Open-Access Streamflow Modeling in the Big Wood River Basin

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USDA

BOISE STATE UNIVERSITY

MONTANA STATE UNIVERSITY

Ecosystem Sciences Foundation

BUREAU OF RECLAMATION

TROUT UNLIMITED
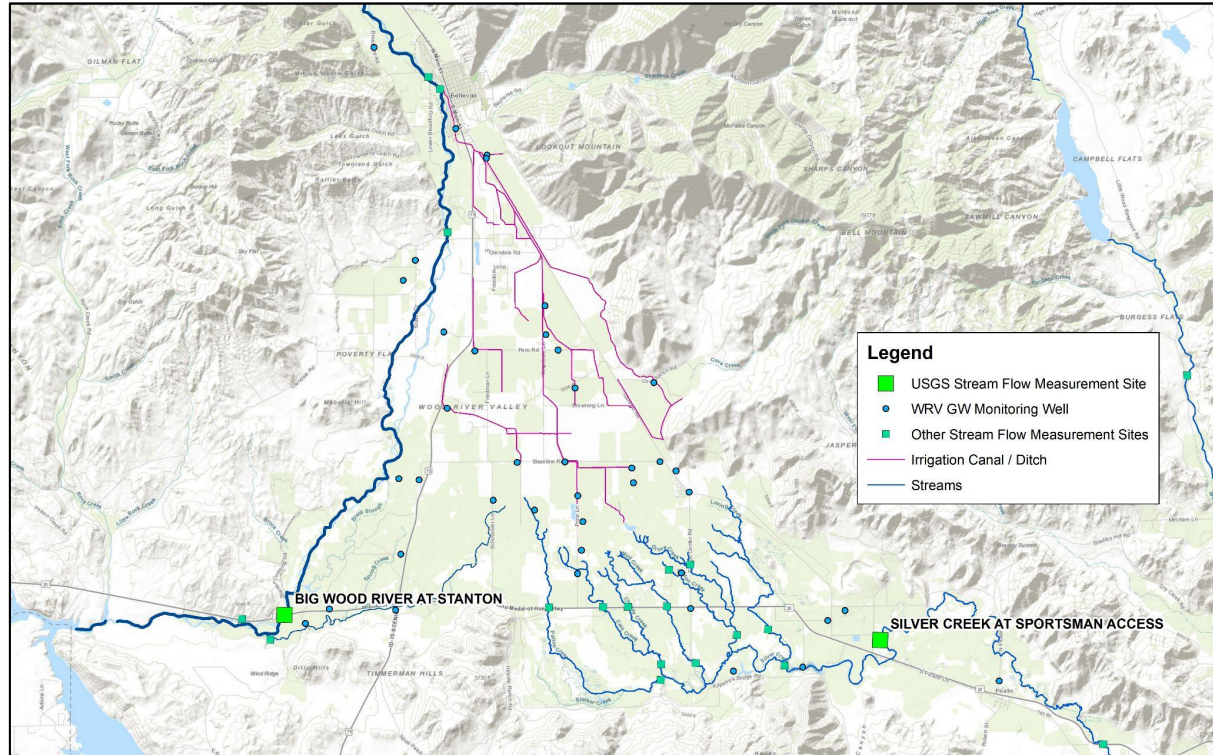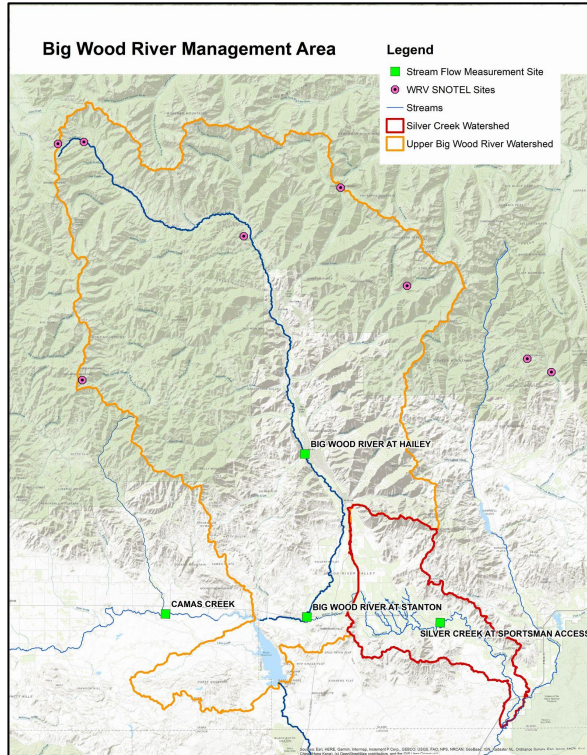
WOOD RIVER LAND TRUST

Origin

- Continuation of work funded by the Wood River Water Collaborative

- Funding from the USDA, Agricultural Food Research Initiative Foundation and Applied Science Program

SILVER CREEK, WOOD RIVER VALLEY, IDAHO

Vision

Easily accessible and useful water data and water forecasting tools for the Wood River Valley.

