

SWIMS Technical Advisory Group

Meeting #5

October 6, 2026

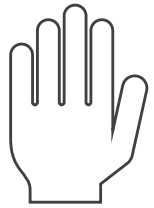
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Agenda

1. Welcome (*9:00 – 9:05*)
2. Follow-up from previous meeting (*9:05 – 9:20*)
3. Streamflow record augmentation (*9:20 – 9:35*)
4. Surface water-groundwater interactions (*9:35 – 9:55*)
5. Discussion (*10:05 – 10:55*)

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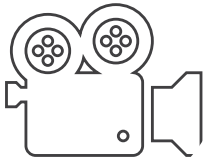
Meeting Rules



Use hand raise feature



Encourage interaction and cameras on (please ask questions to group)



Meetings will be recorded and posted to website

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Validating Statewide ET

Ryan Andrews

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Recap Meeting #4

Importance of consumptive use in water availability modeling framework

- Used to determine reference conditions by calculating natural streamflow (measured flow + water use = natural streamflow)

Information available to support estimation of consumptive use

- Irrigation
  - OWRD's statewide ET dataset provides field scale water use data
- Municipal
  - Reported water use and water management and conservation plans

Validating Statewide ET

- OWRD's Statewide ET dataset is remotely-sensed product that provides field scale water use data for 250,000+ irrigated fields
  - Reference ET, applied water, consumptive use, etc.
  - Incorporates bias correction via comparison with ag weather data
- Prior to implementation into SWIMS modeling framework, TAG suggested validating data
  - Outlined several approaches to provide context for describing development of dataset and compare with other similar data

Validation Approaches

1. Compare satellite-based estimates of reference ET with those measured by weather stations (e.g., AgriMet)
2. Calculate ET based on a water budget approach to compare with remotely sensed data
3. Compare reported water use with water use metrics available in Statewide ET

Potential Outcomes

- Further refine dataset by applying bias correction factors based on trends at locations where weather stations were more recently installed
- Identify regional differences and potential sources of uncertainty
- Align water use patterns between estimated and reported data

