Using raster plots to display aquatic habitat time series

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Background

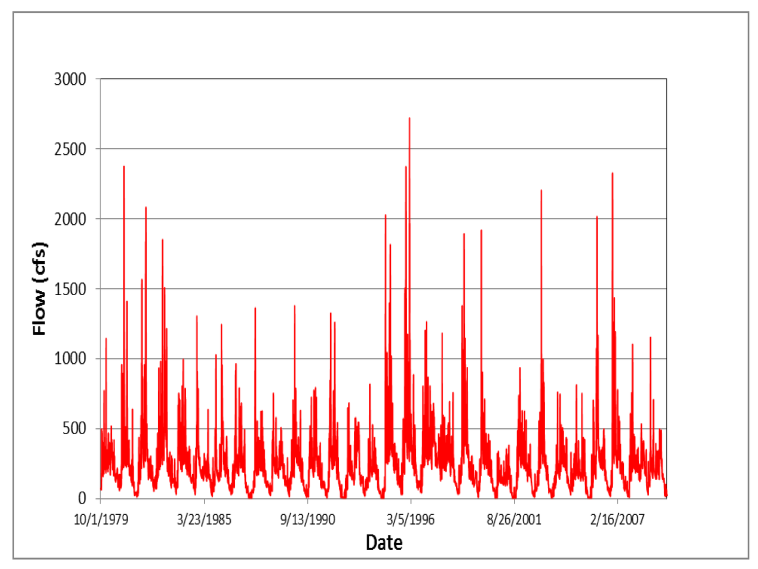
Instream flow studies typically utilize a hydraulic habitat model (e.g. PHABSIM, River2D) to determine the relationship between flow and hydraulic habitat for the species of interest. That relationship (weighted useable area (WUA) or area weighted suitability (AWS)) is then combined with the hydrologic time series alternatives to determine operational impacts to the hydraulic habitat from a project or withdrawal of water. The results of the habitat time series analysis are often presented as x-y time series graphs, habitat duration graphs, or total habitat (area under the curve). While these presentation techniques are useful, raster plots are visually more explicit, easier to understand for the stakeholders, display long time series records without losing short term definition, avoid the habitat duration graph problem of having two flows with the same habitat exceedance value, and can help identify potential habitat bottlenecks.

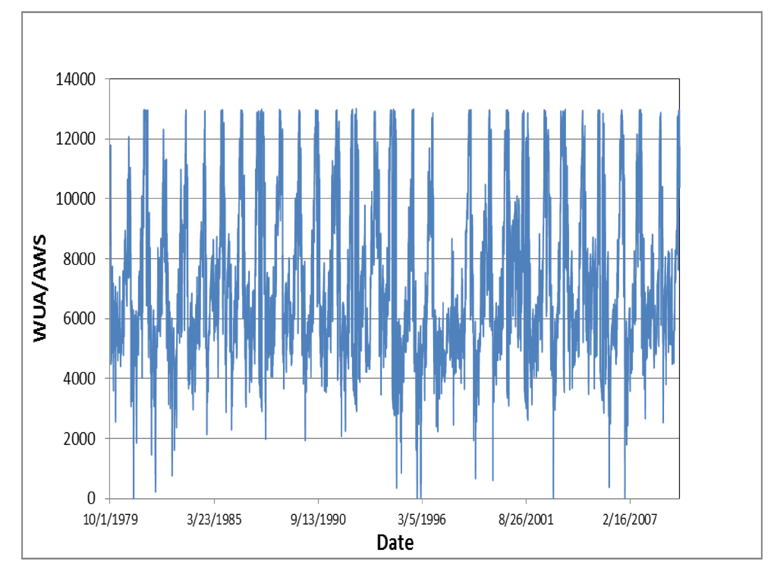
Raster plots, used by the US Geological Survey to show streamflow, are useful in habitat analysis. This poster presents some of the results of a hydraulic habitat time series analysis resulting from multiple water resource alternatives. The raster plots depict hydrologic alternatives and associated hydraulic habitat time, the hydrologic time series with a 50% exceedance habitat value overlay, and plot the difference between water resource alternatives and the historic record.