Objectives

- Collaboration with stakeholders

- Improve forecasts of water availability and water rights

- Develop models of stream health in Silver Creek

- Improve access to information & facilitate data-based decisions via online interface

Project Workflow & Timeline

- Conducted through the winter of 2024
- 3 stakeholder meetings complete

Project Steps and Outcomes:

Develop models and tools to assist with Surface Water / Groundwater Management for water use, water quality and stream health

Forecasting Models

First Step
Improve Big Wood and Silver Creek Water Forecasting Models

Second Step
Stream Temperature and Dissolved Oxygen Model

Third Step
Online, Interactive Tools and Data Visualization

Synthesis:
Outreach, Guidance and Information to Stakeholders

Model Choice

- Physical Models:
  - Representation of the physical processes that move water through the system
  - Utility : retains accuracy even as the system changes
  - Challenges : time / resource consuming to develop, calibrate and run

- Statistical Models:
  - Based on trends and patterns in a given data set
  - Utility : more easily developed and ran than physical models
  - Challenges: Are not robust to events outside of the historical record

Current Streamflow Forecasting Tools

Northwest River Forecasting Center (physical)

- Daily predictions at Hailey
- Uses 10 day weather forecasts, and historic seasonal weather

NRCS (statistical)

- Monthly forecast at Hailey and Camas Creek

The Big Wood Models (statistical)

- Predicts summer streamflow from April 1 - October 1
  - At Hailey, Stanton Crossing, Camas, Silver Creek
- Predictions can be updated daily from Feb 1 - April 30
- Predictions of Day of Allocation

Streamflow Modeling Workflow

- There is a unique statistical model for each month: February, March, April

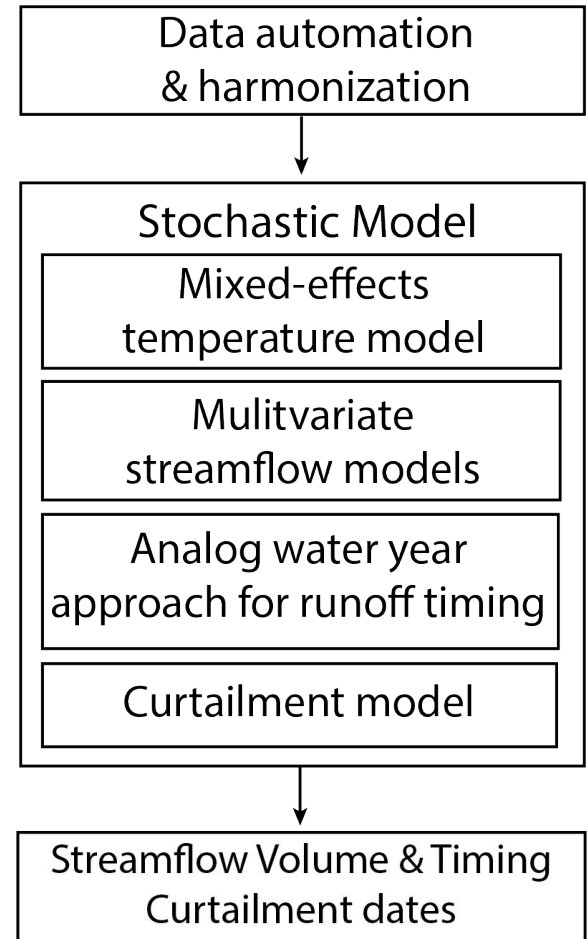- After October 1, the models are updated with the most recent data