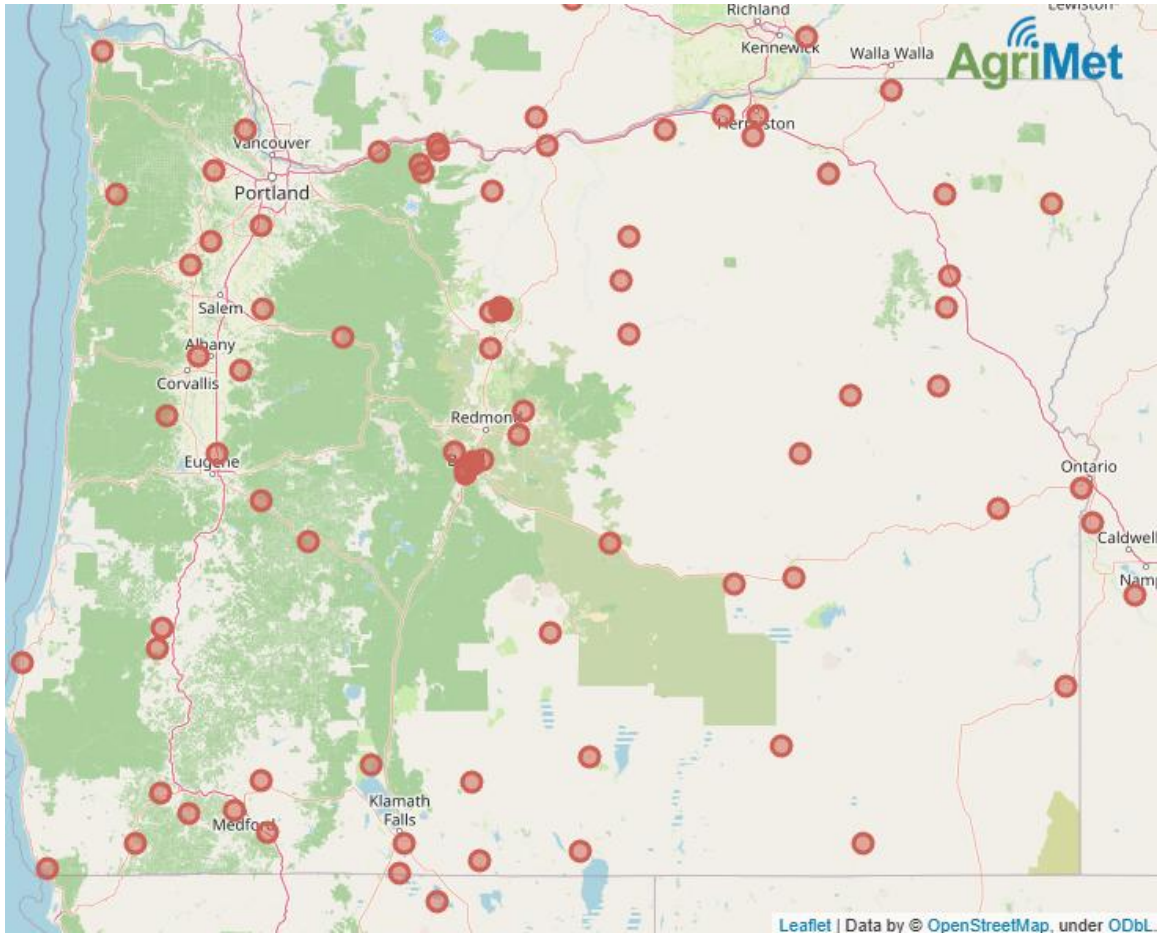
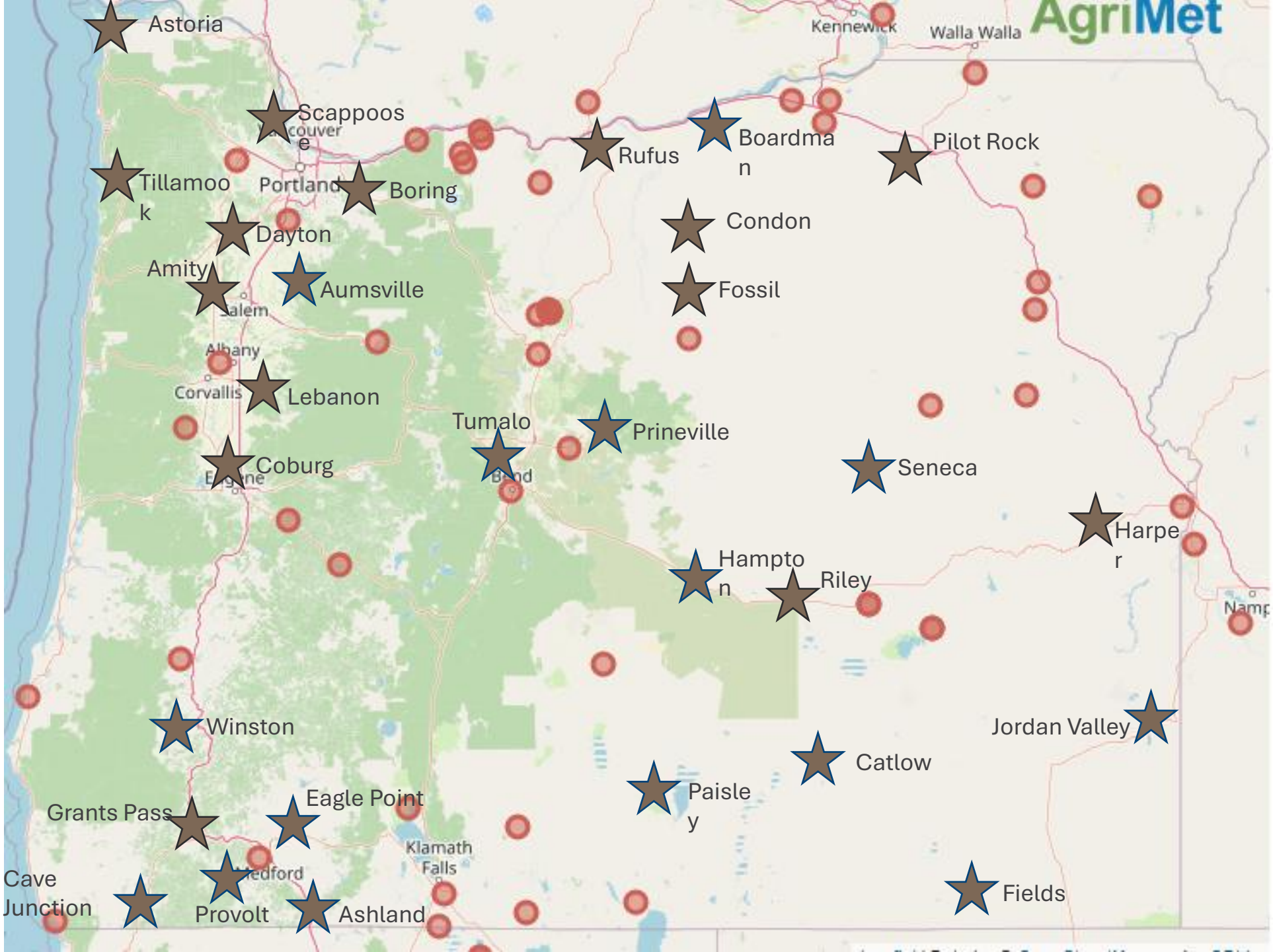


Figure: Oregon's AgriMet station network.

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Map updated: 3/20/24



County	Area
Crook	Prineville
Deschutes	Hampton
Deschutes	Bend
Douglas	Winston
Grant	Seneca
Harney	Catlow
Harney	Fields
Jackson	Ashland
Jackson	Eagle Point
Josephine	Cave Junction
Josephine	Provolt
Lake	Paisley
Malheur	Jordan Valley
Marion	Aumsville
Morrow	Boardman
Clatsop	Astoria
Columbia	Scappoose
Gilliam	Condon
Harney	Burns
Josephine	Grants Pass
Lane	Coburg
Linn	Lebanon
Multnomah	Boring
Polk	Amity
Sherman	Moro
Tillamook	Tillamook
Umatilla	Pendleton
Wheeler	Fossil
Yamhill	Dayton
Malheur	Harper

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Suggested Approach

- Compare reference ET as estimated by Statewide ET with newer AgriMet stations that were recently installed (2023-2024)
  - Newer stations not included in original bias correction effort
  - Inform future updates to dataset
- Compare reported and estimated water use patterns to align seasonal demand curves
  - For instance, does the timing of estimated applied water align with what is reported by water users?
- Existing efforts to improve mapping accuracy of irrigated areas (e.g., OSIRIS)
- Develop seasonal demand curves for reported municipal water use
  - Understanding nuances of reported water use data

