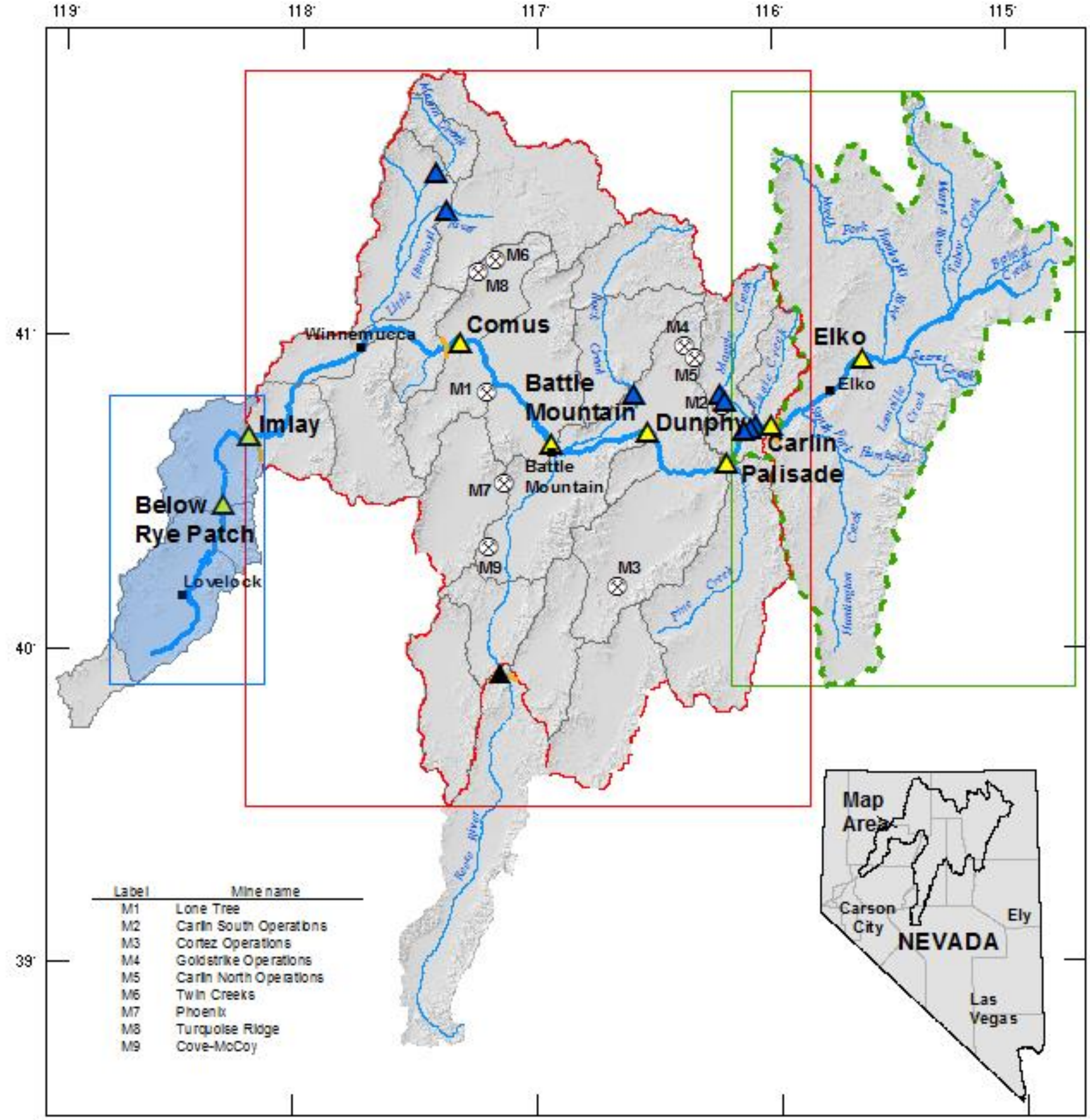
HUMBOLDT RIVER BASIN MODELING UPDATE

Lovelock & Winnemucca
January 14, 2020
Elko
January 15, 2020

DEPARTMENT OF CONSERVATION & NATURAL RESOURCES



Humboldt River Basin Modeling Update - Outline

- Water supply forecast
- Water use and overview of modeling effort
- Model output and Demonstrative Tools to Implement and Apply Results
  - Upper Basin Model
  - Middle Basin Model
  - Lower Basin Model
- Q & A

Water Supply Forecast

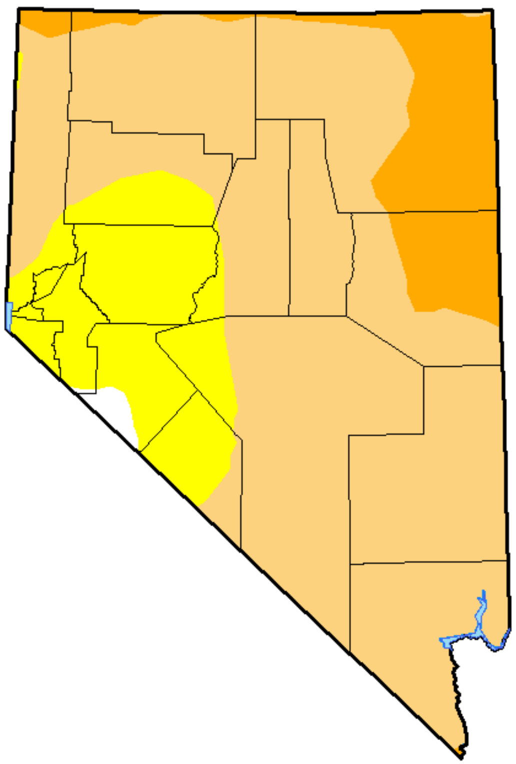
NDWR

January 1, 2019

January 7, 2020

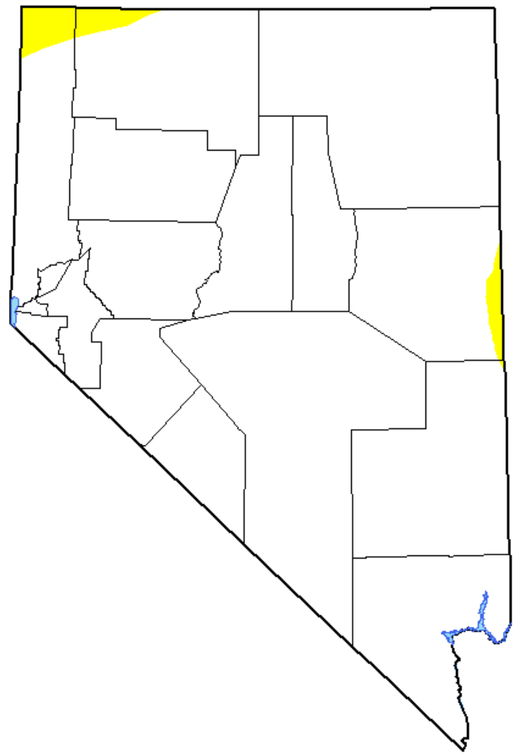
U.S. Drought Monitor

Nevada



U.S. Drought Monitor

Nevada



January 7, 2020

(Released Thursday, Jan. 9, 2020)

Valid 7 a.m. EST

Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	98.08	1.92	0.00	0.00	0.00	0.00
Last Week *12-31-2019*	98.08	1.92	0.00	0.00	0.00	0.00
3 Months Ago *10-08-2019*	80.62	19.38	4.19	0.00	0.00	0.00
Start of Calendar Year *12-31-2019*	98.08	1.92	0.00	0.00	0.00	0.00
Start of Water Year *10-01-2019*	88.81	11.19	4.19	0.00	0.00	0.00
One Year Ago *01-08-2019*	0.71	99.29	81.09	12.84	0.00	0.00