GitHub

github.com/kendrakaiser

R Studio ®

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│      Data automation         │
│       & harmonization        │
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│       Stochastic Model       │
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│  │     Mixed-effects      │   │
│  │   temperature model    │   │
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│  │      Mulitvariate      │   │
│  │   streamflow models    │   │
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│  │   Analog water year    │   │
│  │ approach for runoff    │   │
│  │        timing          │   │
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│  Streamflow Volume & Timing  │
│      Curtailment dates       │
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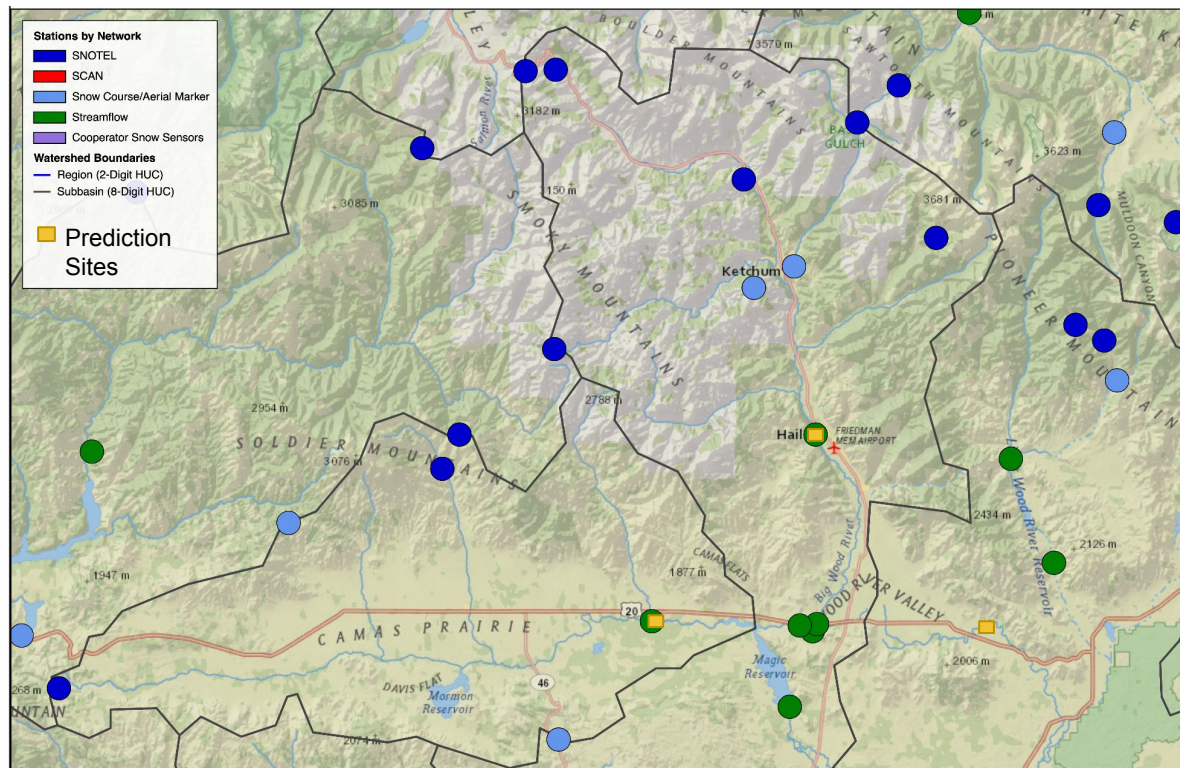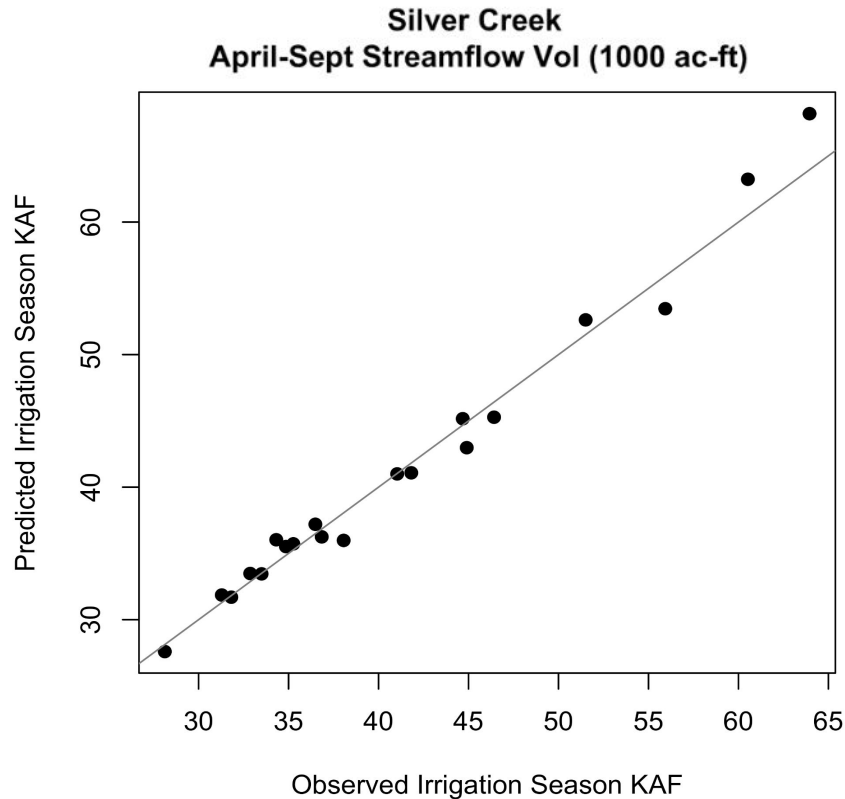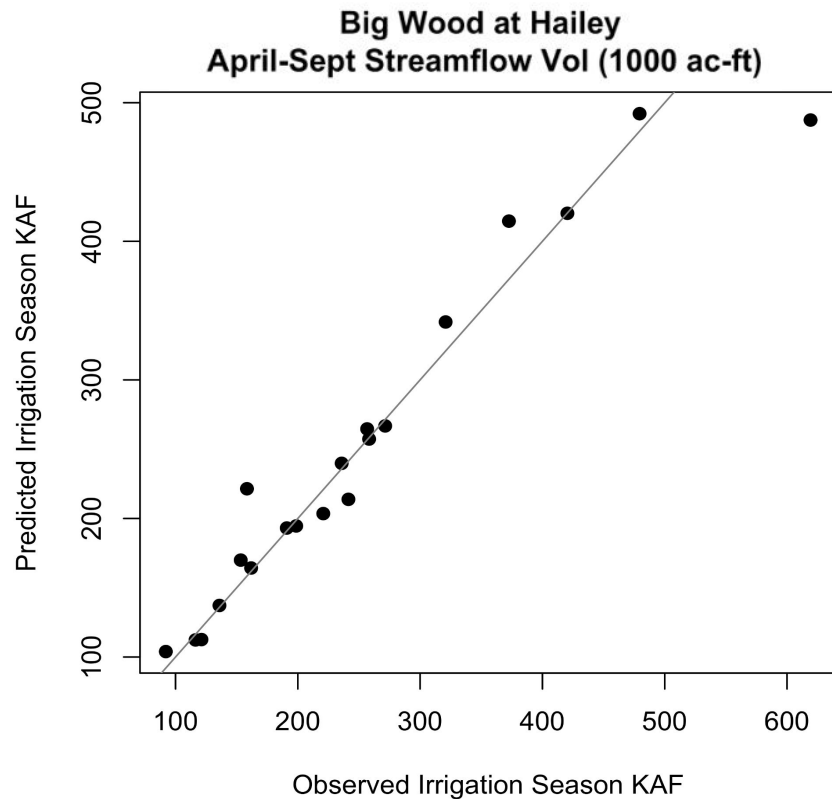
Streamflow Forecasting Data Sources