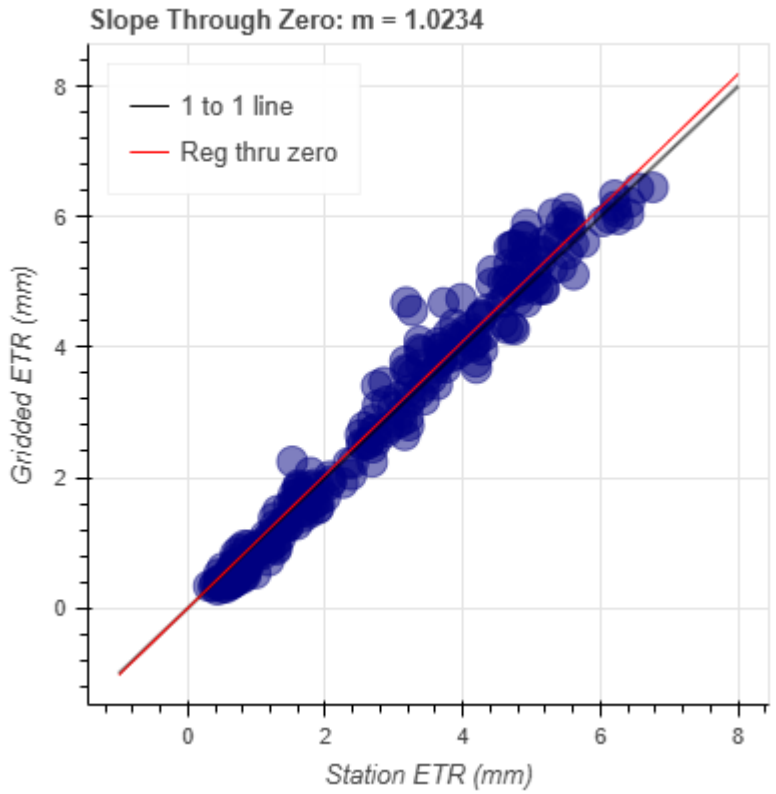


Figure: Comparison of reference ET calculated using weather station data and as estimated via gridded product.

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Streamflow Record Augmentation

Ryan Andrews

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Purpose of Analysis

Purpose

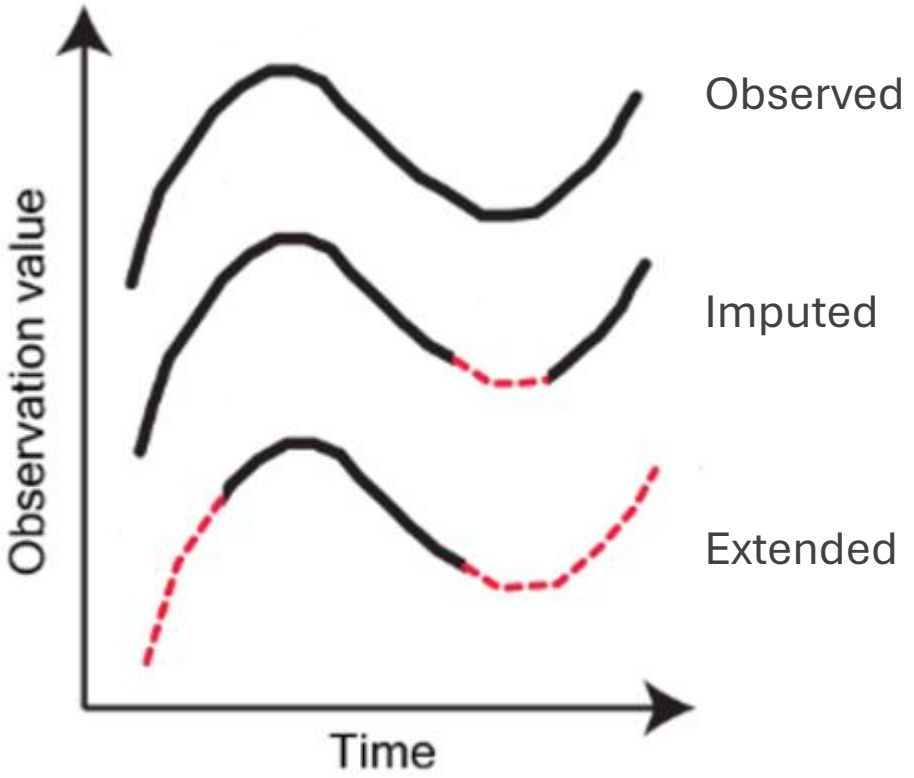
- Evaluate the utility of streamflow record imputation and extension to augment flow records to improve data accuracy and expand data availability

Imputation

- Infilling gaps in mostly complete streamflow records within the base period

Extension

- Extending historical streamflow records to represent conditions during a base period



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Relevance to SWIMS

Accuracy of measured exceedance flows

- Use of less than complete streamflow records may impact exceedance flows calculated using observed data

Expanding candidate gaging stations

- Would increase the number of gaging stations with streamflow data to support development of the natural flow model
- Important in areas with limited streamflow data

Major Questions

Imputation

- Can imputation improve characterization of observed base period exceedance flows at stations with missing data?

Extension

- Is record extension a viable approach for using historical streamflow records to approximate conditions during the base period?

Goals of Analysis

1. Determine whether imputation improves accuracy of exceedance flows
2. Evaluate accuracy of exceedance flows calculated with extended records
3. Develop guidelines for performing record extension

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General Data and Approach

- Used mean daily flow records from 51 least impacted streamgaging stations
- Relied on ARCHI package in R (Automated Regional Correlation Analysis for Hydrologic Record Imputation)
- Tested MOVE.1 and Ridge methods for developing regressions to estimate flows at a target station by using records from a reference station
- Point of comparison was exceedance flows at 20%, 50%, and 80% probabilities
- Imputation refers to infilling gaps in flow records during the base period (i.e., 1991-2020)
- Extension refers to creating synthetic time series during base period by using historical or ‘out-of-phase’ records (i.e., pre-1991)

Approach to Evaluate Imputation

Analysis

- Compare exceedance flows calculated with missing data to those calculated with imputed data to determine which better approximates observed values

Target-Reference Pairing

- Automated pairing based on degree of correlation between target and reference flow records and NSE error threshold to screen resulting regression model (must outperform mean)