Intensity:

- None
- D0 Abnormally Dry
- D1 Moderate Drought
- D2 Severe Drought
- D3 Extreme Drought
- D4 Exceptional Drought

The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. For more information on the Drought Monitor, go to https://droughtmonitor.unl.edu/About.aspx

Author:

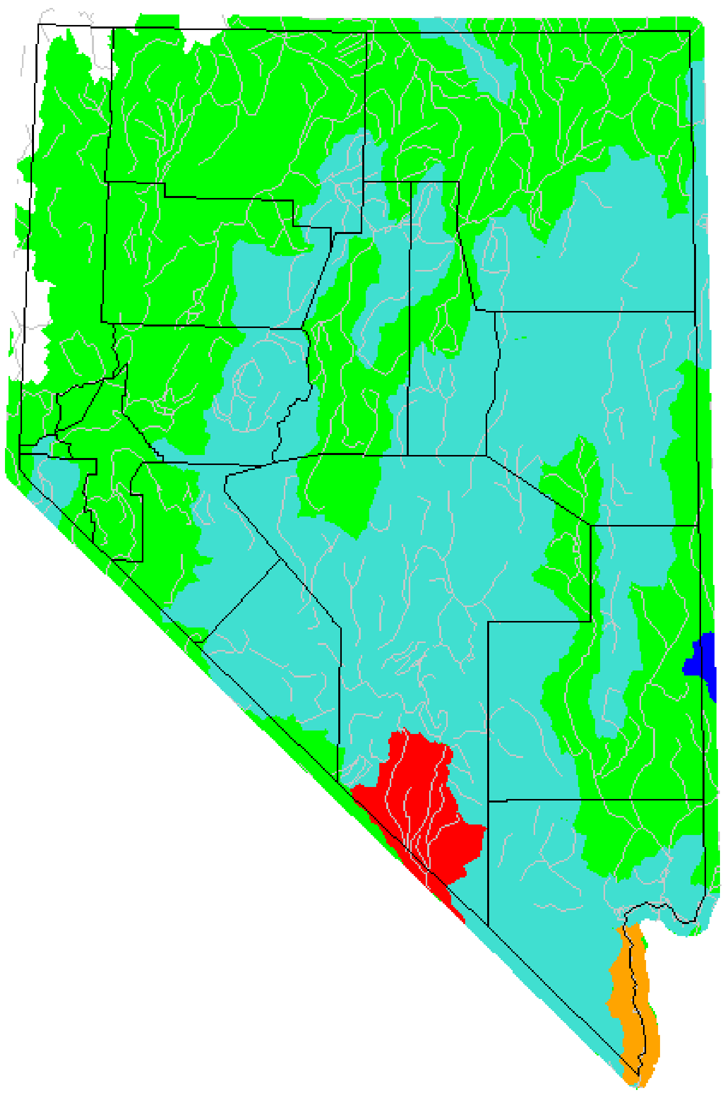
Curtis Riganti
National Drought Mitigation Center

droughtmonitor.unl.edu

Map of 7-day average streamflow compared to historical streamflow for the day of the year (Nevada)

Nevada ▾ or Water-Resources Regions ▾ All Days

Sunday, January 12, 2020



Explanation - Percentile classes							
Low	<10	10-24	25-75	76-90	>90	High	No Data
	Much below normal	Below normal	Normal	Above normal	Much above normal		

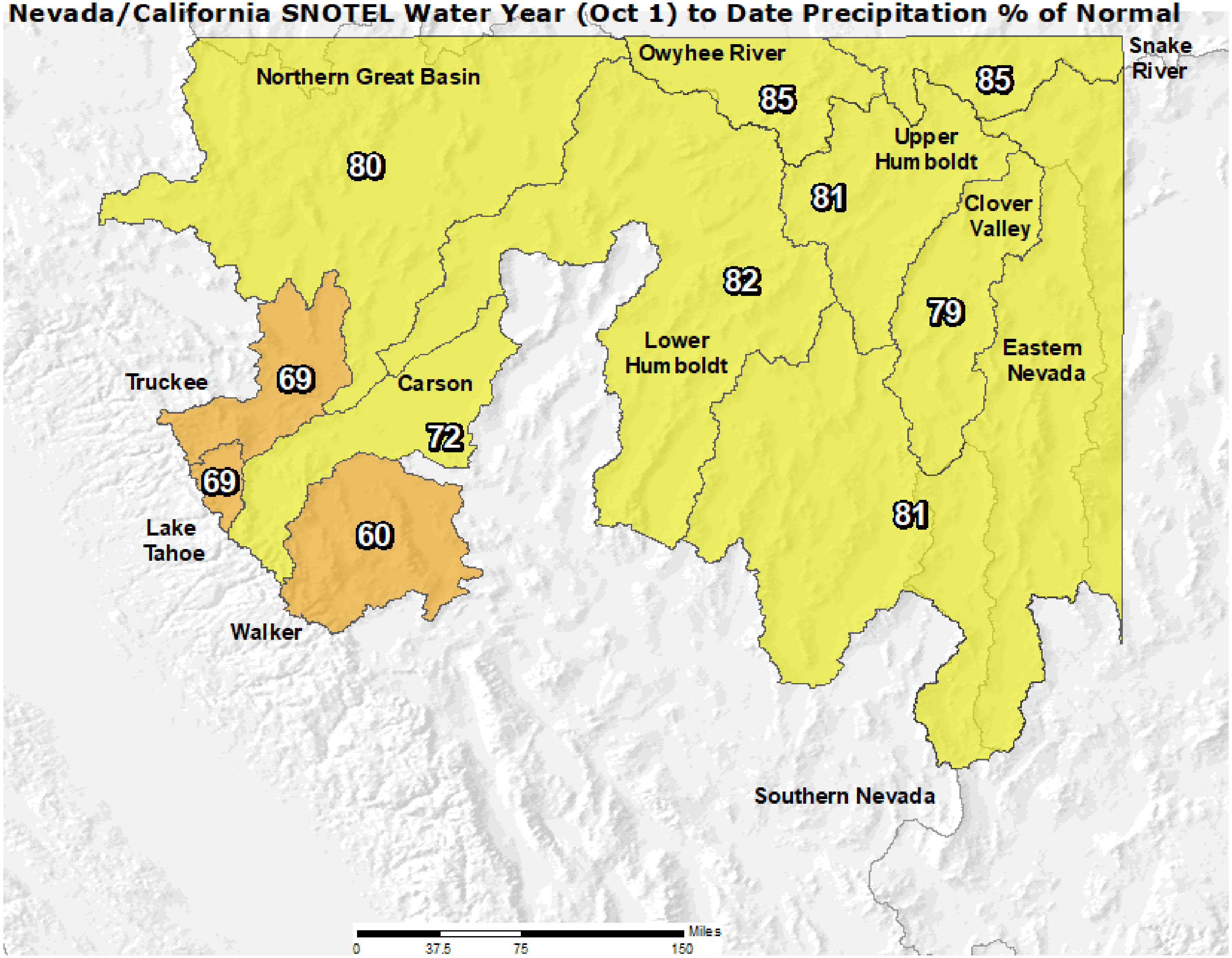
Summary of the percentage of streamgages in each class

Region:	Nevada
Date:	20200113
Low:	0 %
Much below normal:	6 %
Below normal:	15 %
Normal:	54 %
Above normal:	17 %
Much above normal:	6 %
High:	2 %
No. of streamgages:	52

Source: USGS

Nevada/California SNOTEL Water Year (Oct 1) to Date Precipitation % of Normal

Jan 13, 2020



Water Year (Oct 1) to Date Precipitation Basin-wide Percent of 1981-2010 Average

- unavailable *
- <50%
- 50 - 69%
- 70 - 89%
- 90 - 109%
- 110 - 129%
- 130 - 149%
- >=150%

* *Data unavailable at time of posting or measurement is not representative at this time of year*

Provisional data subject to revision

USDA NRCS

The water year to date precipitation percent of normal represents the accumulated precipitation found at selected SNOTEL sites in or near the basin compared to the average value for those sites on this day. Data based on the first reading of the day (typically 00:00).