- **USGS**
  - Historic Annual Irrigation Season Volume
  - Winter Baseflow
- **SNOTEL**
  - Hourly, 12 sites
  - SWE, Temp
- **SNODAS**
  - Daily, 1km^2
  - Snow Covered Extent, SWE, Precip
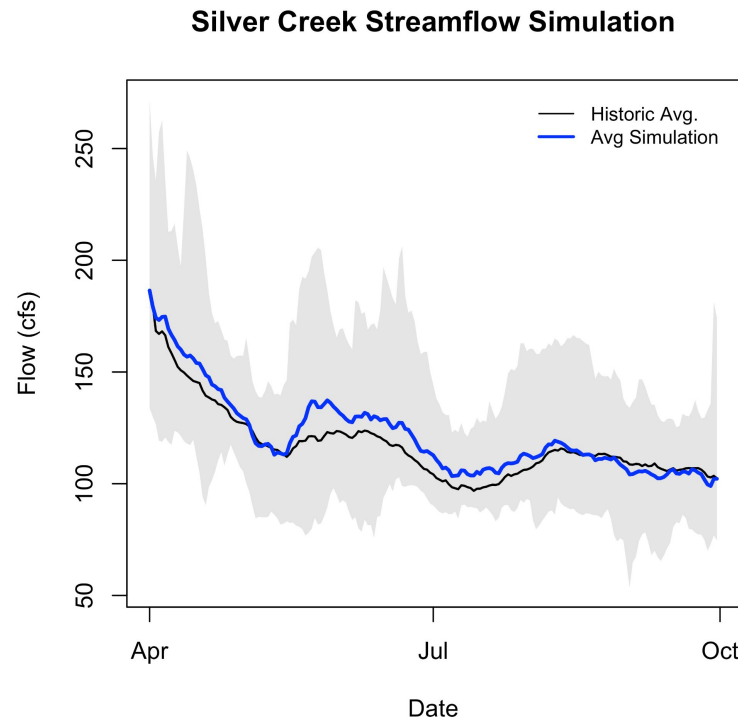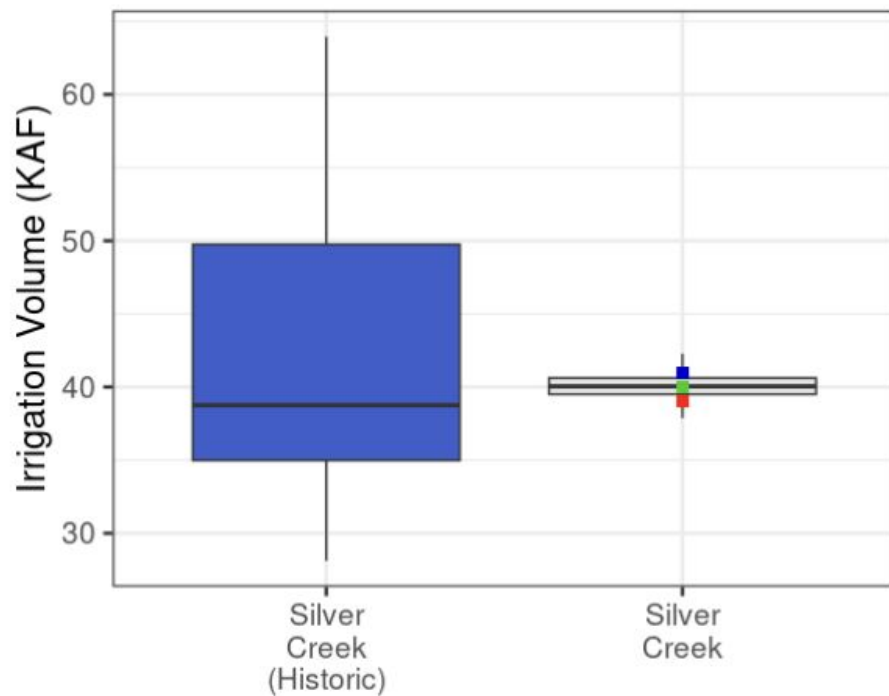- **Agrimet**
  - Hourly, 2 sites (Fairfield, Picabo)

Streamflow Model Fits

	AdjR2	Loocv R2
BWH	92.7	95.04
BWS	97.64	97.79
SC	97.92	98.24
CC	92.74	96.98

Big Wood at Hailey
April-Sept Streamflow Vol (1000 ac-ft)

