



# Air, Water and Aquatic Environments Science Program

Rocky Mountain Research Station



## Western US Stream Flow Metric Dataset

Research

Technology Transfer

Science Application

### Challenge

The flow regime is of fundamental importance in determining the physical and ecological characteristics of rivers and streams. Climate change is predicted to alter flow regimes in the western US, shifting many streams that are currently snowmelt-dominated to ones that receive both rain and snow in the winter. This could have significant impacts to aquatic resources. To study these changes, we have developed a dataset of flow metrics for streams in the western US under historical conditions and climate change scenarios. The dataset is both broad in coverage and fine in resolution.

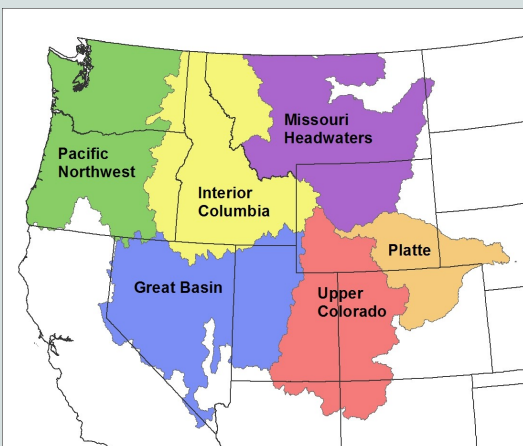
### Dataset Development

The University of Washington Climate Impacts Group, Trout Unlimited, and the US Forest Service Rocky Mountain Research Station used the Variable Infiltration Capacity (VIC) macroscale hydrologic model to estimate stream flows at a daily timestep under historical and forecasted future climate conditions across major river basins of the Western United States. Forecasts were for the A1B emissions scenario for the 2040s and 2080s, using (1) an ensemble of 10 global climate models (GCMs), (2) MICROC3.2, a model that predicts a large amount of warming in the region, and (3) PCM1, a model that predicts a low amount of warming. The individual models (MIROC and PCM) were used to bracket the range of uncertainty in warming, while the ensemble represented a best-guess model consensus. For the historical scenario and each of the six forecasts, we estimated a hydrograph for every individual stream segment in the 1:100,000 scale National Hydrography Dataset (NHD; <http://www.horizon-systems.com/nhdplus/>), excluding large rivers. We then calculated a set of summary flow metrics to describe key attributes of the flow regime for each segment. These include mean annual flow, the mean timing of runoff, and the frequency of high flows in the winter.

### The Bottom Line:

- We have developed a database of stream flow metrics, such as mean annual flow, for streams across much of the western U.S.
- Stream flow metrics are available for both current conditions and future conditions, based on outputs of Global Climate Models.
- Data can be downloaded here:

[www.fs.fed.us/rm/boise/AWAE/projects/modeled\\_stream\\_flow\\_metrics.shtml](http://www.fs.fed.us/rm/boise/AWAE/projects/modeled_stream_flow_metrics.shtml)



### Context

The development of the dataset was motivated by a concern that shifting flow regimes might affect the distribution of stream fishes such as trout. Scientists at RMRS and Trout Unlimited are using the dataset to model trout response to certain flow metrics under current conditions, and then predict how distributions may change as these flow metrics change in the future. However, there are many other potential applications.

LEFT: Coverage of the dataset. Files are divided geographically into six regions based on the National Hydrography Dataset. Rivers with drainage areas exceeding 250 sq. km. are not covered.



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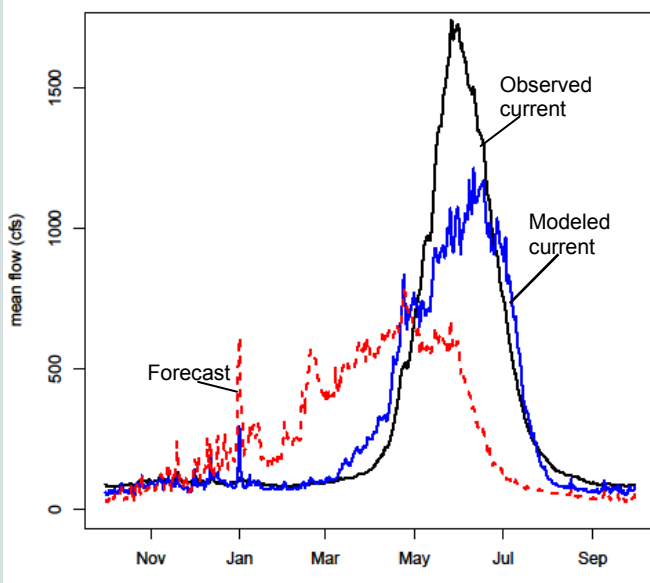


# Western US Stream Flow Metric Dataset

## Flow Metrics Included in the Dataset

- Daily Mean. The mean daily flow, averaged over a year.
- Winter2yr. The probability of a 2-year flow event occurring in the winter.
- Winter 1.5yr. The probability of a 1.5-year flow event occurring in the winter.
- Winter99. The number of days in the winter in which flows are among the highest 1% for the year.
- Winter 95. The number of days in the winter in which flows are among the highest 5% for the year.
- Channelflow. The 1.5-year flow, sometimes considered the channel-forming flow.
- CtrFlowMass. Timing of the center of the mass of flow. Also called center of timing or CT. The day of the water year at which 50% of the year's flow has passed. This metric can indicate snow vs. rain-dominated systems.
- Summer95\*. The number of days in the summer in which flows are among the highest 5% for the year.
- Summer20\*. The number of days in the summer in which flows are 20% of the daily mean.
- MeanSummer. The mean flow during the summer.
- Highlow\*. The ratio of high flow magnitude to low flow magnitude.
- Flow7q10. The 7-day low flow with a 10-year return interval.

\*Note: Based on our validations, metrics indicated with an asterisk are not reliable and are not recommended for use.



ABOVE: Example of modeled vs. observed flows. Mean annual hydrographs for Johnson Creek, Idaho: historical gaging station data (black line), modeled historical conditions (blue line), and forecast conditions under the 2080s A1B climate scenario using the composite of 10 models (dashed red line). Note the projected shift to earlier runoff and higher winter flows. Each of these hydrographs represents a 20-year average.

## Publications

Wenger S.J., C.H. Luce, A.F. Hamlet, D.J. Isaak, and H.M. Neville, 2010. [Macroscale hydrologic modeling of ecologically relevant flow metrics](#). *Water Resources Research* 46: W09513, doi 10.1029/2009WR008839.

Wenger, S.J., D.J. Isaak, J.B. Dunham, K.D. Fausch, C.H. Luce, H.M. Neville, B. E. Rieman, M.K. Young, D.E. Nagel, D.L. Horan, G.L. Chandler. In revision. Role of climate and invasive species in structuring trout distributions in the Interior Columbia Basin. In revision for *Canadian Journal of Fisheries and Aquatic Sciences*.

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