Prepared by:
USDA/NRCS National Water and Climate Center
Portland, Oregon
http://www.wcc.nrcs.usda.gov

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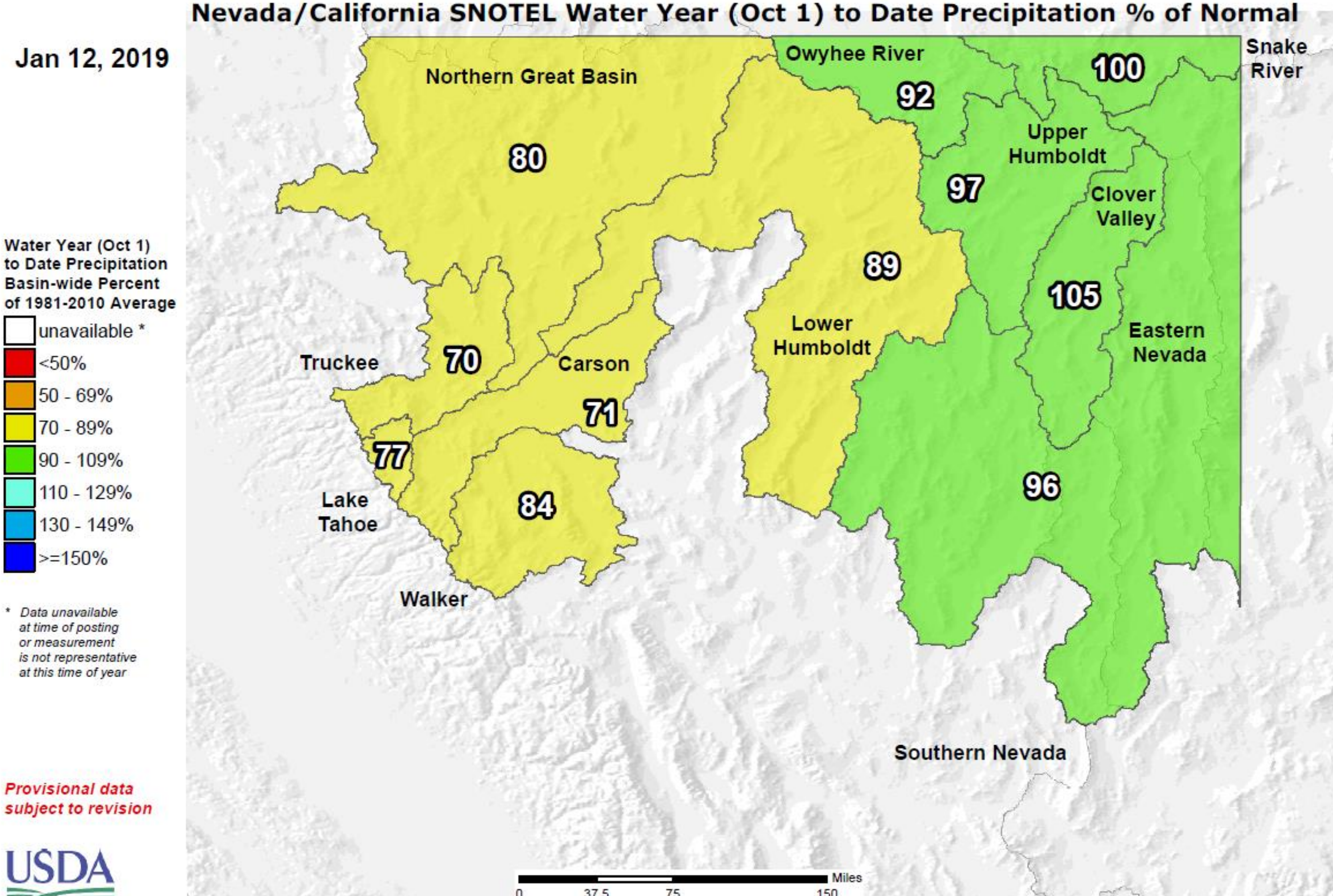
Jan 12, 2019



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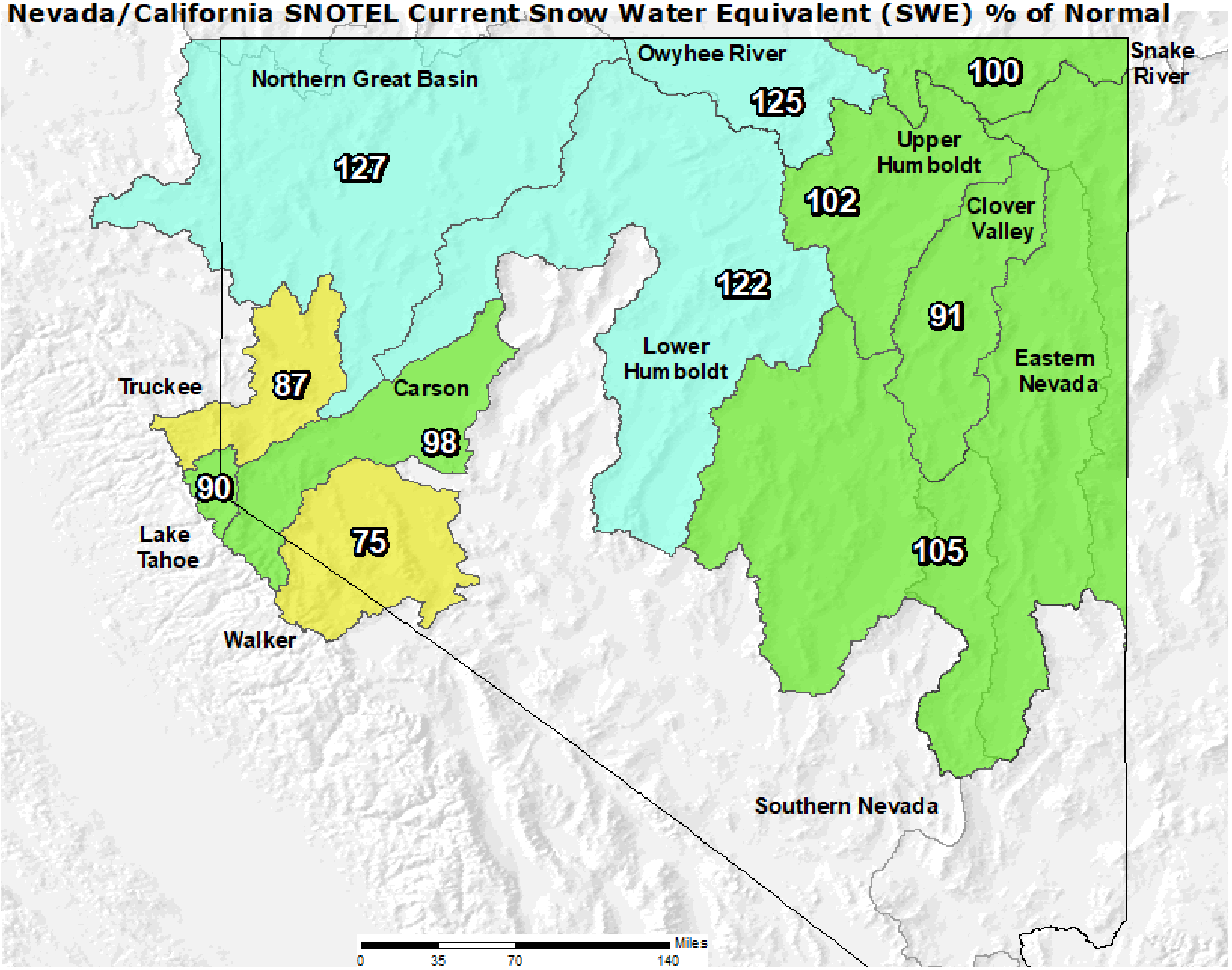
Nevada/California SNOTEL Current Snow Water Equivalent (SWE) % of Normal