Silver Creek
April-Sept Streamflow Vol (1000 ac-ft)

Irrigation Season Volume Model Output


Silver Creek Streamflow Simulation

# Caveats to Streamflow Forecasting Models

- The models explain previous streamflow volumes really well using historical conditions
  - If future conditions are outside of historical observations the models may not perform well
  - We do not explicitly incorporate summer precipitation or irrigation practices

Hydrograph Recession Analysis

- What: Statistical analysis of the rate at which streamflow returns to baseflow

- Why: this is an additional way to understand behavior of the watershed and late season water availability

- These may improve late season streamflow forecasts but it is still exploratory at this point
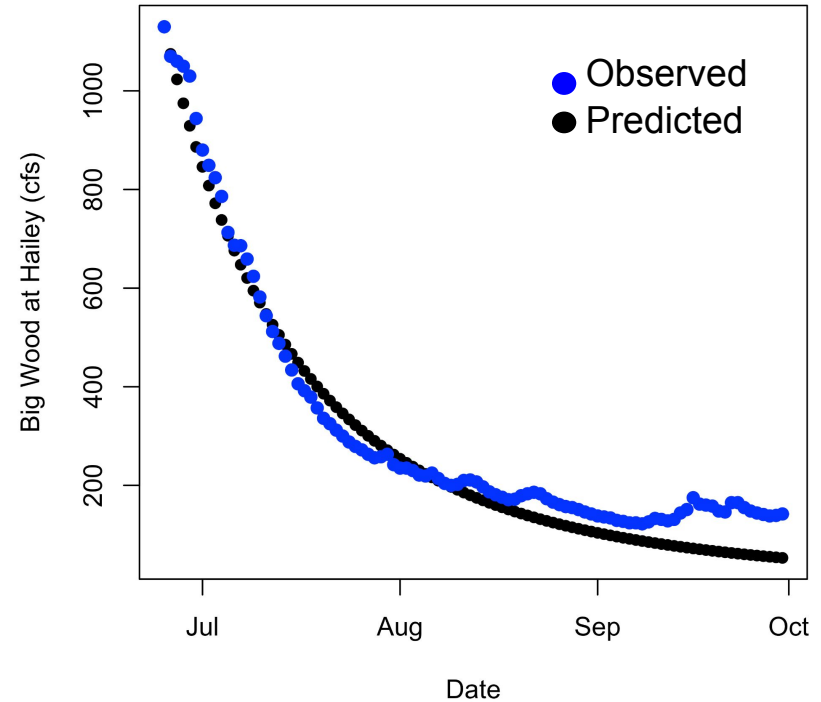
Water Right Curtailment Predictions
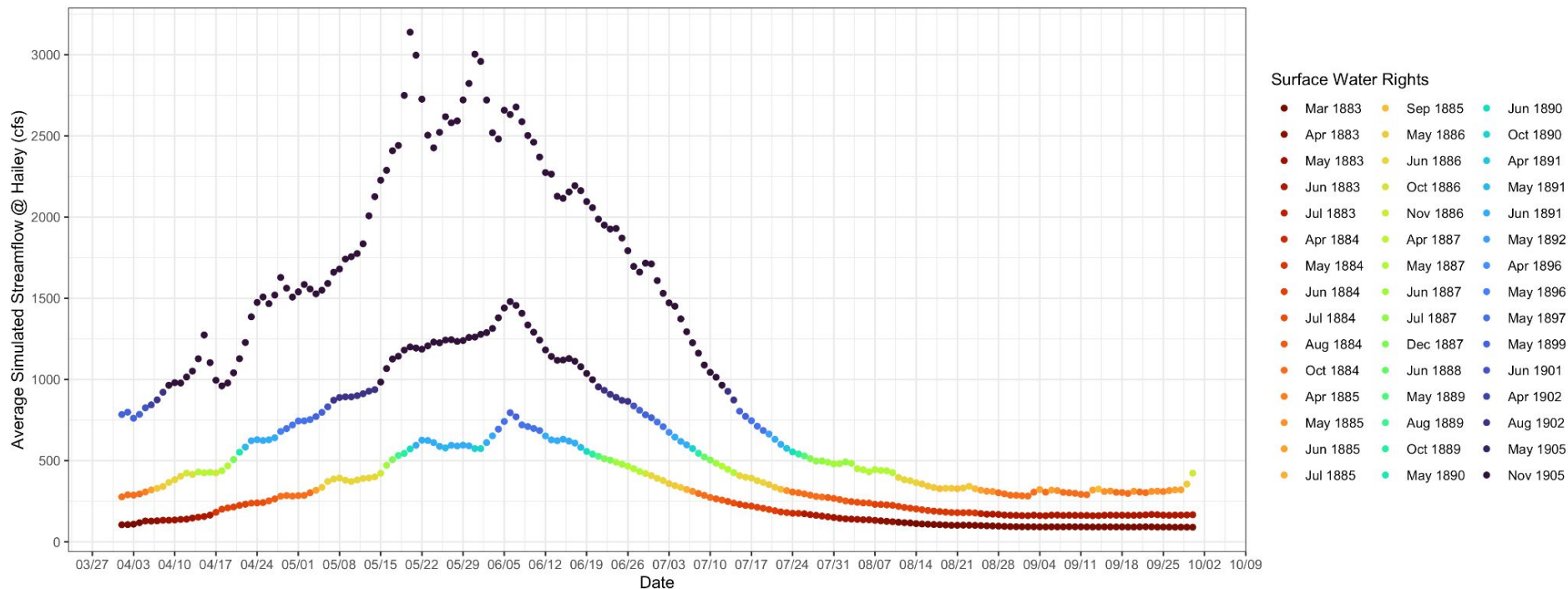
Average hydrograph scaled to the predicted volume with water rights curtailed based on in-stream flow at Hailey