Methods

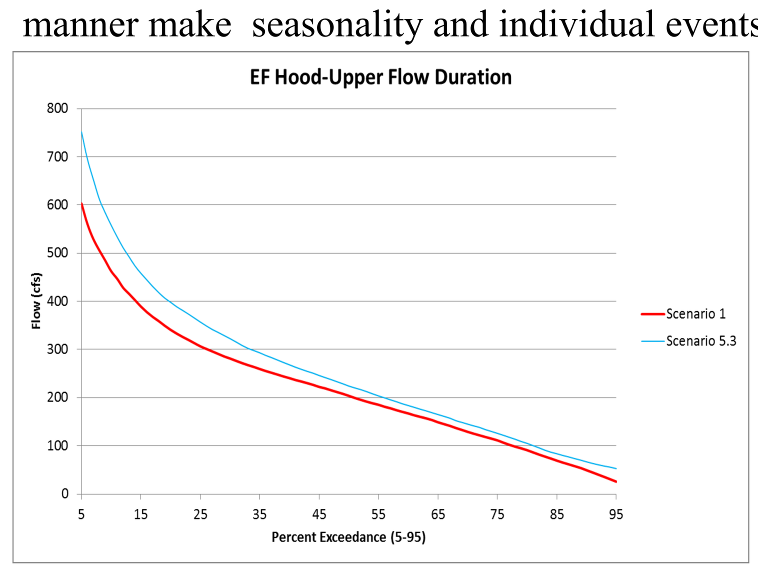
Raster plots are pixel-based plots for visualizing and identifying variations and changes in large multidimensional data sets. Originally developed by Keim (2000) they were first applied in hydrology by Koehler (2004) as a means of highlighting inter-annual and intra-annual changes in streamflow. The raster hydrographs in WaterWatch (http://waterwatch.usgs.gov/?id=wwchart_rastergraph), like those developed by Koehler, depict years on the y-axis and days along the x-axis. The results of a hydraulic habitat model from the East Fork Hood River combined with the flow time series from the historical record and a climate-modified water resource alternative are used to demonstrate several uses of the raster chart for presentation of the hydraulic habitat time series analysis results. In electronic format such as PowerPoint presentation mode, the user can toggle between two comparative raster plots on the same slide and see where and when changes to the raster hydrograph and hydraulic habitat index occur anywhere in the time series and identify potential habitat bottlenecks and likely problems with an operation scenario.