Holdout Data

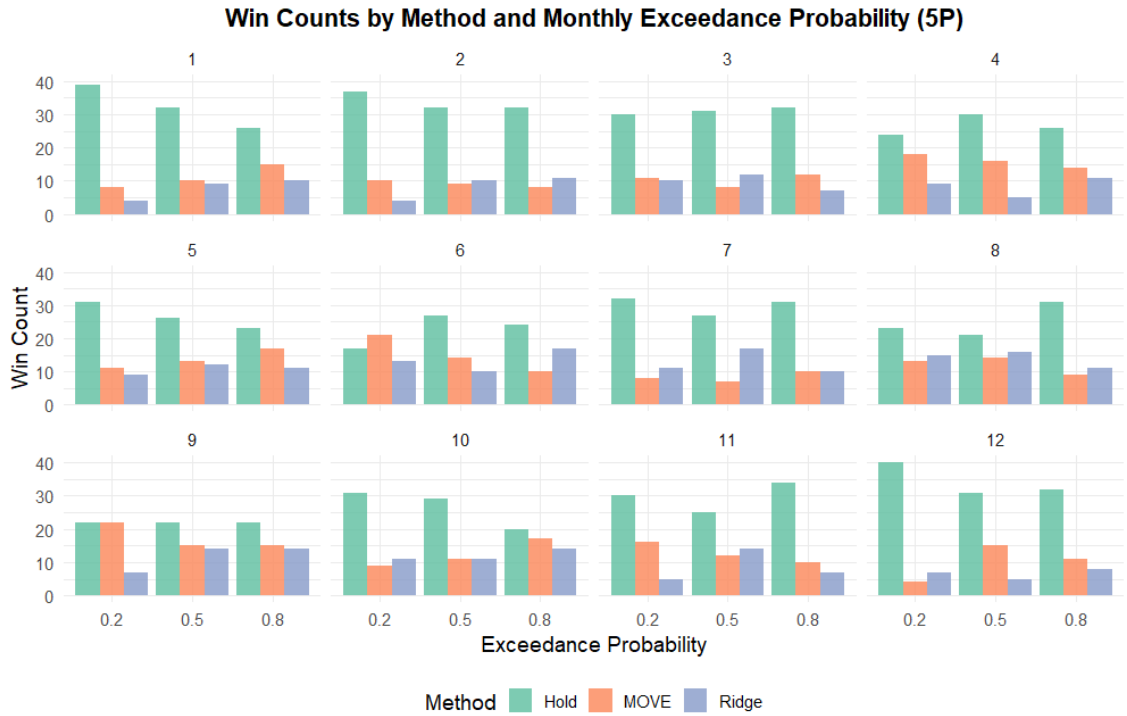
- Created 100 time series of mean daily flow records during the base period with proportions of 5, 10, 15, and 20% of random missing data

Imputed Data

- Used target-reference regressions to impute data to infill gaps of missing data

Imputation Findings

- Monthly exceedance flows calculated with missing data and imputed data were significantly different
  - Annual results not significant
- Error increased as the exceedance probability decreased and the proportion of missing data increased
- Overall, exceedance flows calculated with missing data were closer to observed values
  - Imputation tended to introduce error
- Results suggest not to impute prior to calculating exceedance flows



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Approach to Evaluate Record Extension

Analysis

- Determine whether exceedance flows calculated with extended records better approximate base period conditions compared to those calculated with the out-of-phase records

Target-Reference Pairing

- Based on recommended guidance suggesting importance of regional hydrologic similarities, drainage area ratio, and flow correlation

Out-of-Phase Record Subsamples

- Created 3- to 15-year subsamples of out-of-phase records (i.e., records between 1960-1990) where target and reference stations had concurrent records
- Created subsample specifically for records from 1980-1990 time period

MOVE.1 Regression

- Used records from out-of-phase subsamples to build regressions using the MOVE.1 approach and create synthetic time series during base period

Additional Questions

- Does length of record used to build regression influence results?
- Does more recent data provide better information for approximating conditions?

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Pairings and Station Results

- Majority of pairings made between stations within the same HUC8 (N = 31), followed by Administrative Basin (N = 11)
  - Correlation between base period flows ranged from 0.39 – 0.99
  - Drainage area ratios ranged from 0.50 – 3.59
- Characteristics of poor performing pairs
  - Stations in Upper Deschutes Basin (above Wickiup Reservoir)
  - Disproportionate mean annual flows
  - Large differences in coefficient of variation
    - Spring-fed streams, upper headwater streams

Pairing Group	N
HUC8	31
Admin Basin	11
HUC6	2
Ecoregion Level 2	6
Region (east/west)	1