Online Data & Model Visualization

- Problem: **Data** has historically been in many places
  - Solution: Centralized database

- Problem: **Individuals have to navigate** to many websites to gather information
  - Solution: Provide daily model output, figures & tables in one website

Big Wood Streamflow and Water Quality Dashboard

Overview   Streamflow Forecasts   Stream Temperature Forecasts   Data Explorer

Big Wood River Streamflow and Water Quality Tools

The Big Wood River Dashboard is an interactive set of tool to visualize observational data and modeling ouput in the Big Wood River Basin and Silver Creek.
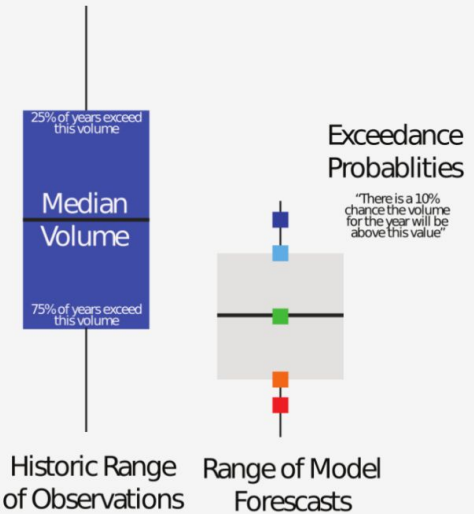
This integrates data from a range of sources and provides timely information that may be used to inform water management in the basin. Use the toolbar at the top of the page to select the data or information category of interest and you'll be directed to a dynamic graph for visualization.

The Big Wood Streamflow Tools provide real-time forecasts of the irrigation season streamflow volumes on the Big Wood, Camas Creek, and Silver Creek. The Water Quality Tools are focused on stream health in Silver Creek as it pertains to the trout fishery. The data explorer allows you to dig into the datasets behind these models, and explore changes over time.

Streamflow Forecasts Tab

Streamflow Forecasting Output

The streamflow forecasting suite predicts total irrigation season runoff volume, "center of mass", and timing of delivery calls in the Big Wood River Basin (above Magic), Camas Creek and Silver Creek.

25% of years exceed this volume

Median Volume

75% of years exceed this volume

Historic Range of Observations

Exceedance Probablities

"There is a 10% chance the volume for the year will be above this value"

Range of Model Forecasts

Streamflow forecasts are shown as boxplots in comparison to the range of historical conditions. The exceedance probabilities align with the Northwest River Forecasting Center probabilities for comparison. The median forecasted

Streamflow Forecast as of 2024-04-15

Exceedance	Big Wood at Hailey	Big Wood at Stanton	Silver Creek	Camas Creek
90%	251	145	45	68
75%	259	151	45	70
50%	269	159	45	73
25%	278	165	46	75
10%	287	172	46	77

Forecasted irrigation season streamflow volumes (KAF) with exceedance probabilities. The 50th percentile is the average forecast. These probabilities are aligned with the Northwest River Forecasting Center for comparison purposes.