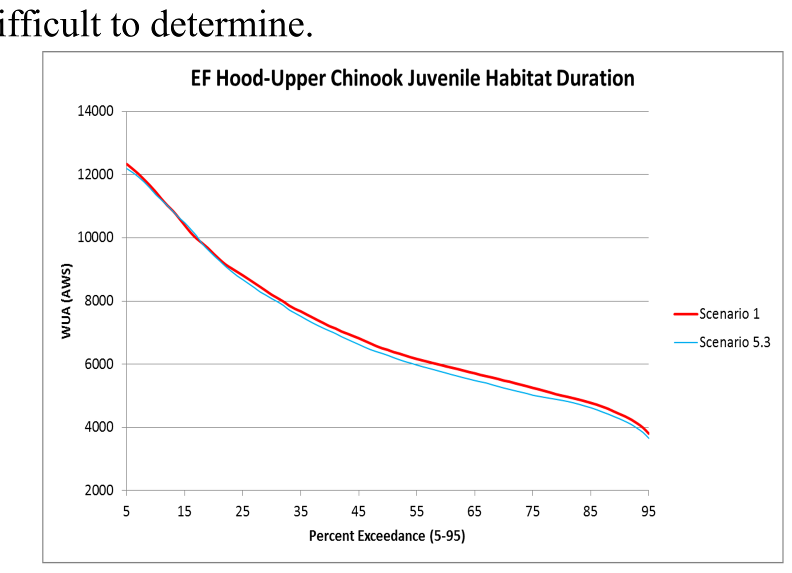
Results



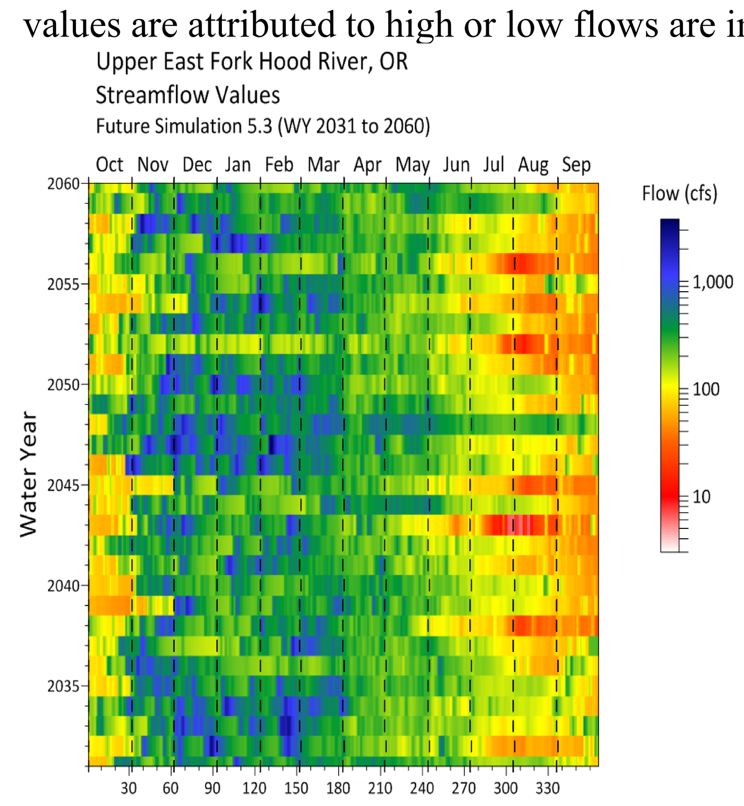


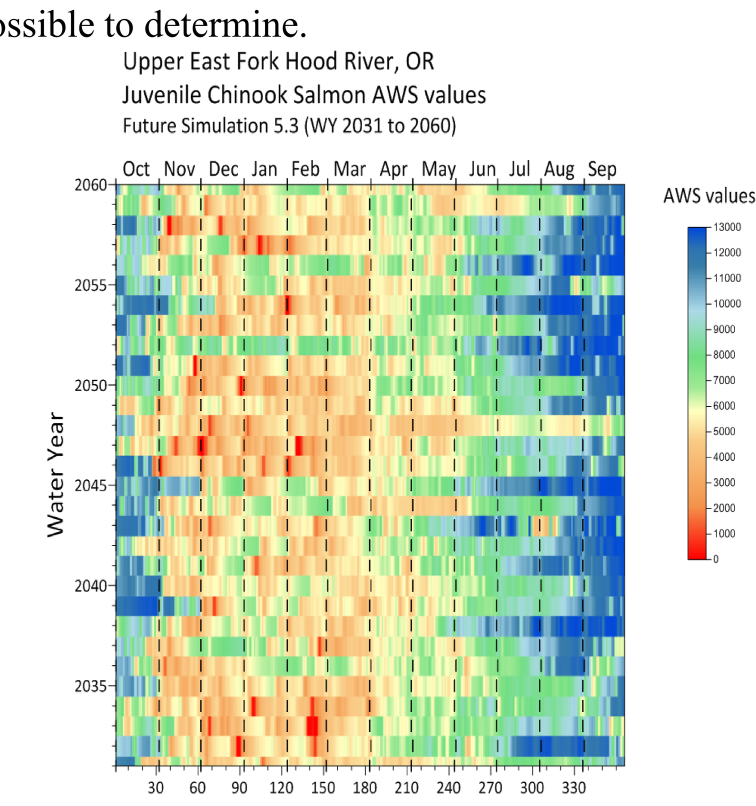
East Fork Hood River flow and juvenile Chinook habitat time series presented in a typical manner make seasonality and individual events difficult to determine.



