

**Henry Lorenzen**  
Chair  
Oregon

**Bill Bradbury**  
Oregon

**Phil Rockefeller**  
Washington

**Tom Karier**  
Washington



## Northwest Power and Conservation Council

**W. Bill Booth**  
Vice Chair  
Idaho

**James Yost**  
Idaho

**Pat Smith**  
Montana

**Jennifer Anders**  
Montana

May 3, 2016

### MEMORANDUM

**TO:** Council members

**FROM:** Lynn Palensky

**SUBJECT:** Briefing on impacts of 2015 drought on stream flows

### BACKGROUND:

**Presenters:** Chris Konrad, Research Hydrologist, U.S. Geological Survey (USGS) at the Washington Water Science Center and Greg Fuhrer, Acting Deputy Regional Director, USGS NW, will be presenting.

**Summary:** Chris and Greg will be presenting the findings from the *Western Low Flow Study* to measure and analyze water in six northwest states. The presentation will focus on the 2015 drought in the Columbia Basin and how streams tend to be more or less resilient or sensitive to drought. The study looked specifically at a year with near-normal rainfall, and well-below average snow pack. Climate change in the Pacific Northwest has been gradually warming rivers and reducing snowpack and runoff for several decades. Those trends are likely to continue for the next several decades, so it will be more important to understand the effects on tributaries and how we might focus efforts to protect and connect those most resilient to drought.

**Relevance:** One of the Council's emerging high priorities addresses "preserving program effectiveness by ... taking into account the effects of climate change." (See p. 116 of the Council's 2014 Fish and Wildlife Program.)

Workplan: This presentation addresses Council work plan item 2.B, which promotes regional fish and wildlife recovery by prioritizing and implementing 2014 Fish and Wildlife Program actions.

Background: The climate change sub-strategy in the Council's 2014 Fish and Wildlife Program calls on the federal action agencies, in coordination and collaboration with others, to "assess whether climate change effects are altering or are likely to alter critical river flows, water temperatures or other habitat attributes in a way that could significantly affect fish and wildlife important to the program." The program also identifies a need to "continue to encourage, monitor, and promote public awareness of pertinent climate change research and information and assess how it should influence program mitigation efforts." Chris Konrad's presentation addresses aspects of both of these measures.

More Info: See project website summary:  
<http://wa.water.usgs.gov/projects/lowflow/summary.htm>

Also see recent related Council presentations:

1. November 2015 Council Meeting: [Briefing](#) on identifying, protecting and enhancing climate refugia for salmonids in the Pacific Northwest: Dan Isaak, USFS.

2. January 2016 Council meeting - Stan Gregory: The Distribution and Use of Cold Water Refuges in the Willamette  
<http://www.nwcouncil.org/media/7149855/c02.pdf>

3. April Council Meeting- Ritchie Graves: [Presentation](#) on NOAA Fisheries' 2015 Adult Sockeye Passage Report: Ritchie Graves, NOAA; Rock Peters, U.S. Army Corps of Engineers; Russ Kiefer, Idaho Department of Fish and Game.

# Impacts of 2015 Drought on Streamflow in the Columbia River Basin

Chris Konrad  
US Geological Survey  
Tacoma, WA  
May 11, 2016

# Overview of USGS Investigation



Western US had low snowpack, warm temperatures, and an extended summer dry period in 2015

USGS is investigating streamflow response in six western states

## Objectives

- Document extent and severity of 2015 drought
- Assess differences in sensitivity across systems in 2015
- Identify factors influencing vulnerability of particular systems to future droughts

# Importance of Low Flow

## ***Streams that resist drought***

- high “unit-area” low flow, constant year-to-year
- provide cold-water refugia for fish
- priorities for habitat protection and connection.