Jan 13, 2020



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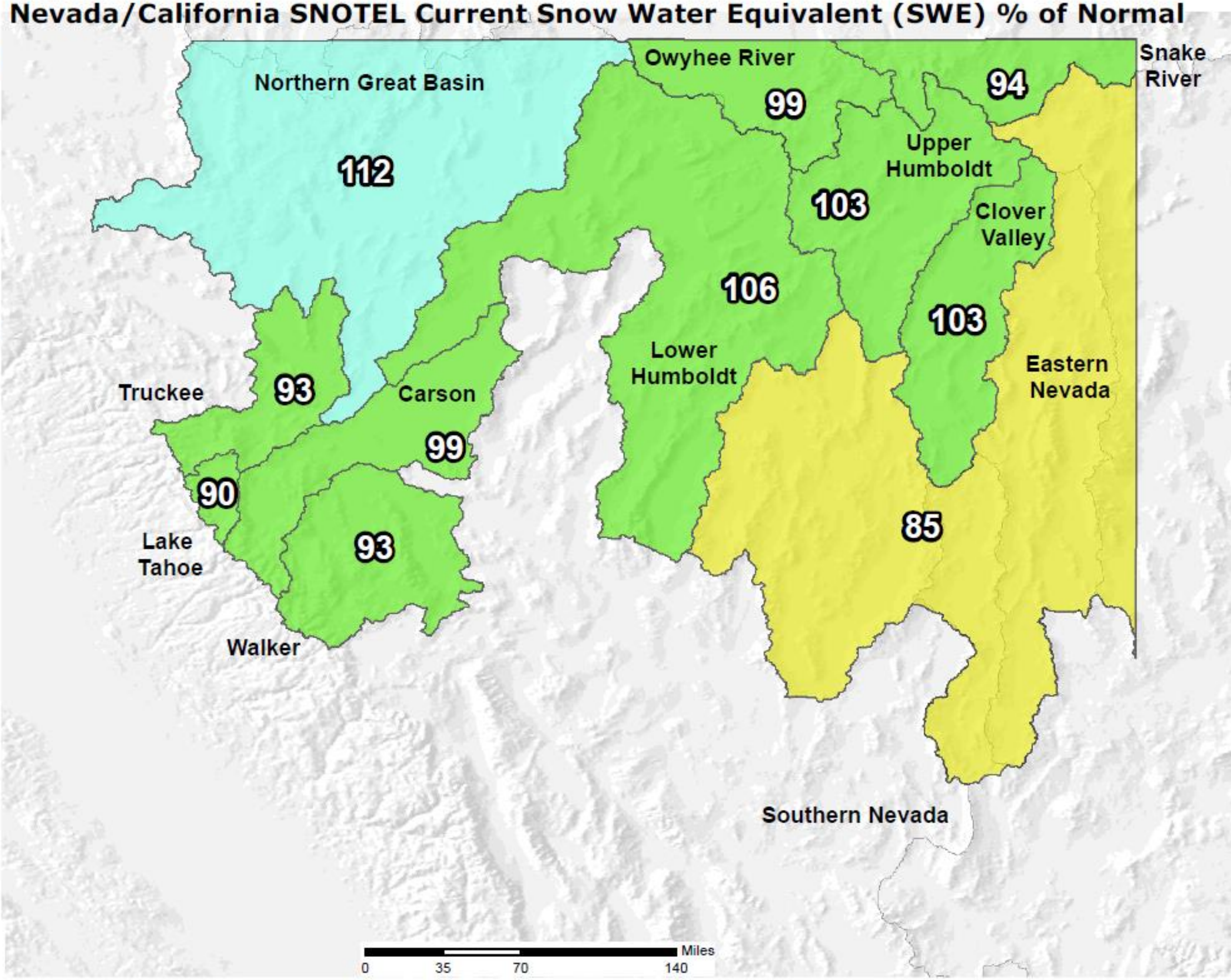