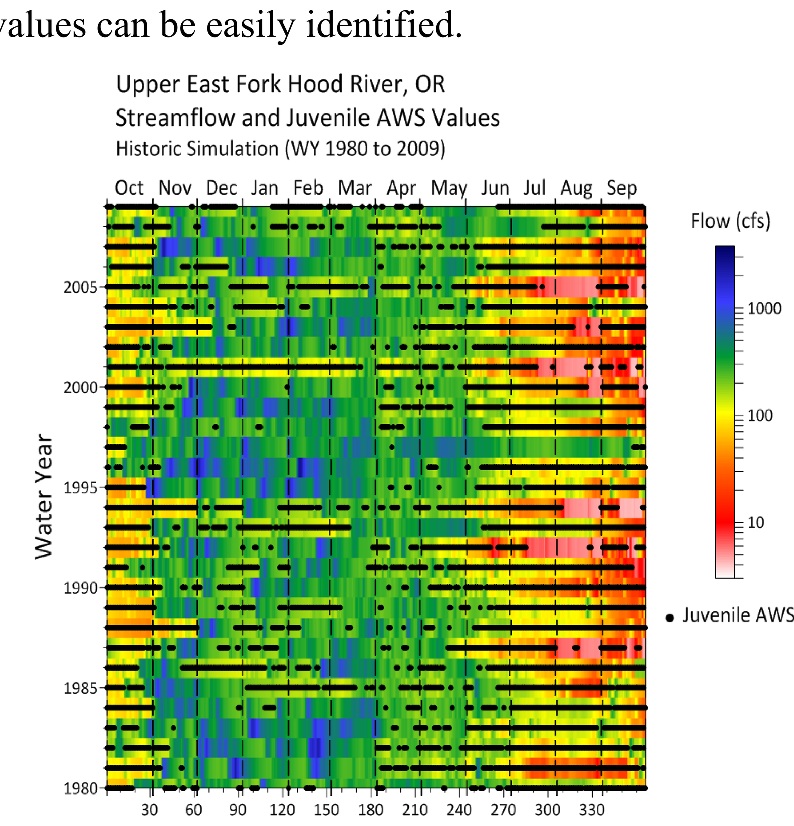


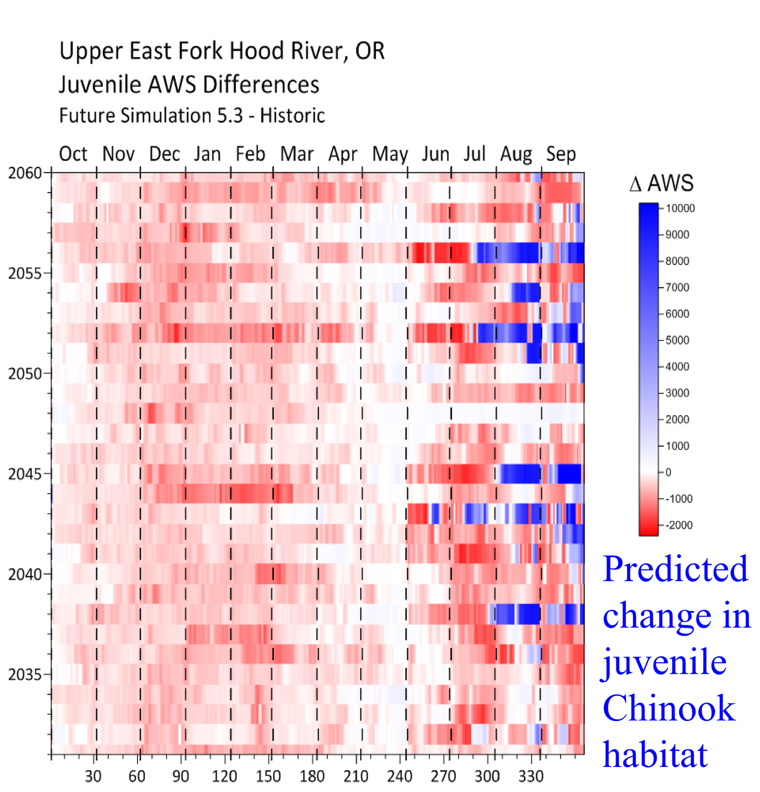
East Fork Hood River flow and Chinook juvenile habitat duration graphs comparing the historical record (Scenario 1) to a warm, wet climate with increased consumption, conservation and storage (Scenario 5.3) depict general trends, but seasonality, individual events, and whether low habitat values are attributed to high or low flows are impossible to determine.





The warm wet increased use, conservation, and storage scenario flow and juvenile Chinook habitat raster time series plots depict individual events, and seasonality. Flows creating particular habitat values can be easily identified.





The Upper East Fork Hood historical raster hydrograph with black dots plotted for each day that the AWS is greater or equal than the 50% exceedance value for juvenile Chinook rearing shows low habitat values are caused by both low and high flows. The difference between the historical and future 5.3 scenario raster graph depicts decreases in juvenile Chinook hydraulic habitat throughout the entire year except during the typically low flow late summer; a potential habitat bottle neck.

Conclusions

Raster plots depict habitat time series analysis results and enable the user to:

- Easily identify seasonal trends in hydraulic habitat
- Identify individual events and the impact on hydraulic habitat even in long time series data sets
- Avoid the problem of habitat exceedance (duration) graphs depicting one exceedance value for two flows
- Use multiple layers with both hydrograph and habitat information
- Depict the detailed change in habitat when comparing a proposed operational scenario to historical records
- Identify habitat bottlenecks
- Present the data set electronically and toggle between raster plots of hydrographs and habitat time series scenarios, visually depicting the impacts of the flow regime.

Literature cited

Keim, D.A. 2000. Designing pixel-oriented visualization techniques: theory and applications. IEEE Transactions on Visualization and Computer Graphics, 6(1), 59-78.

Koehler, R. 2004. Raster Based Analysis and Visualization of Hydrologic Time Series. Ph.D. dissertation, University of Arizona. Tucson, AZ, 189 p.

Acknowledgments

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Digital Photoframe

The digital photoframe depicts the electronic presentation of hydraulic habitat time series information and illustrates how the presenter can switch between hydrograph and habitat, multiple habitat time series plots, and habitat change plots to visually demonstrate the impacts of a proposed operating scenario. In PowerPoint, the images are stacked and animated so that the presenter can toggle back and forth allowing stakeholders to visually understand the impacts of an operating scenario.