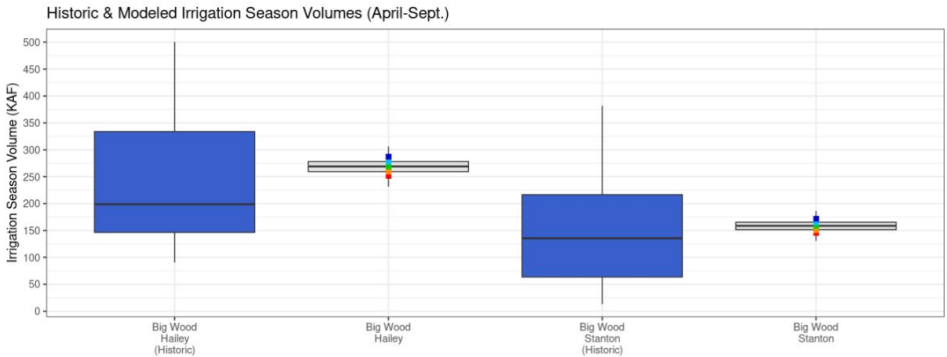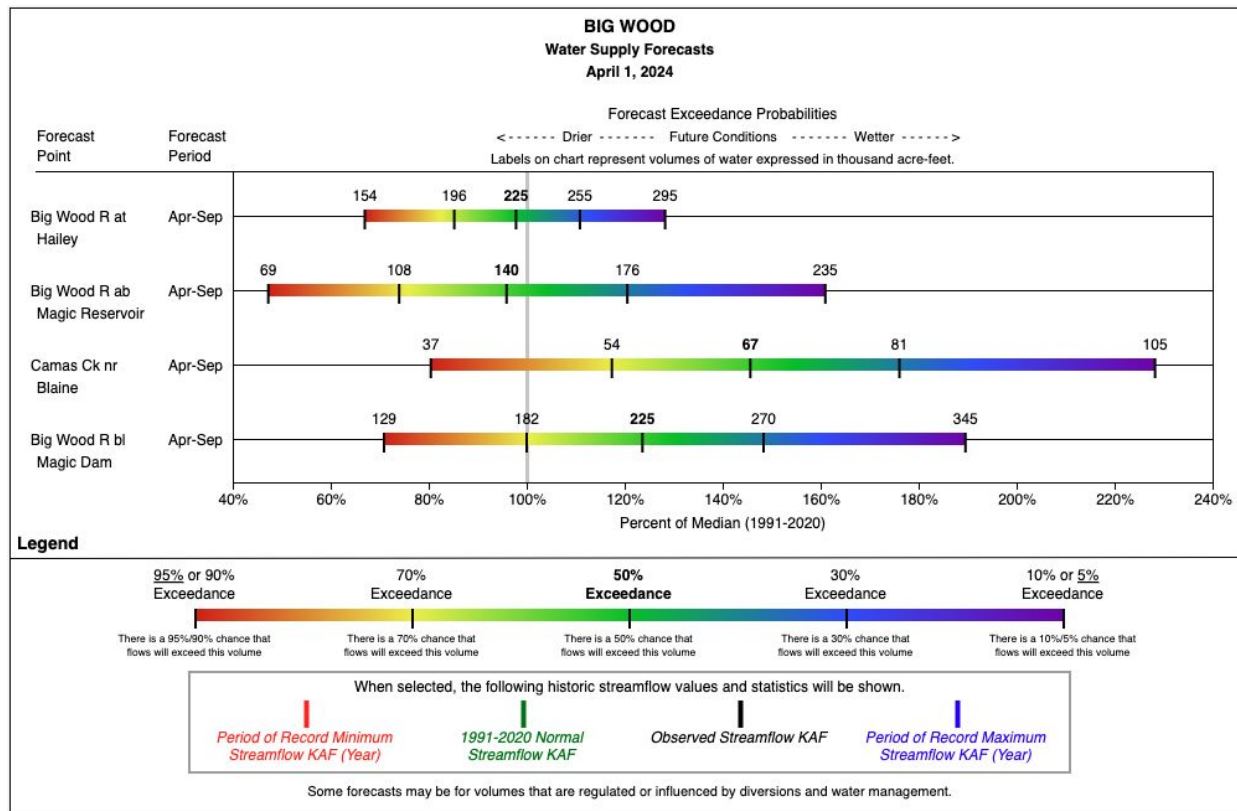Historic & Modeled Irrigation Season Volumes (April-Sept.)

Figure 1: These box plots show the historic range of irrigation season volume (blue) and the forecasted range of volumes (grey) for each gage. The boxes represent the 25th - 75th percentiles and the solid line in the middle is the median forecasted value.

Comparison to NRCS Forecast Figures

Additional Forecast Figures in Development

Early in the water year (October - January) the uncertainty in the forecasts is high - the "whiskers" range from 97-450 KAF, while the most likely values within the yellow box are 150-300 KAF

Water Supply Forecasts
BIG WOOD - AT HAILEY
Period   APR to SEP -- Water Year 2023
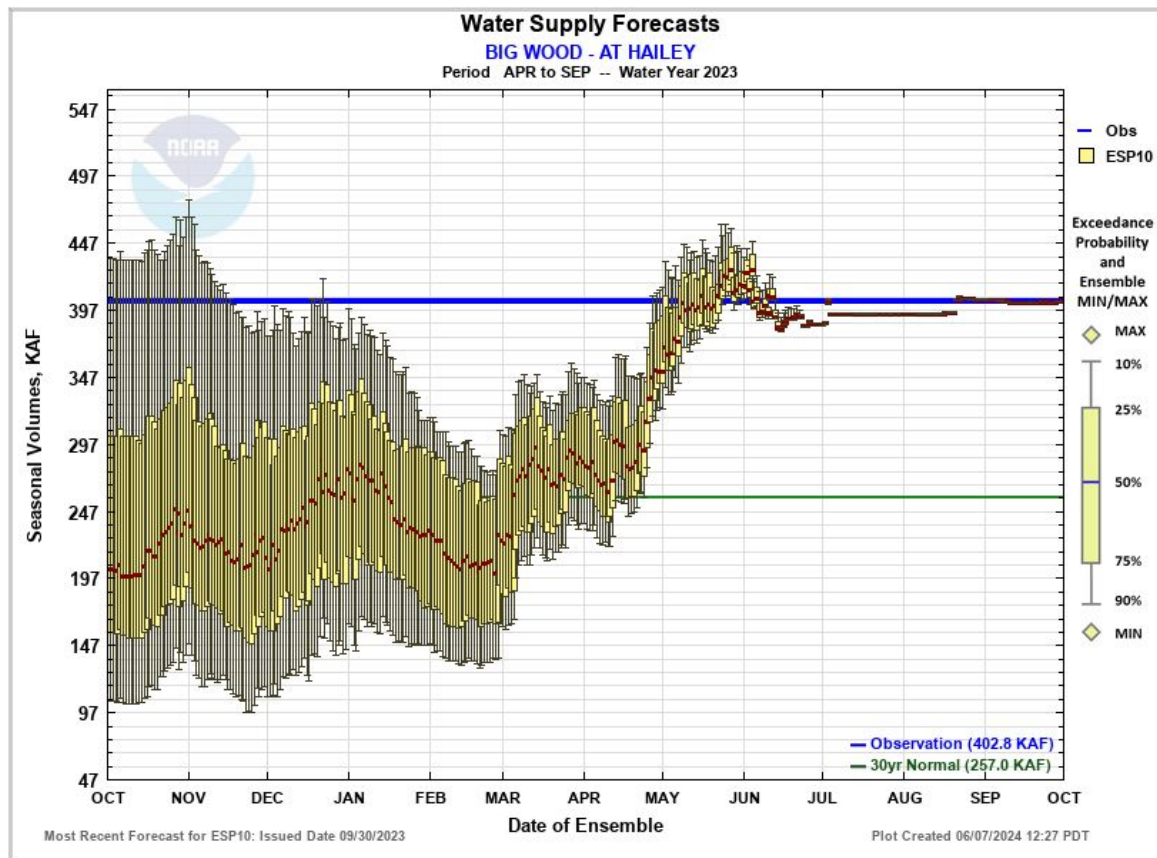
Additional Forecast Figures in Development