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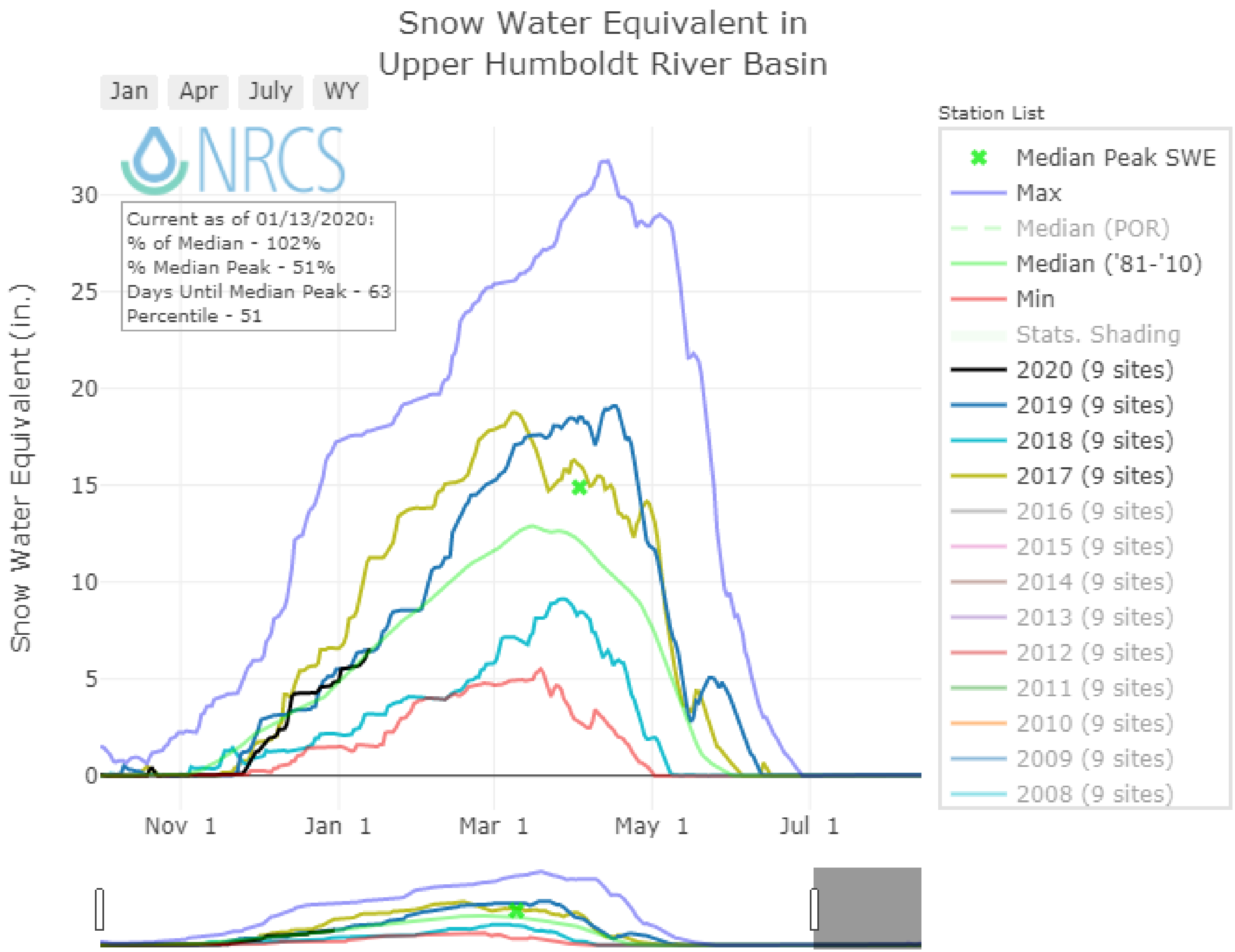
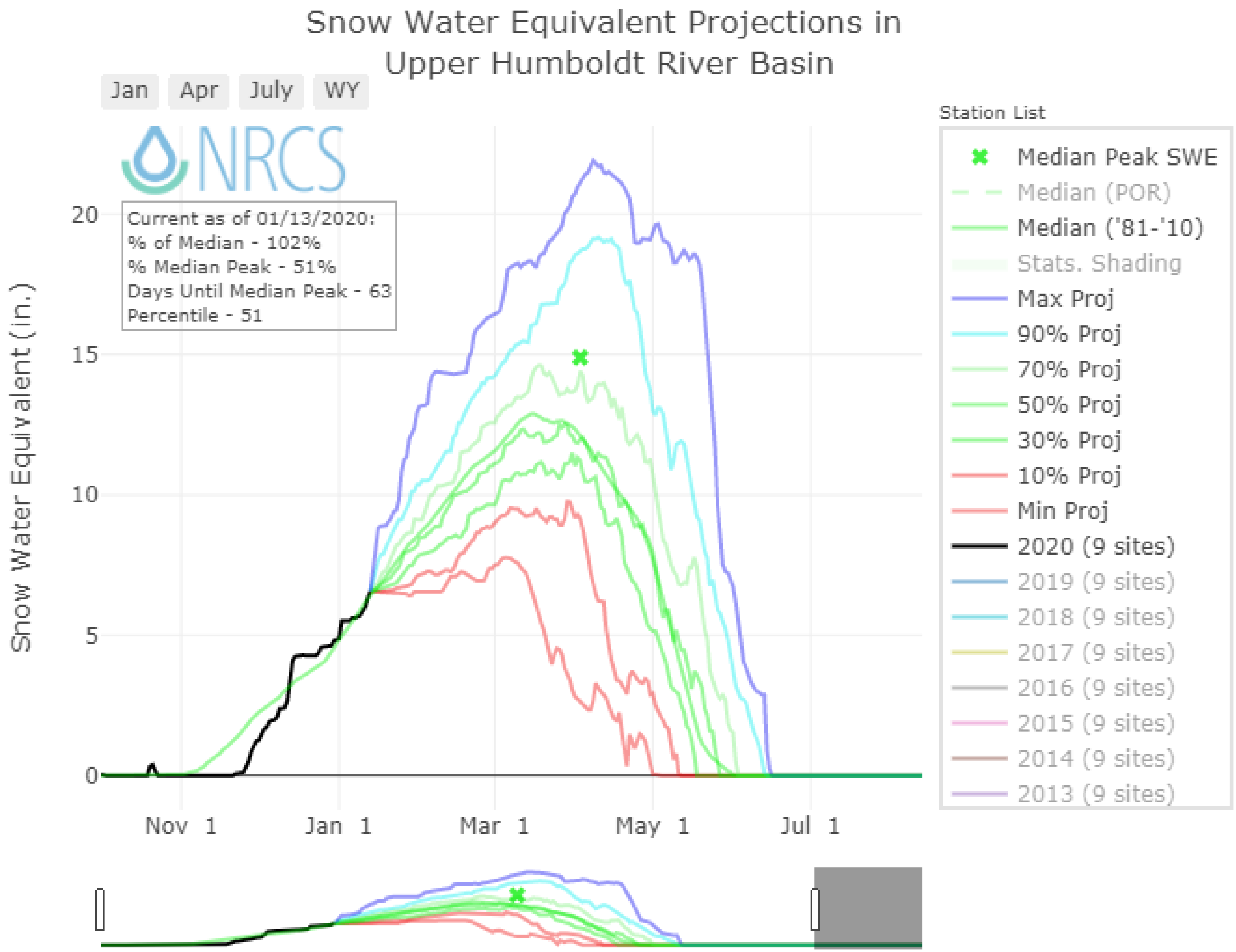


Statistical shading breaks at 10th, 30th, 50th, 70th, and 90th Percentiles.

For more information visit: 30 year normals calculation description.