Table: Number of pairings by hydrologic or physiographic region

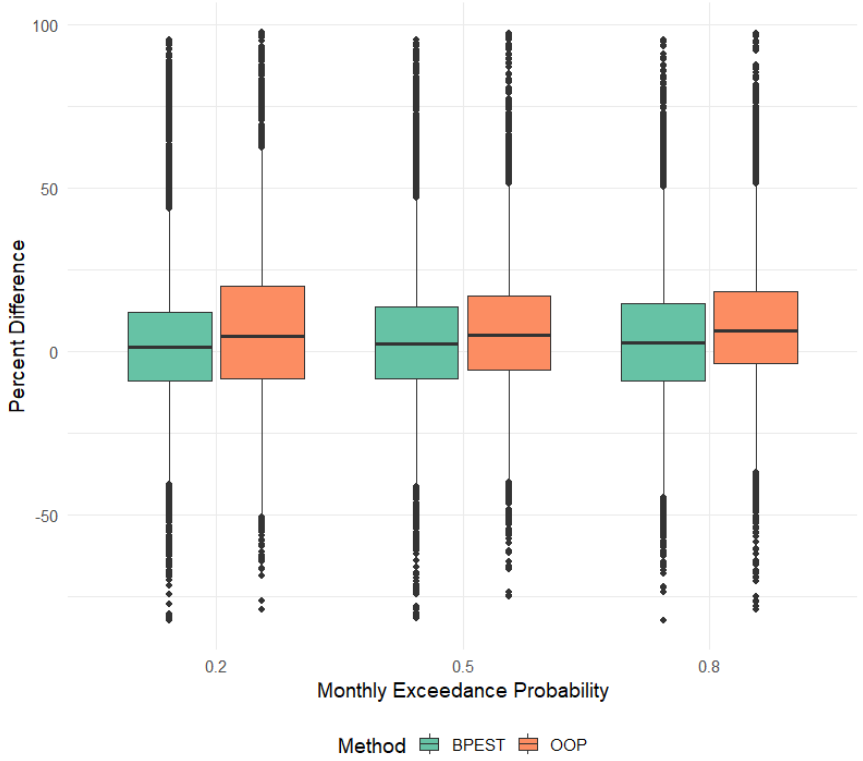
Metric	Min	Mean	Max
NSE	-2.52	0.68	0.99
Median Percent Error	-66.34	1.71	22.01
Median Absolute Percent Error	3.73	17.10	66.69

Table: Station performance metrics

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Results for Monthly Exceedance Flows

- Record extension better approximates base period monthly exceedance flows
  - Results vary by month; out-of-phase records better approximate base period conditions in low flow summer months
- Range in error was similar across all exceedance probabilities
- Little to no relation between model fit and pairing guidance characteristics (e.g., streamflow correlation, drainage area ratio) when taken individually
- Some pairings may produce decent results overall, though they can still produce outliers for any given month

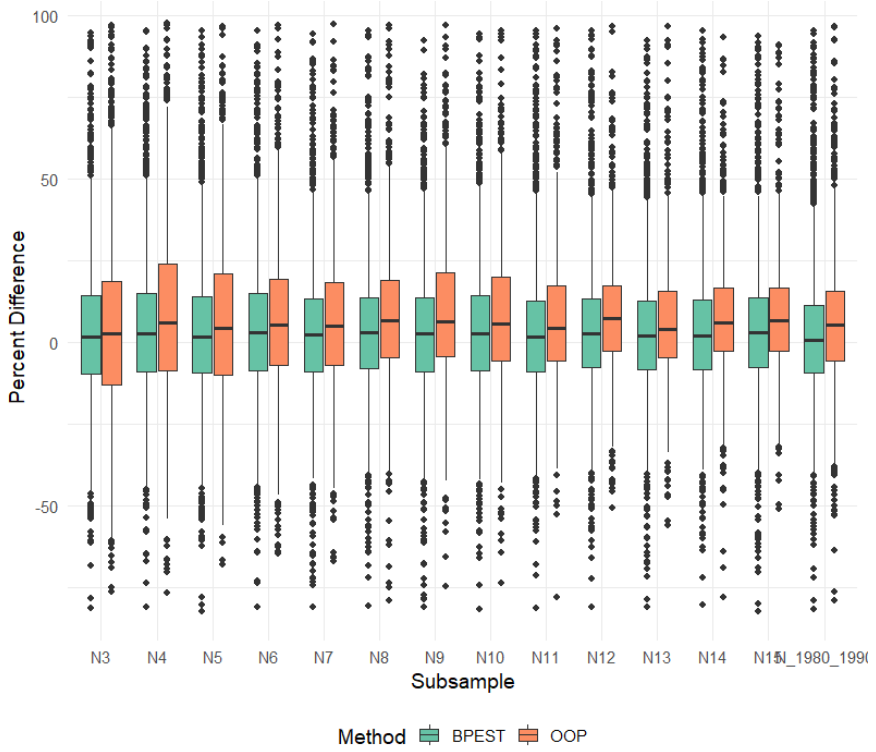


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Effects of Length and Timing of Record

- Length of record had little effect on model fit following record extension
- Record extension using more recent flow data (1980-1990) tended to outperform use of older records at all exceedance probabilities

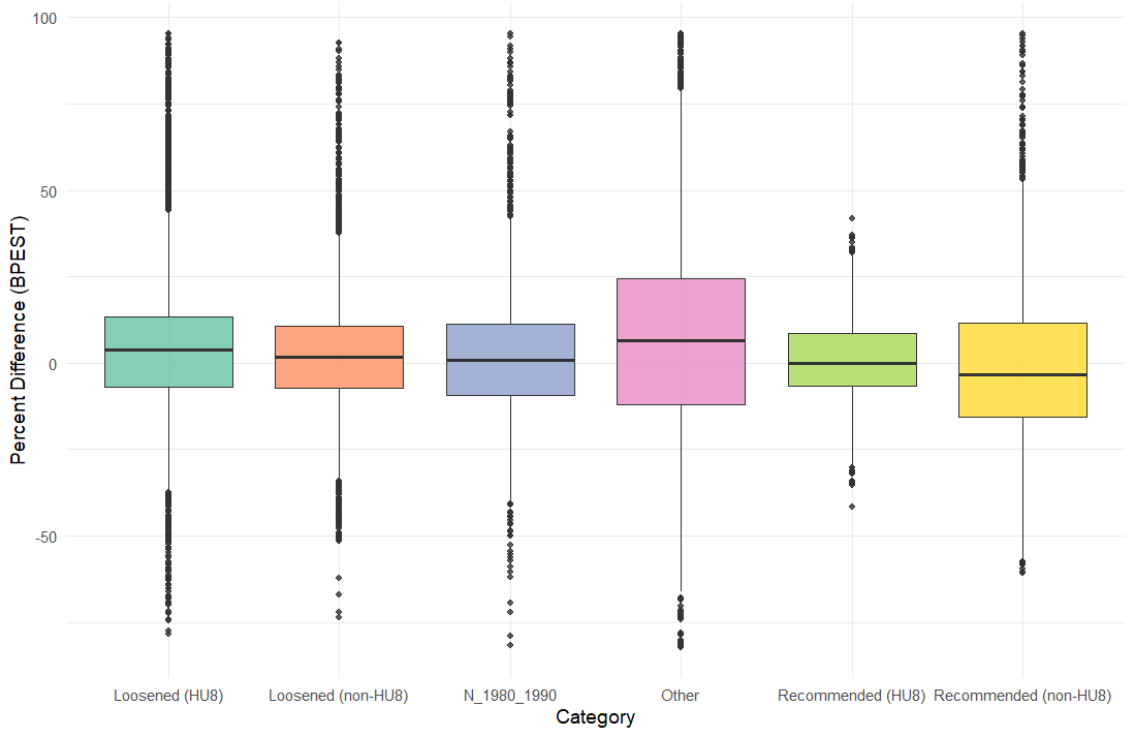
Exceedance probability	Mean Percent Error Subsamples	Mean Percent Error 1980-1990	p-value
80%	42.4	33.5	0.02*
50%	56.7	43.9	0.01*
20%	92.6	78.0	0.02*



