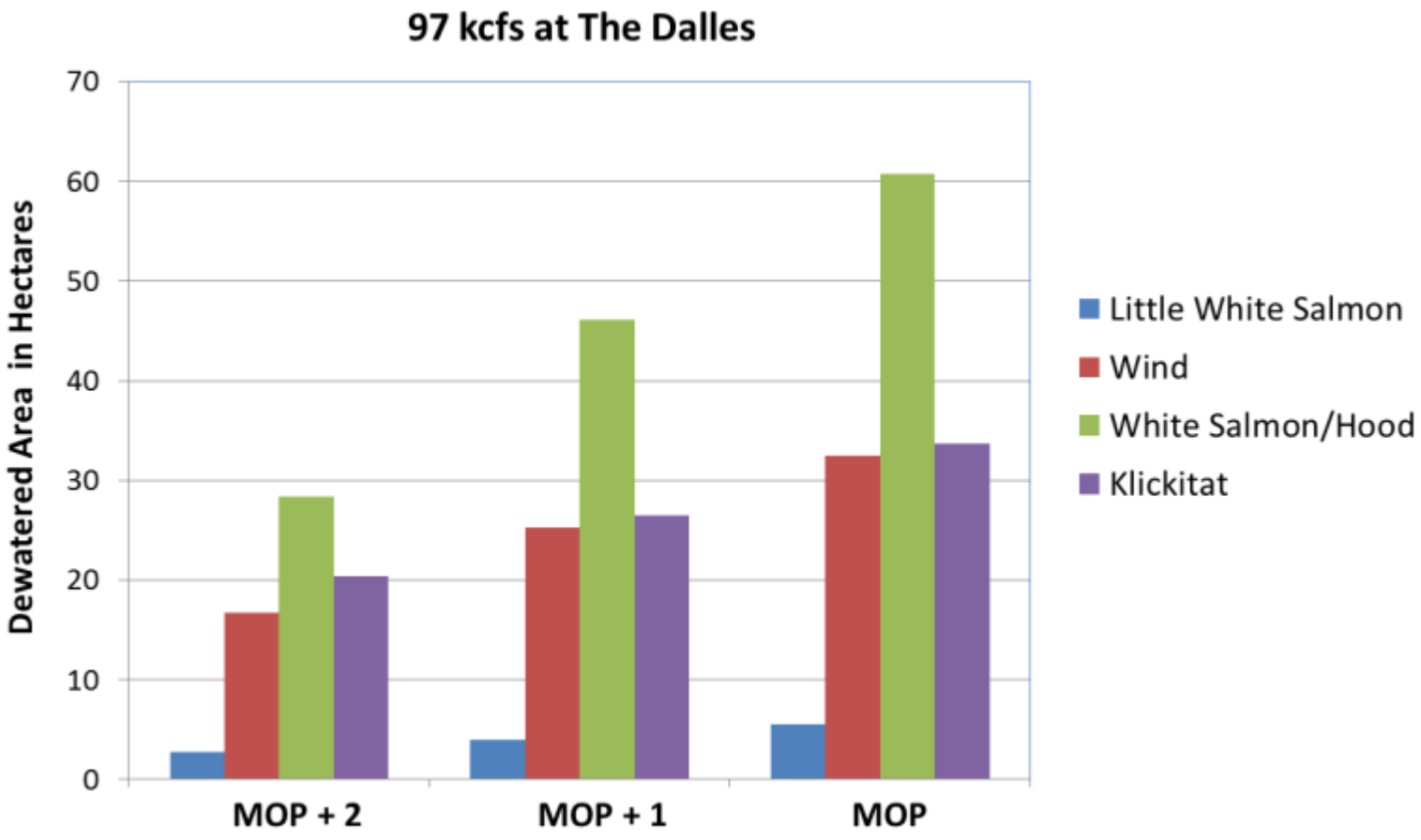
- Measurements obtained from prior surveys converted to bottom elevations and incorporated into the surface.
- Elevation contours added based on underwater features visible in aerial photos. Features generally no deeper than 13-ft below the surface.
- Elevation contours added based on subjective interpretation of existing point-survey data.
- All new data sets were interpolated to a 50 x 50-ft square grid to create bathymetric surface for hydraulic model.