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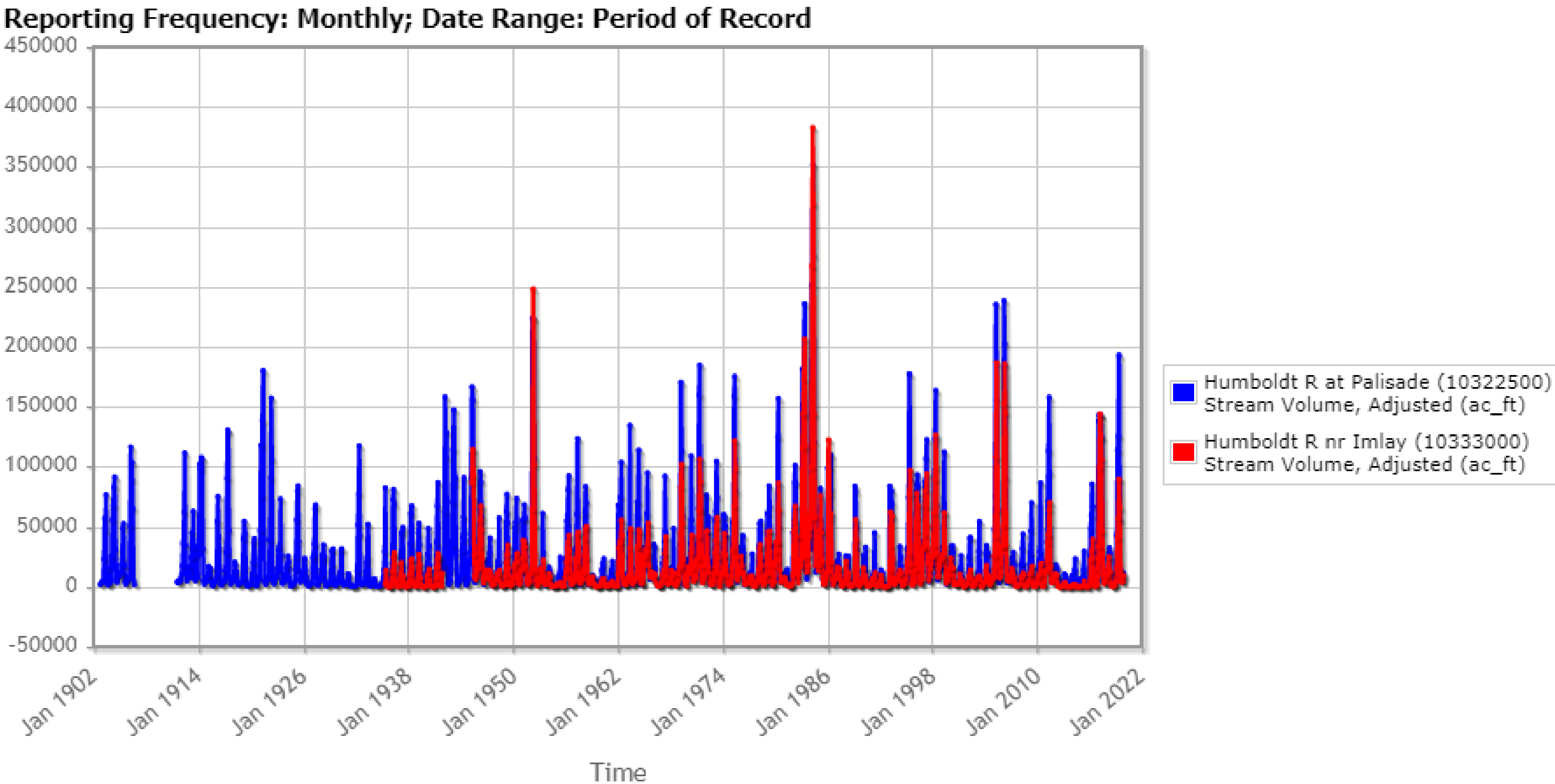
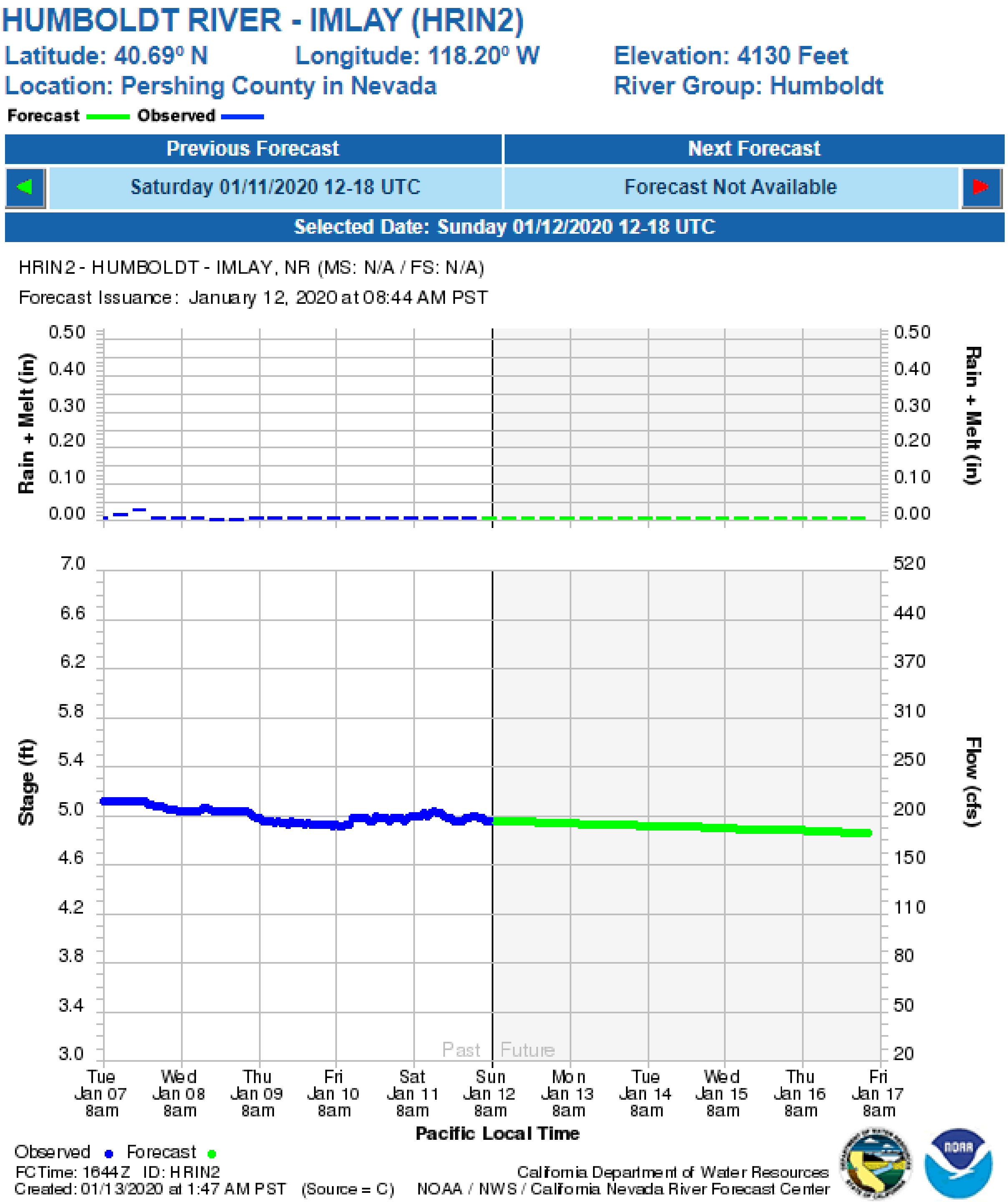
Humboldt River Flow, 1902-2019



Source: NRCS



JAN 12, 2019: Humboldt River Forecast (short-term)

Source: NOAA

JAN 1, 2020: Rye Patch Reservoir Storage

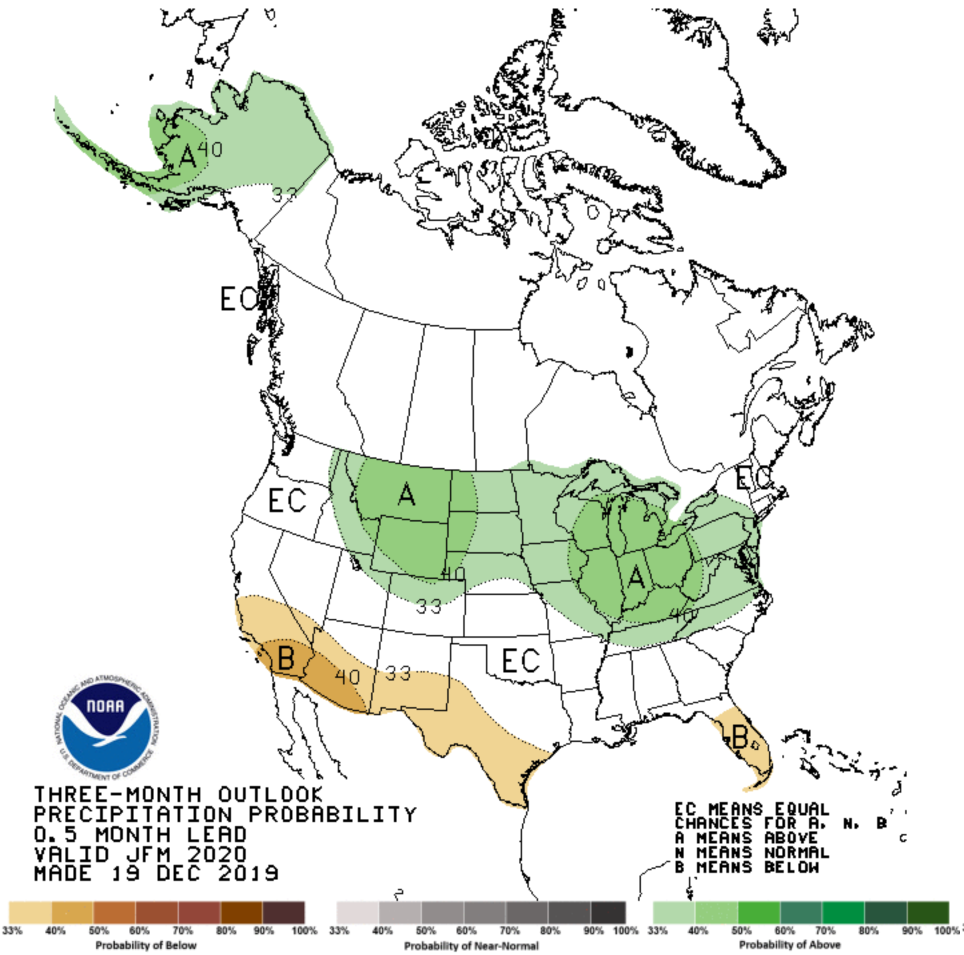
Rye Patch Reservoir			
Current		Last Year	Average
KAF	% of Capacity	KAF	KAF
175.4	90	80	69.2