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Developing Guidance

- Following recommended guidance (correlation >= 0.9 & DAR 1 – 2) and considering regional hydrology (i.e., HUC8) produced best results (small sample size of N = 4)
- Loosened guidance (correlation >= 0.8 & DAR 0.5 – 4) produced slightly expanded range of error in interquartile range
    - Greater extremes in overall range of error
- As few as three years of overlapping record can be used to develop regressions to extend records
- Avoid pairings with large differences in mean annual discharge and coefficient of variation



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Discussion Questions

- Does the value of additional station-level streamflow data outweigh the risks of uncertainty when extending streamflow records?
- Are you aware of any guidance to inform the pairing of target and reference stations?

Surface Water-Groundwater Interactions

Cortney Cameron

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Introduction & Overview

⚠️ Challenges of streamflow depletion

- Estimating magnitude and timing is complex
- Increasingly important for water management

📌 Current approach in WARS

🔗 Importance for SWIMS

💡 Possible approaches

🛠️ Proof of concept

❓ Specific questions

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Historical Context: Current Approach in WARS

- Water rights with Hydraulic Connection (HC) and Potential for Substantial Interference (PSI) with surface water included in WARS assuming full capture (consumptive use) at time of withdrawal
  - Prior to 1988 (OAR 690-009), groundwater rights were not evaluated for HC or PSI with surface water sources
- Other approaches used for Scenic Waterways and for certain basin programs

Relevance to SWIMS

💻 Natural streamflow model development

- Addbacks to gages for depletion based on actual pumping during the base period

⚖️ Water availability calculations

- Debit (modeled) natural streamflow for depletion based on rate/duty and season of use

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SWIMS: Natural Streamflow Model

❓ Current recommendation is to exclude from natural flow model development any gages with significant streamflow depletion

- Data limitations on actual pumping over time during the base period
- Error introduced to flow would likely outweigh benefits of additional gages

🔎 Team will be working with staff to identify gages to exclude

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SWIMS: Water Availability Calculations

📌 Need approach that is reasonably accurate and scalable to thousands of wells statewide addressing:

- Magnitude and timing of depletion
- Which stream(s) impacted
- Multiple wells

💡 Possible approaches

- Simplified approach
- Analytical methods
- ~~Statistical methods – emerging, difficult to assign causation~~
- ~~Numerical models – available for very few basins in Oregon~~

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Simplified Approach

📏 Identify which wells to include

- PSI (Potential for Substantial Interference)
- Hydraulic Connection (HC)
- Distance-based or other approaches
- Conservative (all wells)

💯 Assume (eventual) 100% capture, less return flows

📅 Decide how to distribute depletion across the year

↩️ Decide how to handle return flow

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Analytical Methods

🏛️ Widely used in the literature and across states/agencies to calculate streamflow depletion

🔀 Designed for one well-stream case but methods to extensible

- Zipper et al. (2019) [*WRR*]: analytical depletion functions (ADFs)
  - Analytical method – e.g., Glover and Balmer (1954), Hunt (1999)
  - Proximity criteria (which streams) – e.g., specified radius, basin
  - Apportionment criteria (how to split to streams) – e.g., inverse distance, web

🛠️ Appropriateness of different analytical methods highly dependent on local hydrogeology and data availability

↩️ Decide how to handle return flow

Data Availability for ADFs

📜 **Water rights and reviews** – location, rate, duty, season; work with Groundwater staff to scrape/digitize information, such as aquifers pumped and confined/unconfined classifications

🚰 **Pump tests** – work with Groundwater staff to leverage database

🔢 **MODFLOW models** – compile information from existing models for Oregon (Klamath, Harney, Deschutes, Willamette) and nationally (National Groundwater Model)

🗺️ **Geologic maps** – Oregon Geologic Data Compilation (ODOGAMI), National Geologic Map Database (USGS), basin reports

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Analytical Methods: Proof of Concept

VS Compare depletion estimates from numerical model and analytical methods using an Oregon model

🎯 Goals of initial test

- Evaluate scalability of an analytical workflow
  - Not a proposal to use MODFLOW directly in SWIMS
- High-level comparison of depletion estimates among methods
  - What "errors" can we expect (magnitude, bias, spatial)?
  - Do more complex methods improve accuracy?
- If approach seems useful, will extend into a formal documented analysis