Example bathymetric coverage - Wind River



Inundation changes based on flow and MOP levels

- Largest variation at White Salmon/Hood rivers followed by Wind, Klickitat and the Little White Salmon.



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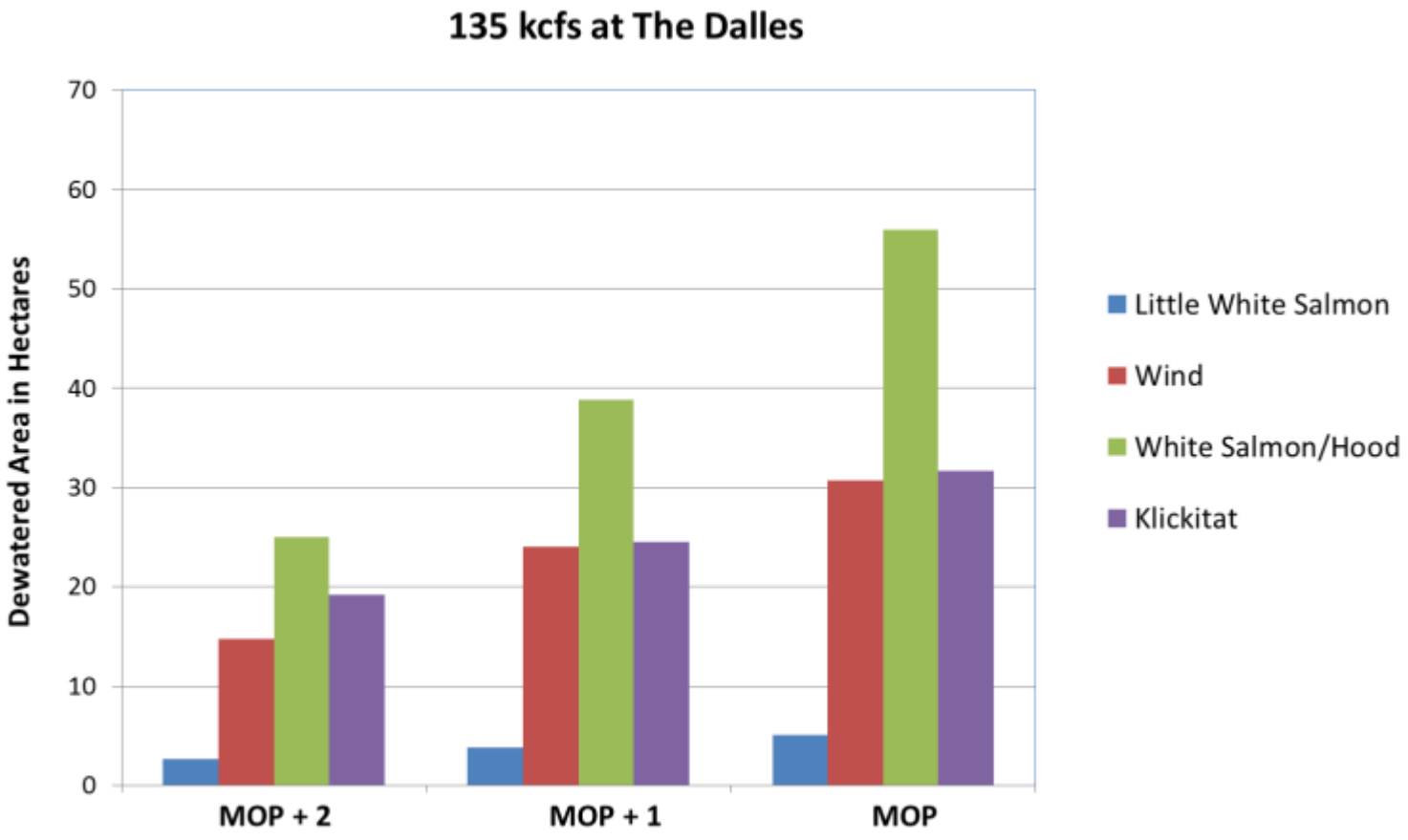
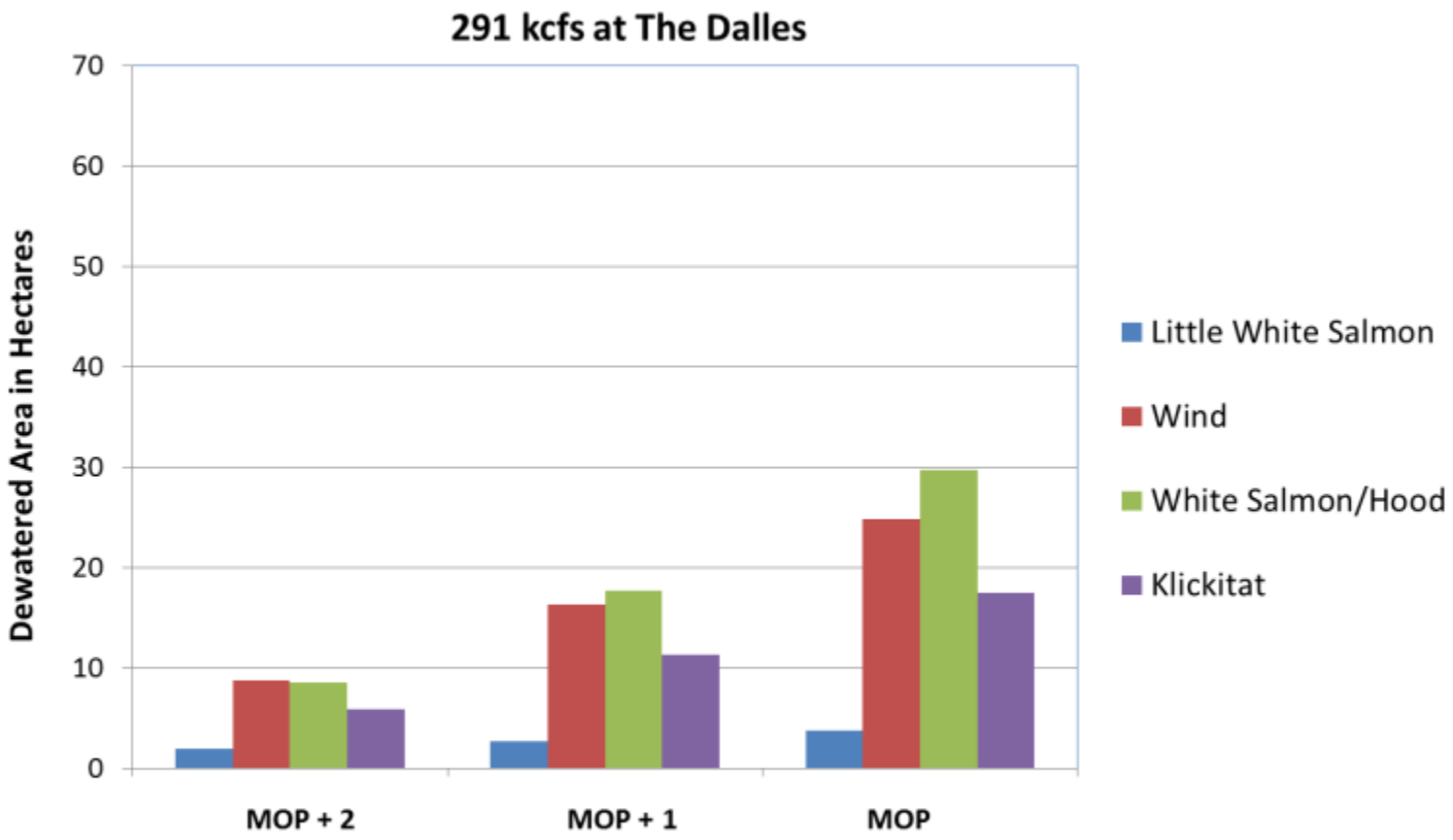