Reservoir Storage Summary for the end of December 2019

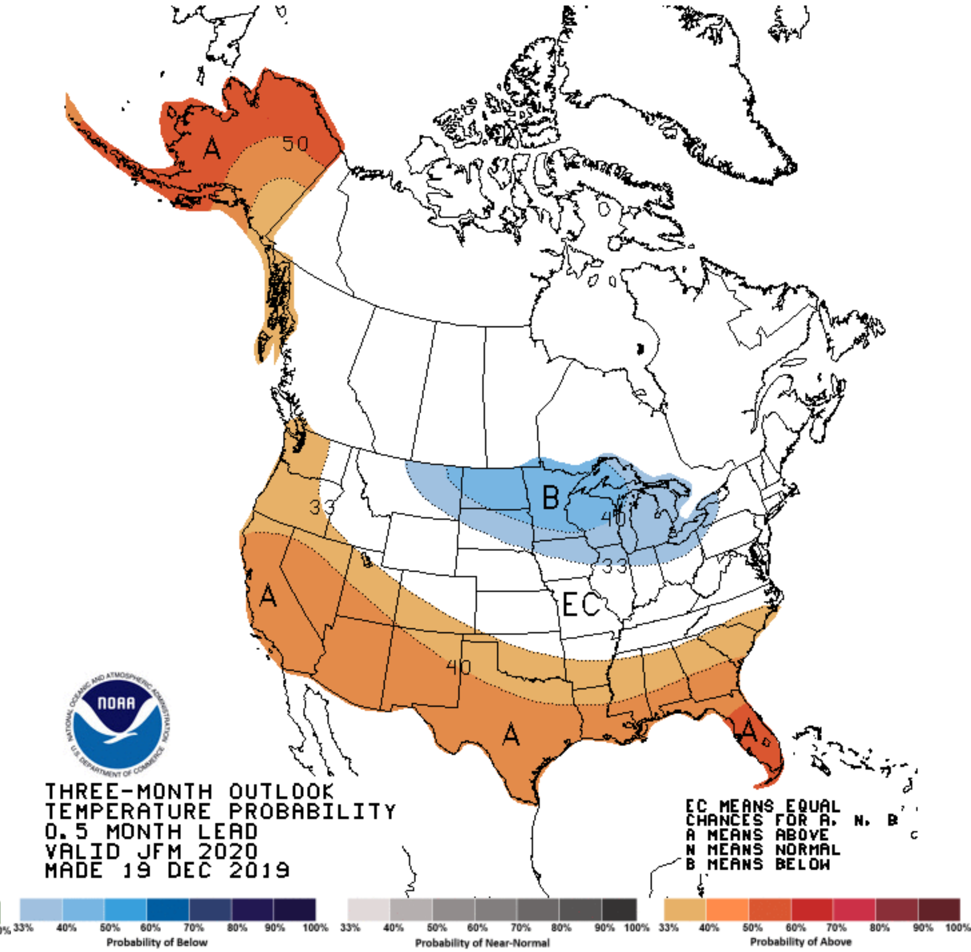
Source: NRCS

3 – Month Outlook

Precipitation



Temperature



Resources

National Weather Service

https://www.weather.gov

NRCS

https://www.wcc.nrcs.usda.gov/snow

Great Basin Weather and Climate Dashboard

https://gbdash.dri.edu

USGS WaterWatch

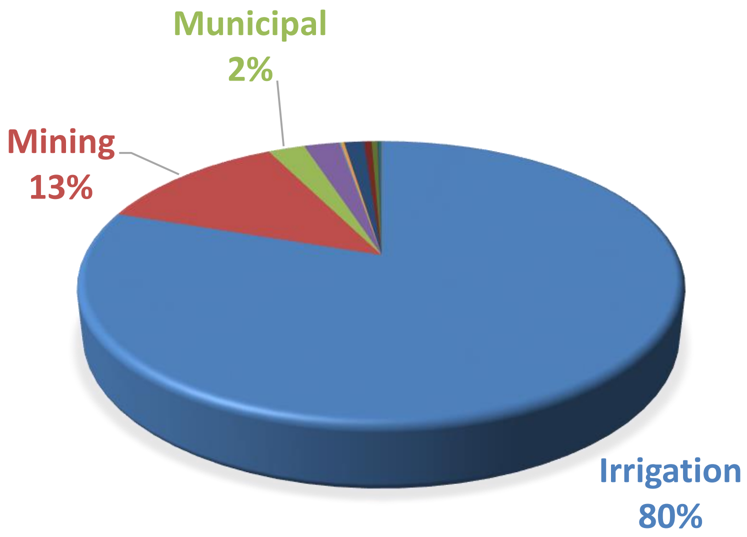
https://waterwatch.usgs.gov/index.php

Humboldt River Basin Water Use

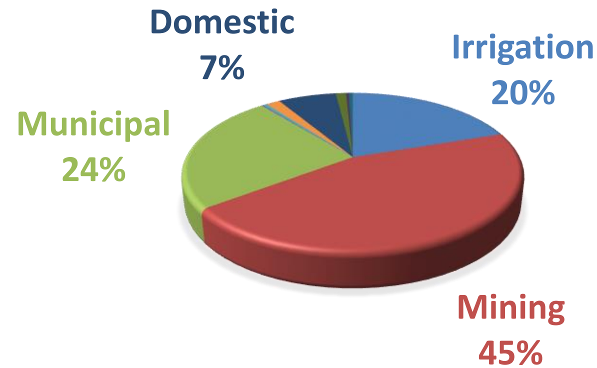
NDWR

Humboldt River Basin Preliminary 2018 Pumpage Inventory

MIDDLE & LOWER BASINS



UPPER BASIN: ABOVE PALISADE

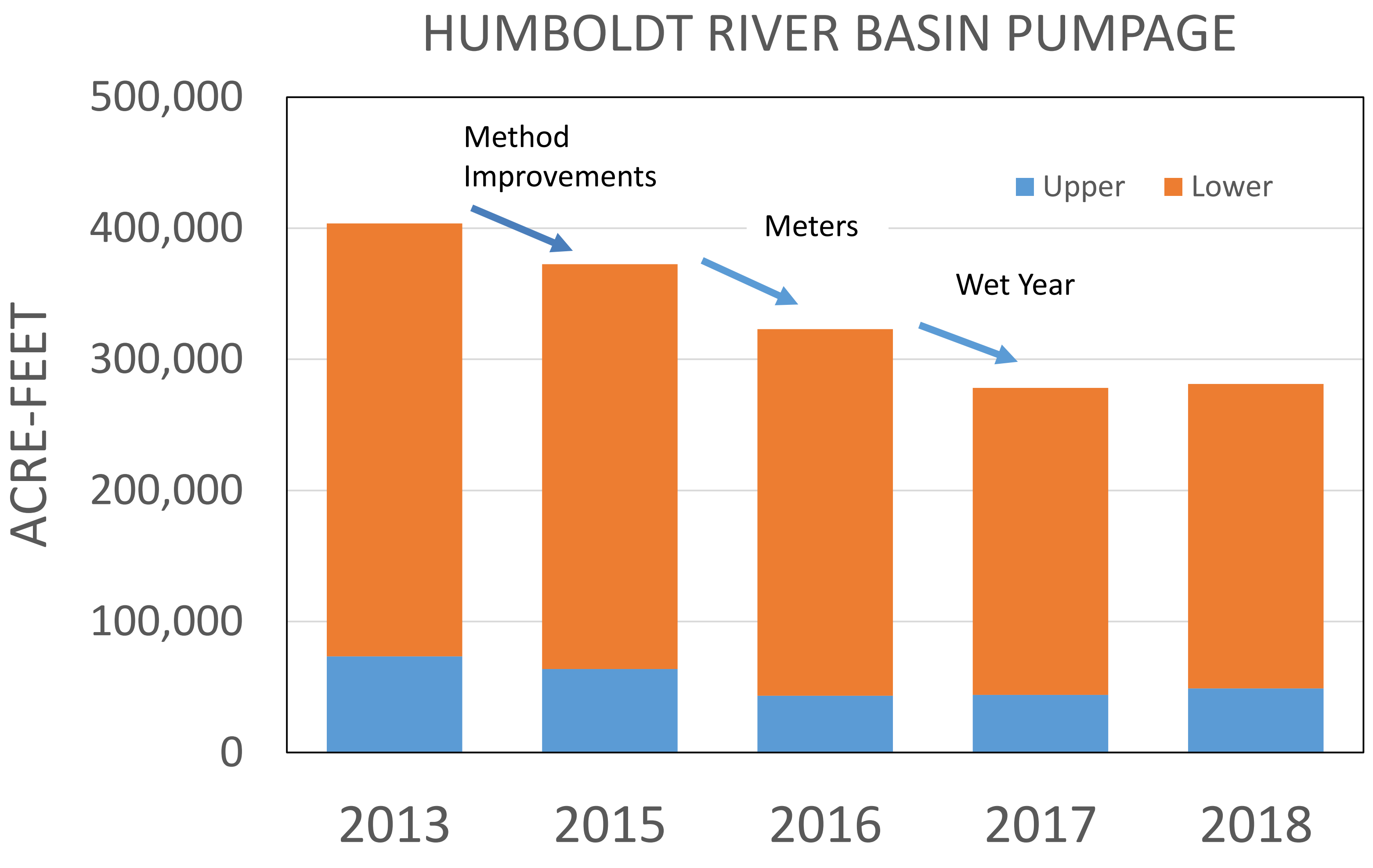