## ***Streams that are vulnerable to drought***

- low unit-area low flow, variable year-to-year
- priorities for water transactions
- could be affected by groundwater withdrawals

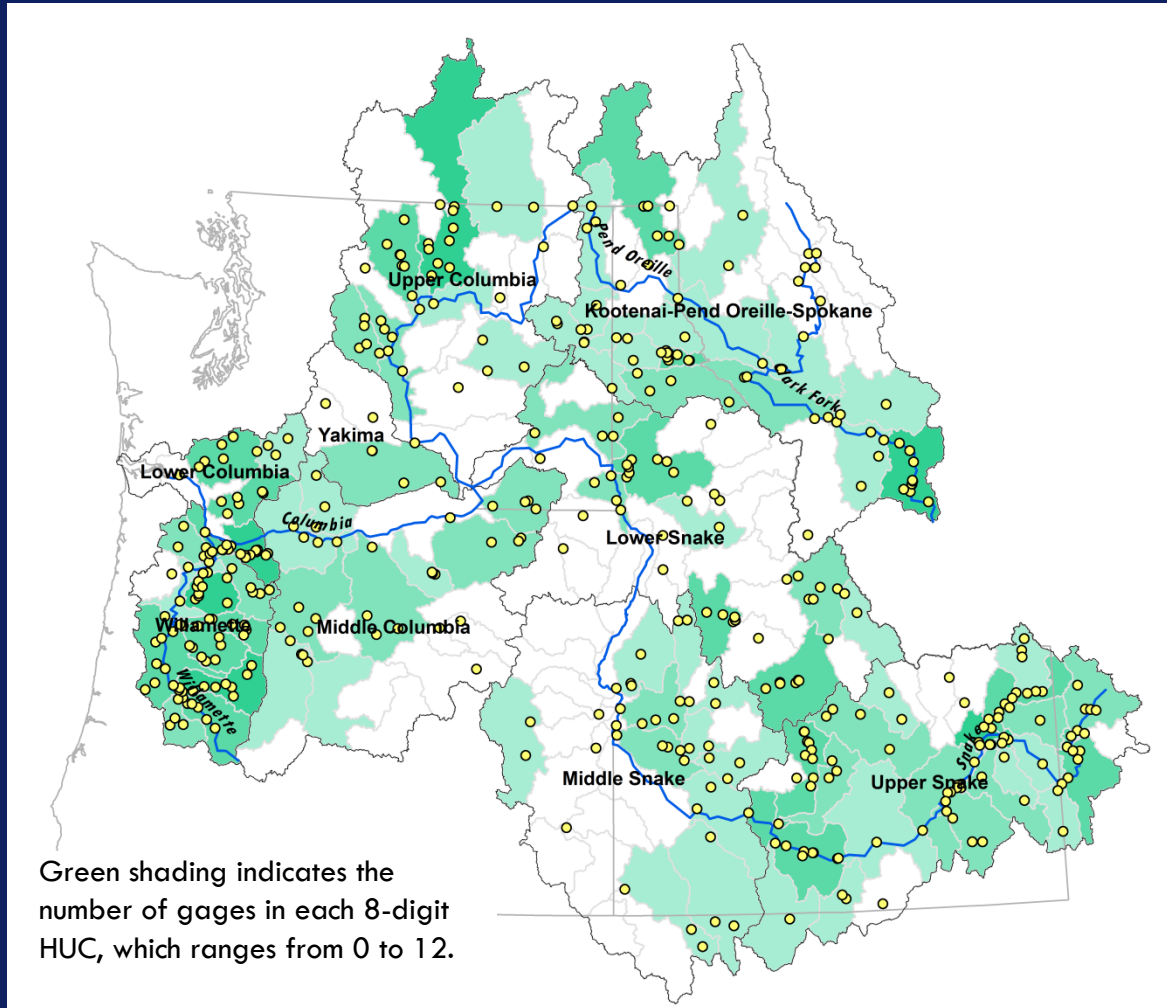
# Analysis of Factors Affecting Low Flows

Stream vulnerability to drought depends on precipitation, snow and ice melt, and groundwater. Ice melt and groundwater reduce vulnerability of streams to single-year drought.

Primary question: what was the comparative influence of these factors on 2015 low flows at gaged sites?

If the vulnerability of streams can be linked to specific factors, water managers will be able to forecast where water availability is likely to be an issue in a particular year.