Change in inundation for a river flow of 135 kcfs

Inundation changes based on flow and MOP levels



Change in inundation for a river flow of 291 kcfs

Unsteady model outputs

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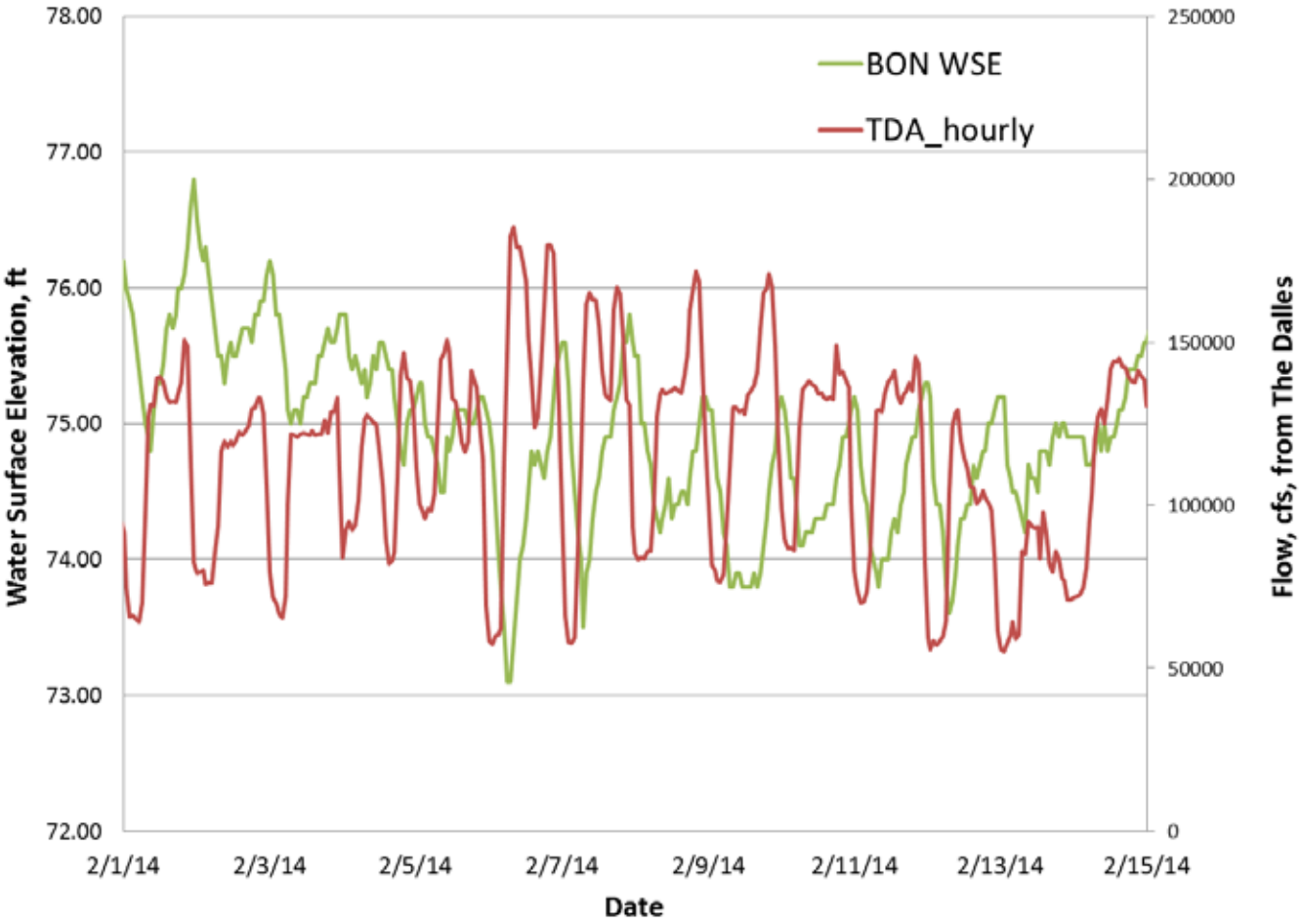
- 2-week period in February 2002 was selected due wide range in forebay elevations.
- 2.5-ft variation in WSE occurred during this period in 2002 and a 3.7-ft change occurred in 2014.
- Duration of changes were variable and generally did not stay constant for more than a 5-hr period.
- Outflow at The Dalles Dam is dynamic- can change 100 kcfs/hour period- directly impact WSE at BONN forebay.

Unsteady model outputs (2002)

Unsteady MASS2 boundary conditions for Bonneville Dam and The Dalles hourly flow from February 1 to 15 in 2002.