🛠️ Methods in brief

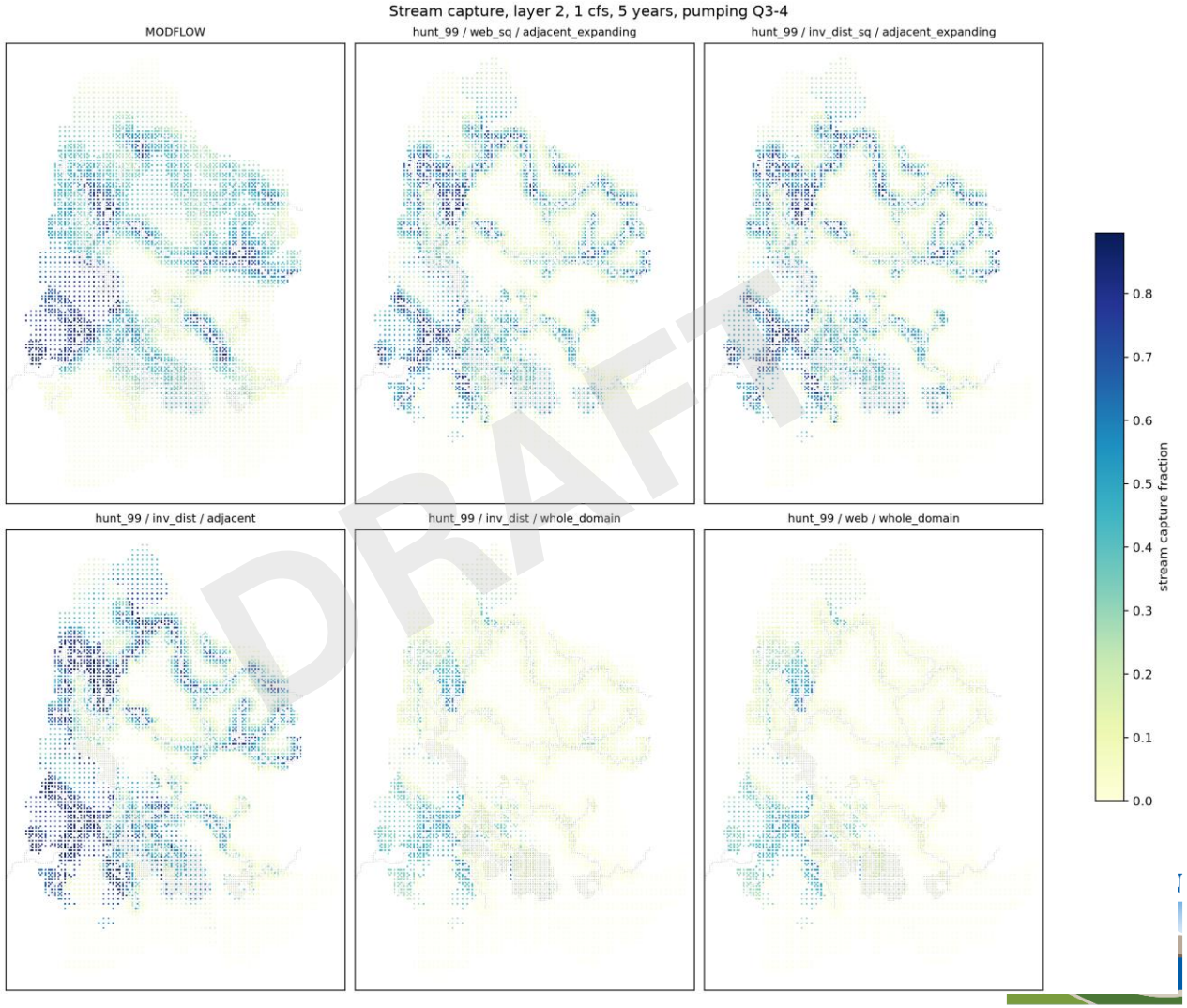
- Gannett et al. (2012) for Upper Klamath Basin
  - Setup: 5 years pumping from April to September 24 hours at 1 cfs*
- Analytical depletion functions (analytical, proximity, apportionment)
  - Setup: ingest stream locations, transmissivity, etc. from MODFLOW

Example Result: Individual Well Capture

Shown: Hunt (1999) with different proximity and apportionment approaches

Analytical methods average somewhat conservative in initial tests but wide variability

“Best” method depends on performance metric selected (mean absolute error, bias, etc.)