# Columbia River Basin Sites

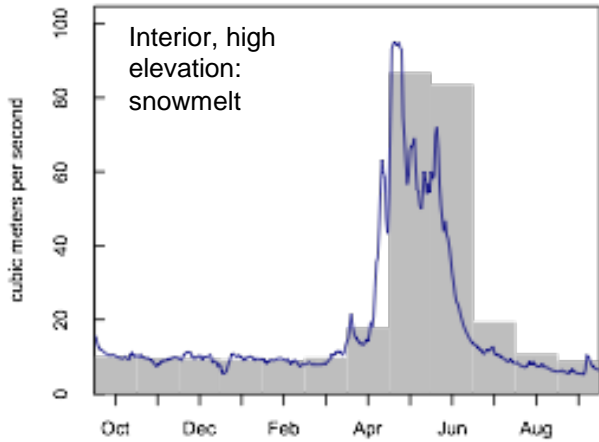


434 gages located in all of the major sub-basins and many watersheds

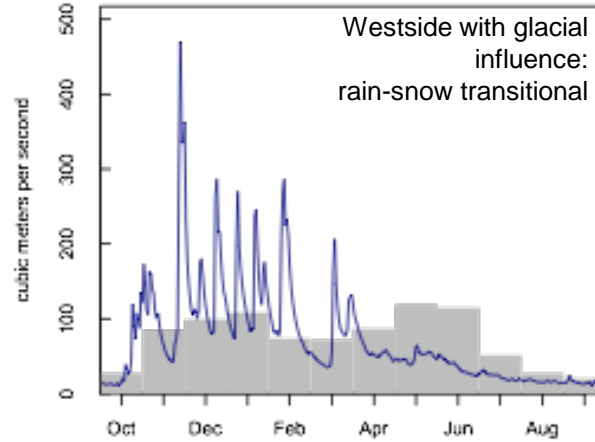
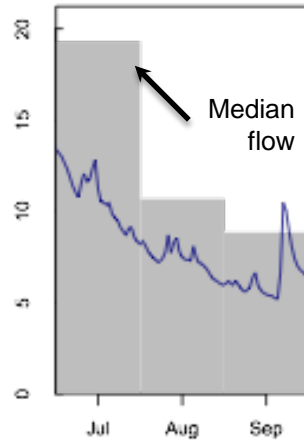
Gaps in about half of the watersheds (white)

Low flow measurements during the summer of 2015 at 340 un-gaged sites

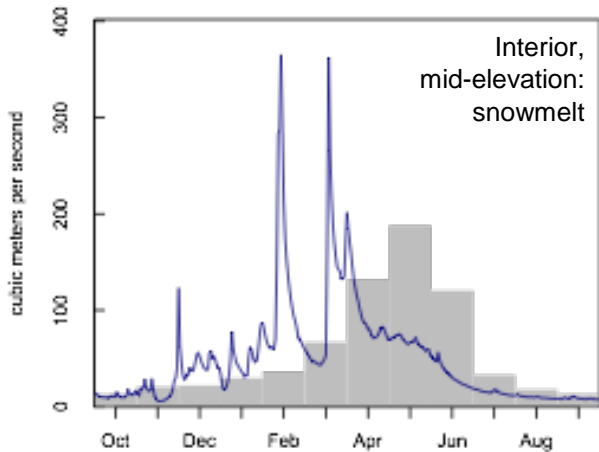
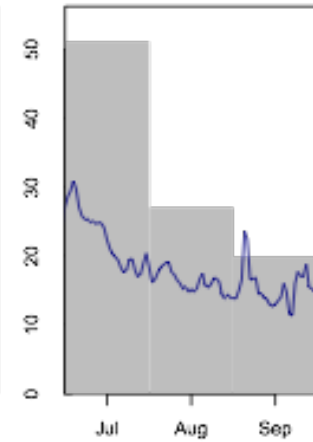
# Streamflow in 2015 was below normal