Unsteady model outputs (2014)

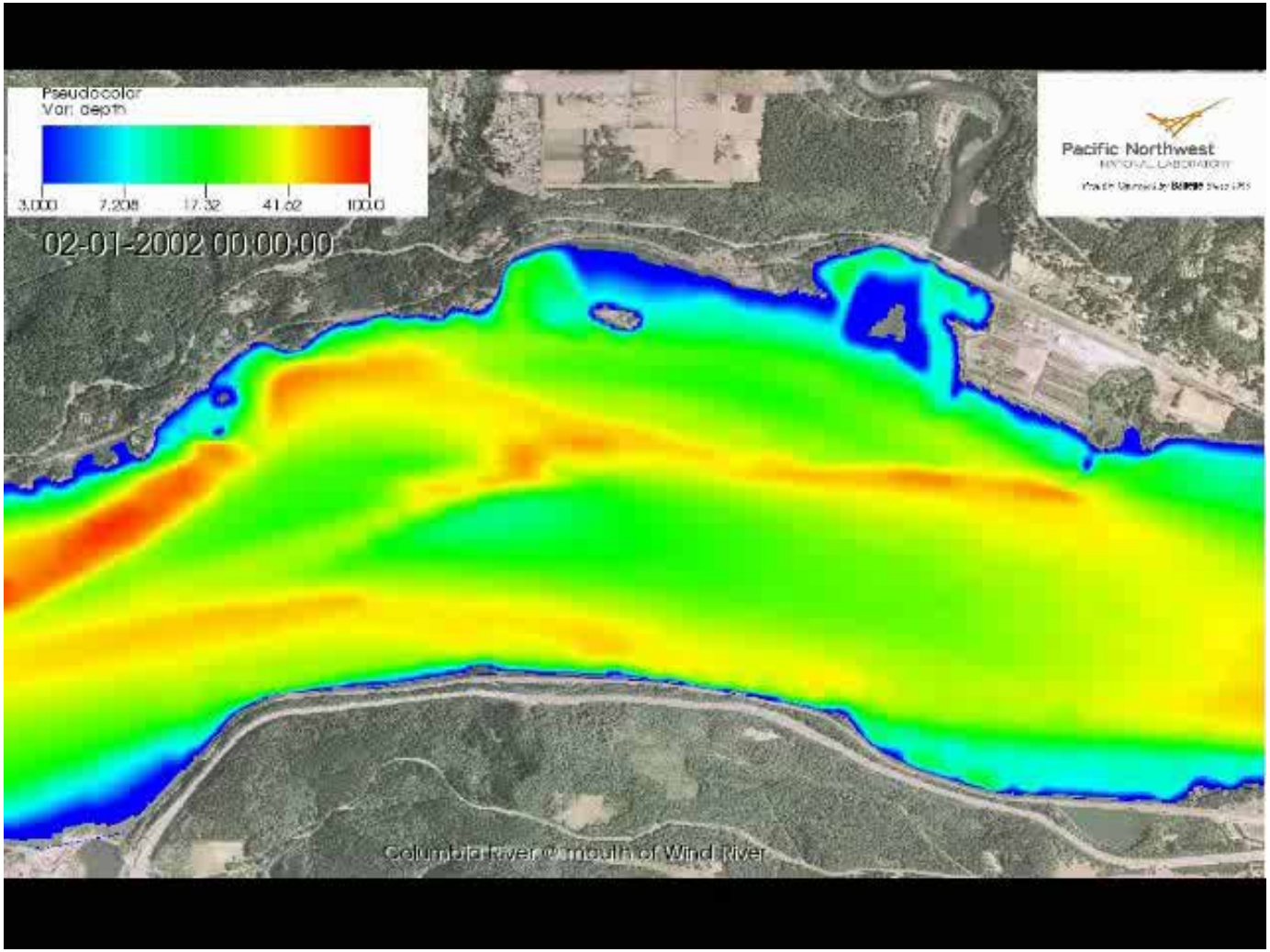


The Dalles Dam flows and Bonneville Dam forebay WSE for February 1 to 15 in 2014.

Conclusions

- MASS2 indicated delta regions near the White Salmon and Hood rivers is most susceptible to WSE changes.
- WSE can vary by 2.5 to 3.7-ft on weekly periods and 2.2-ft on daily basis.
- The rates of changes were variable and generally did not stay constant for more than a 5-hr period.
- Additional bathymetric data needed to improve the representation of habitats in MASS2 and to better classify substrate composition or LIDAR surveys done at regular intervals.

Example model run (Wind River)



Acknowledgements

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