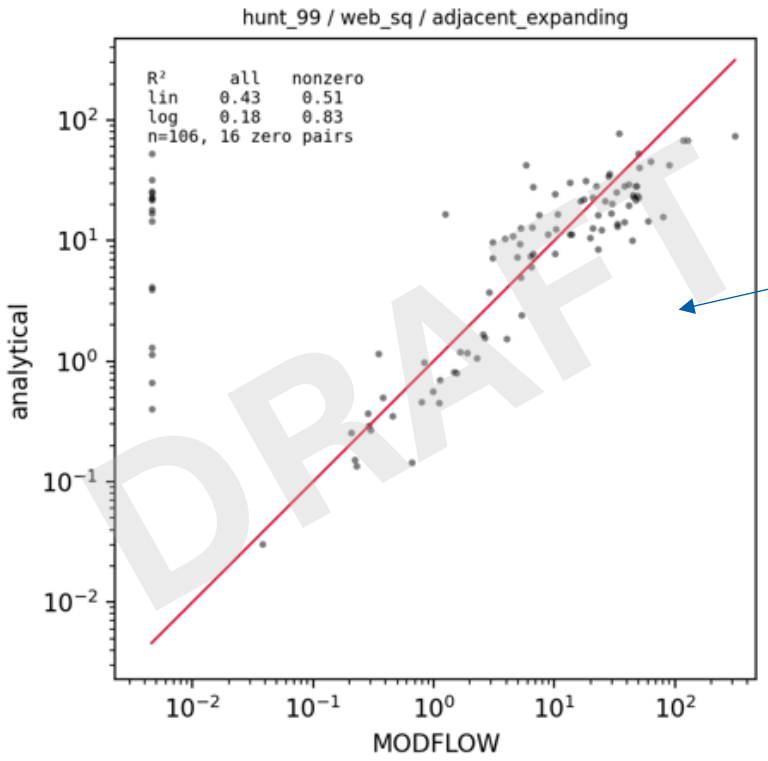


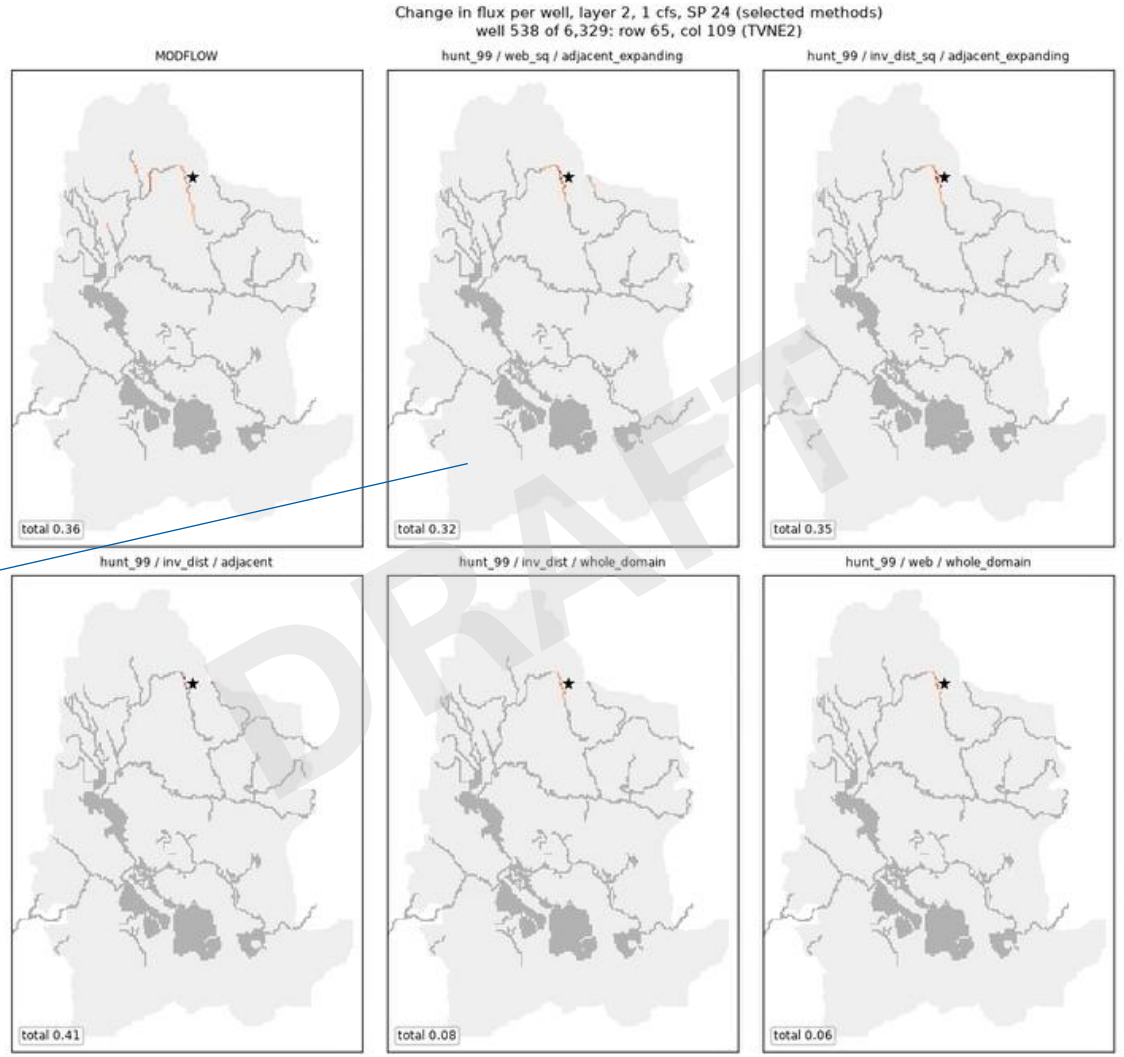
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Example Result: Reaches Affected by Well

Geographic unit of interest is surface water availability basin

Initial results promising at HUC-12 level





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Initial Thoughts

📐 Initial tests suggest analytical depletion function approach promising as scalable but with important limitations

- Worth continuing investigation more formally?
- Worth extending to other Oregon MODFLOW models?

⚠️ Results depend on:

- Conceptual model fit
- Data availability (for this test, able to conveniently ingest parameters and compare to numerical estimates)
- Setup (e.g., years and rate of pumping)
- Metric(s) emphasized (e.g., mean absolute error, bias, NSE)

Discussion Questions

Analytical (or simple) methods
- Pros/cons of different methods
- Different for different regions?

Wells to include
- PSI? HC? Distance? All?
- Pros/cons of different methods

Return flows
- Timing of returns vs. timing of depletion
- Consumptive use similar to surface water?
- Note: Future meeting topic

Gage addbacks
- Do risks outweigh benefits for natural flow model?

Hydrogeologic and other data
- What is available?
- Best sources?

Multiple wells
- Where is superposition not reasonable?

Proximity & multi-stream
- Inverse distance? Web?

Rate and timing
- Rate, duty, season of use?

Additional research
- What else should we consider to make defensible decisions?

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Thank you!

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