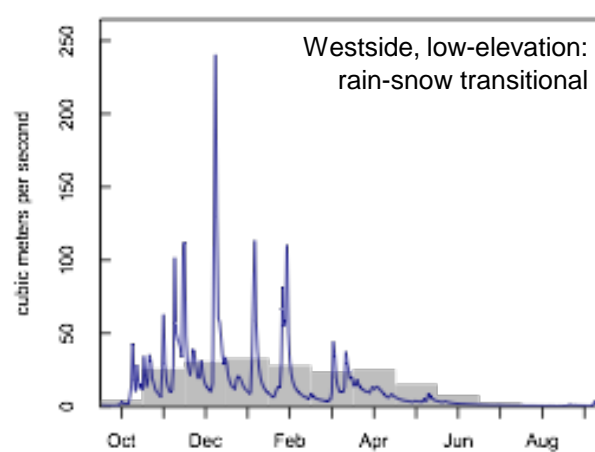
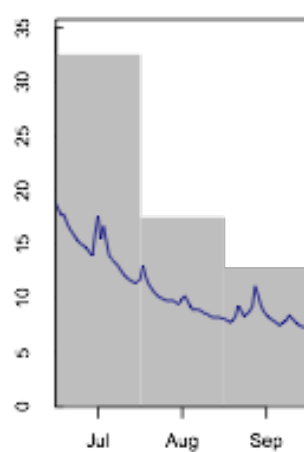
Snake River above Jackson Lake, WY



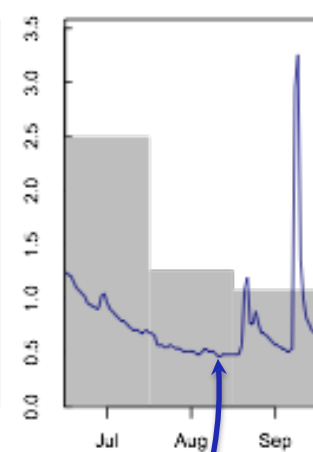
Cowlitz River at Randle, WA



St. Joes Creek at Calder, ID



Quartzville Creek near Cascadia, OR



Westside, lower elevation rivers and streams generally had the most extreme low flows in 2015.