By March, the forecast goes above 257 KAF

Daily forecasts allow you to track how the conditions are changing

Water Supply Forecasts
BIG WOOD - AT HAILEY
Period APR to SEP -- Water Year 2023
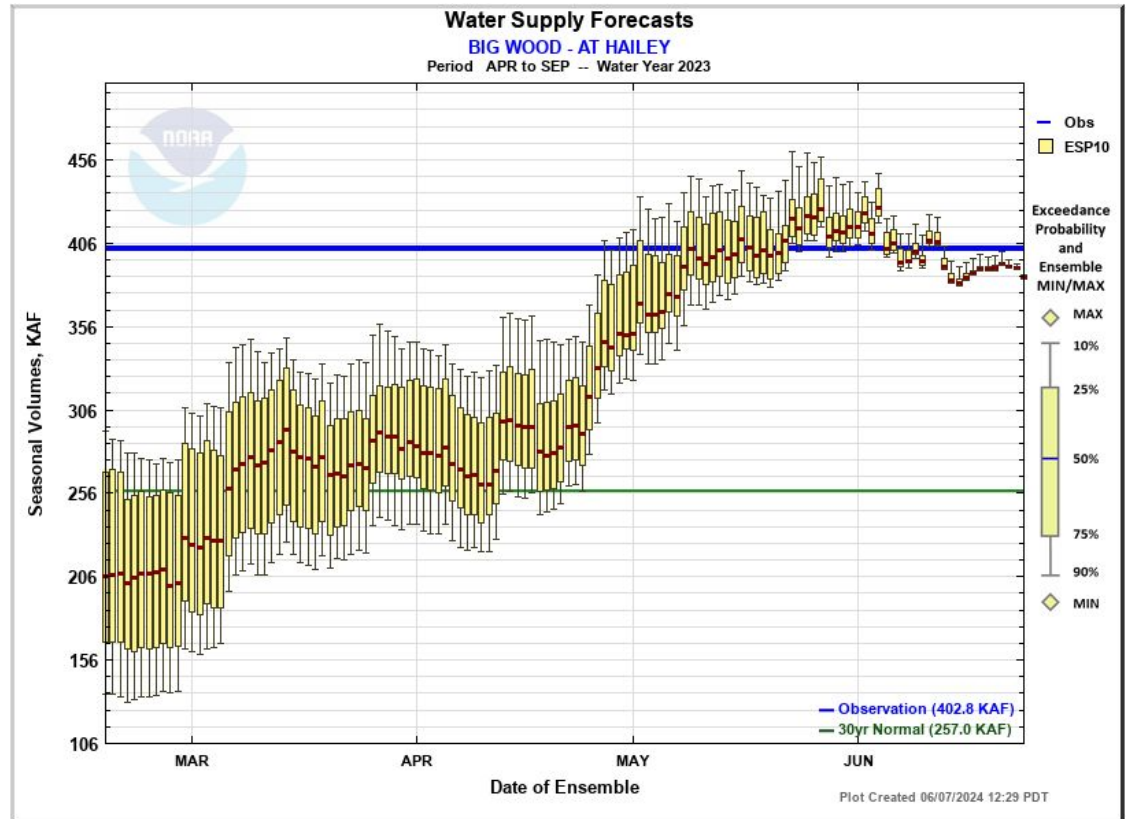
Next Steps

- Continued updates to online interface from user input
  - Transferring to IWRRI - website will be updated by January 2025
- Development of May model
- Continued development of recession analysis
- Additional evaluation of model by IDWR & peer reviewed publication

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SILVER CREEK, WOOD RIVER VALLEY, IDAHO