*Provisional Information*

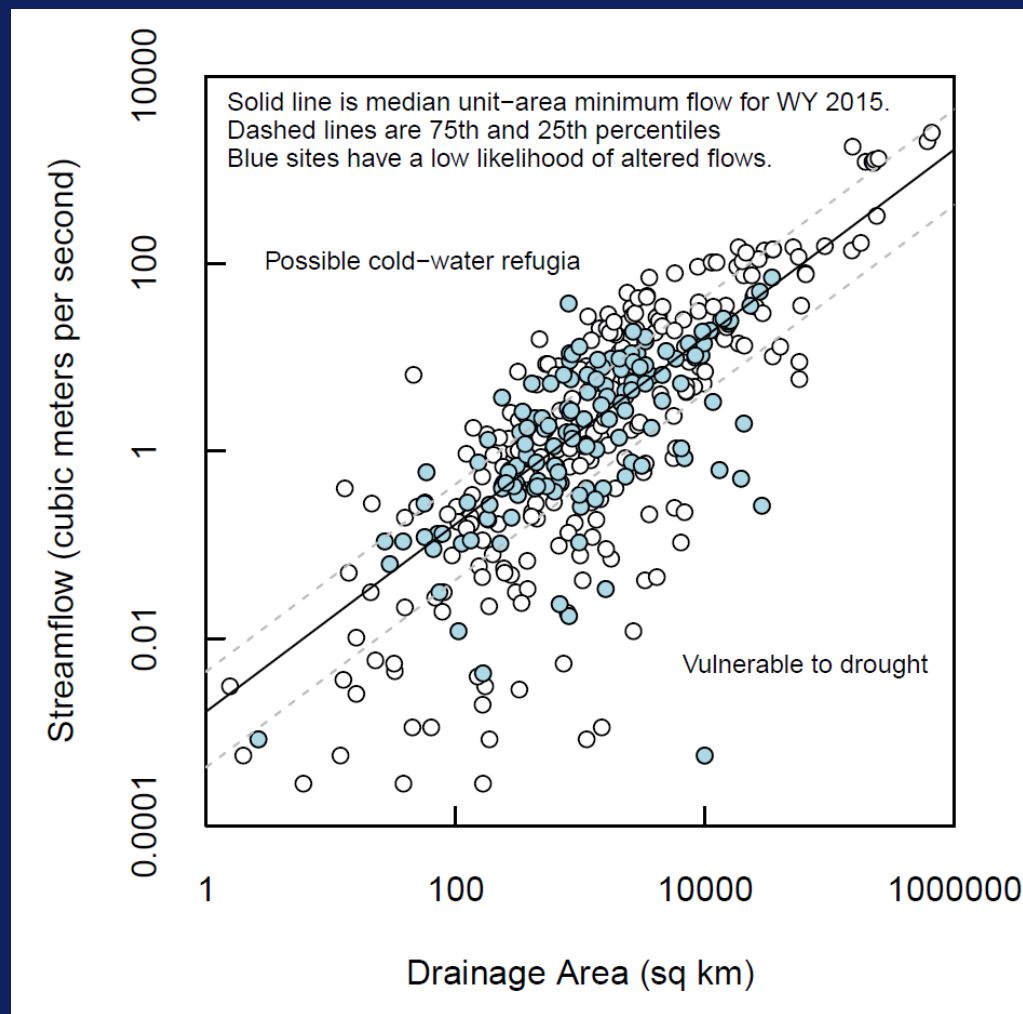


# 2015 Low Flows at USGS Gages in Columbia River Basin

Median unit-area low flow  
~0.15 cfs per sq mile  
(diagonal line)

Only 4% higher for 184  
“natural-flow” sites (blue  
shading)

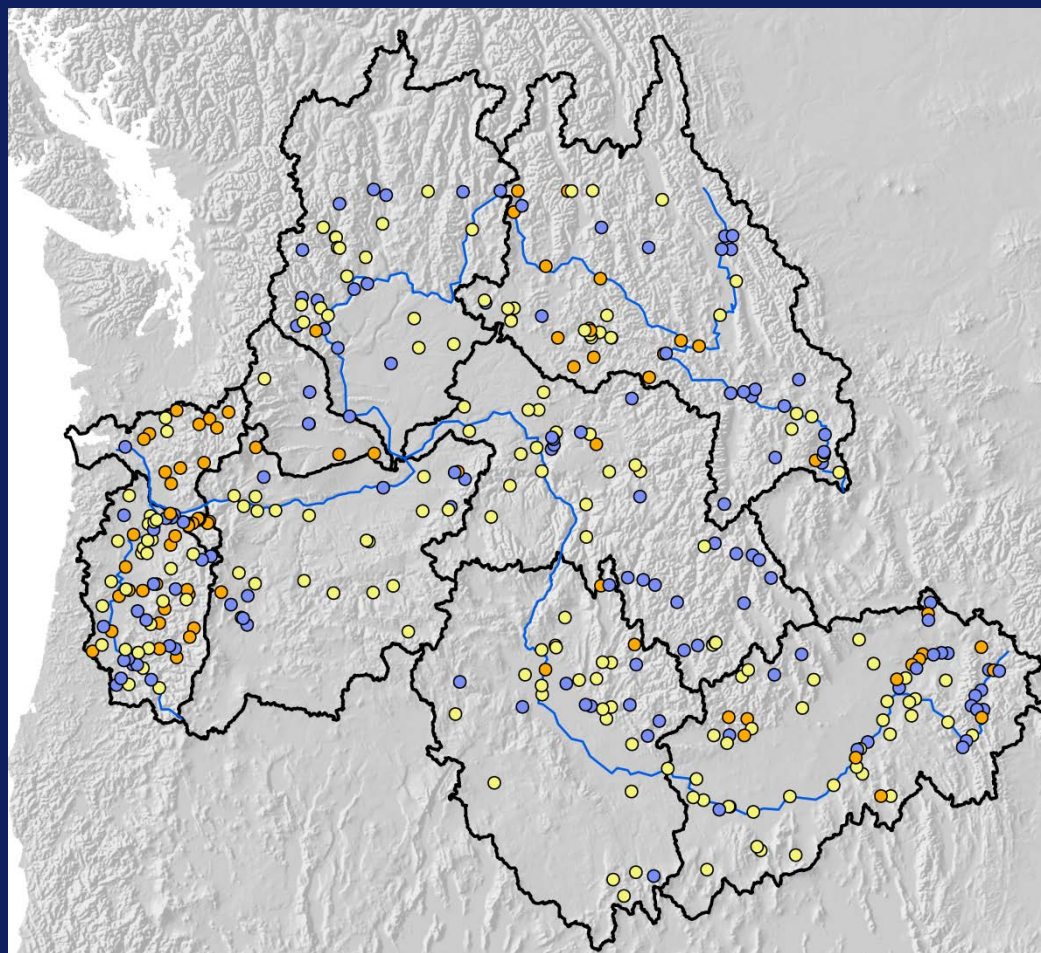
Variability in unit-area  
streamflow due to  
differences in precipitation  
and groundwater



# Were Low Flows Extreme in 2015?

Difference between extreme and normal low flow is small: 10<sup>th</sup> percentile is typically 60% of the median (“2-year”) annual low flow or about 0.05 cfs/ sq mile.

Low flows in 2015 were lower than normal in especially in Willamette, Lower Columbia, Spokane, and Upper Snake.

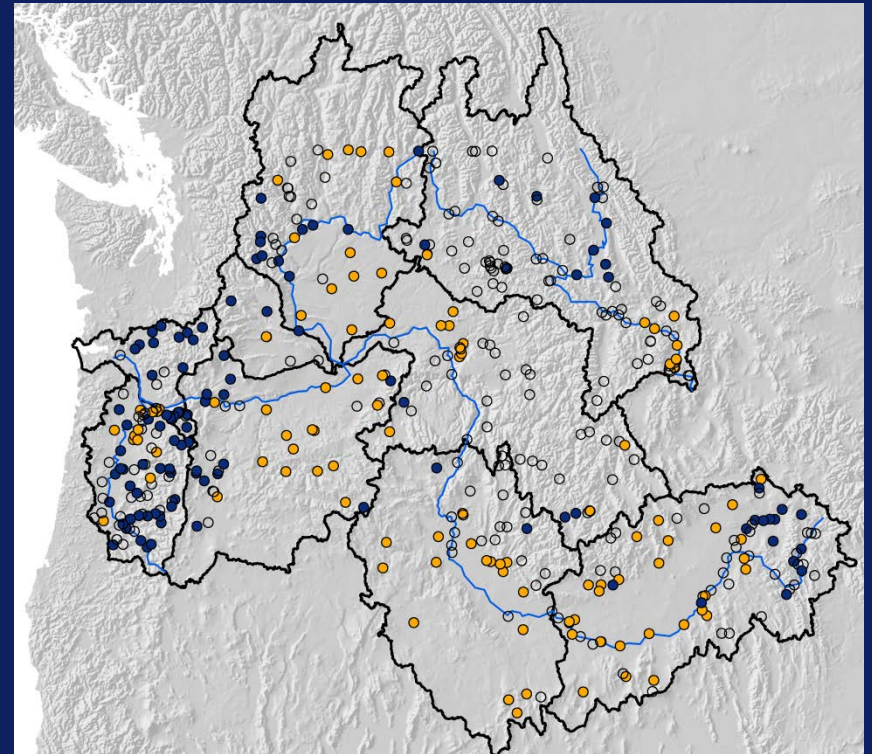
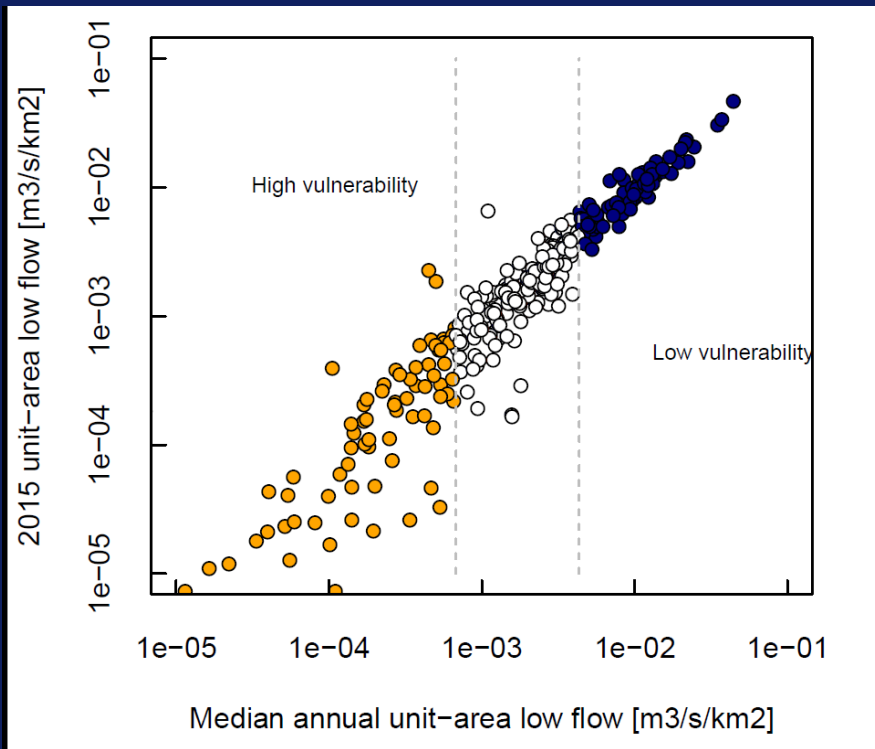


Blue –above normal low flow

Yellow –below normal low flow

Orange – >0.05 cfs/sq mile below normal

# Assessing Stream Vulnerability to Drought



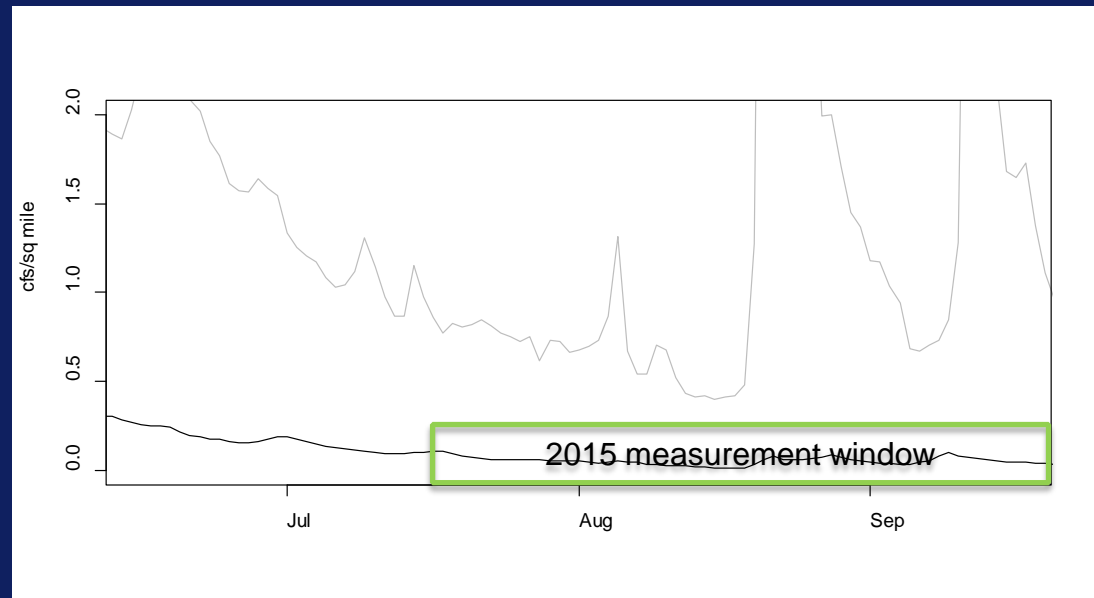
Median annual low flow provides a simple index of vulnerability.

# Assessing Stream Vulnerability to Drought

Median annual low flow provides a simple measure of stream vulnerability to drought.

Measurements made from July through September were likely to be within 0.2 cfs/sq mile of 2015 low flow.

Difference between daily and minimum streamflow for 95<sup>th</sup> and 50<sup>th</sup> percentiles of gages.



# Next Steps

## Products from initial analysis (2016)

Assessment of stream-specific vulnerability to drought

Method for estimating low flows from single measurements

## Possible tasks for the future

1. Expand the assessment of stream vulnerability to ungaged sites;
2. Basin-wide mapping of stream vulnerability
3. Assess groundwater recharge from snowmelt in rivers and its significance for base flow and water supply during droughts
4. Incorporate stream-specific vulnerability into drought forecasting

# Summary

Streamflow was below normal in the Columbia River Basin during the summer of 2015 particularly because of the lack of snowmelt.

Low flows were exceptionally low in some streams (westside, low elevation) but were close to normal in many streams.

Past response of streams is a good indicator of their vulnerability to drought. There is value to having even one low flow measurement.