70% of mining use was groundwater discharged to Maggie Creek

~232,000 AF

~49,000 AF

Humboldt River Basin Groundwater Use

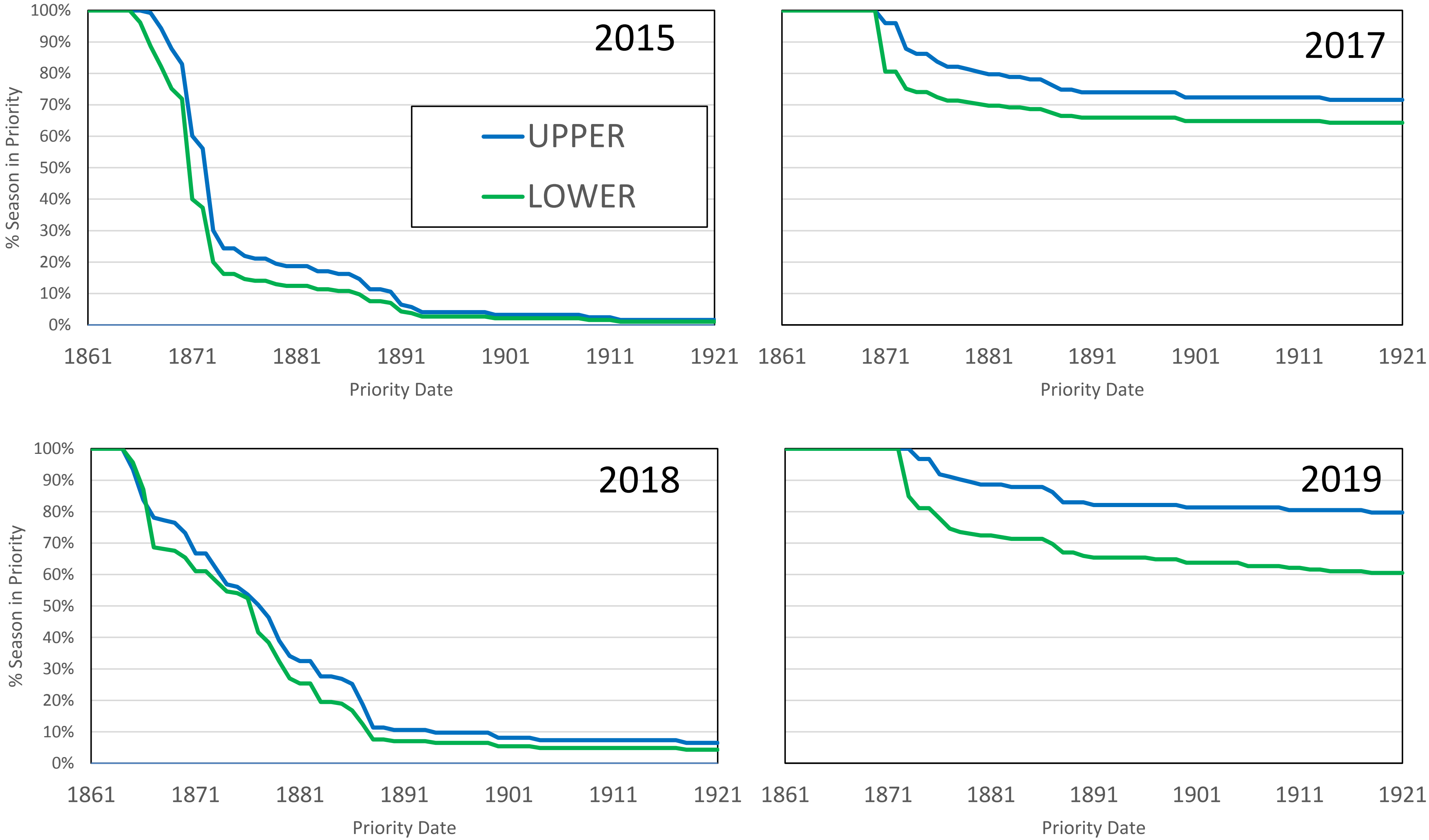


Humboldt River Decree Water Use

	Palisade Flow	Scheduled Delivery Above Palisade	Scheduled Delivery Below Palisade	Lovelock Delivery		Storage Outside Season	Unapp'd Water	Days Serving 1921
				Scheduled	Served			
	acre-ft	*acre-ft (Priority)*	*acre-ft (Priority)*	*acre-ft*	*acre-ft*	*acre-ft*	*acre-ft*	*#*
2018	112,565	112,631 (1879)	79,264 (1876)	38,281	62,470	25,445	0	8
2019	530,457	342,403 (1904)	177,167 (1888)	97,657	344,862	27,725	48,926	112

Pine Creek, Rock Creek, Willow Creek not included

Decree Water
Scheduled Delivery by Priority

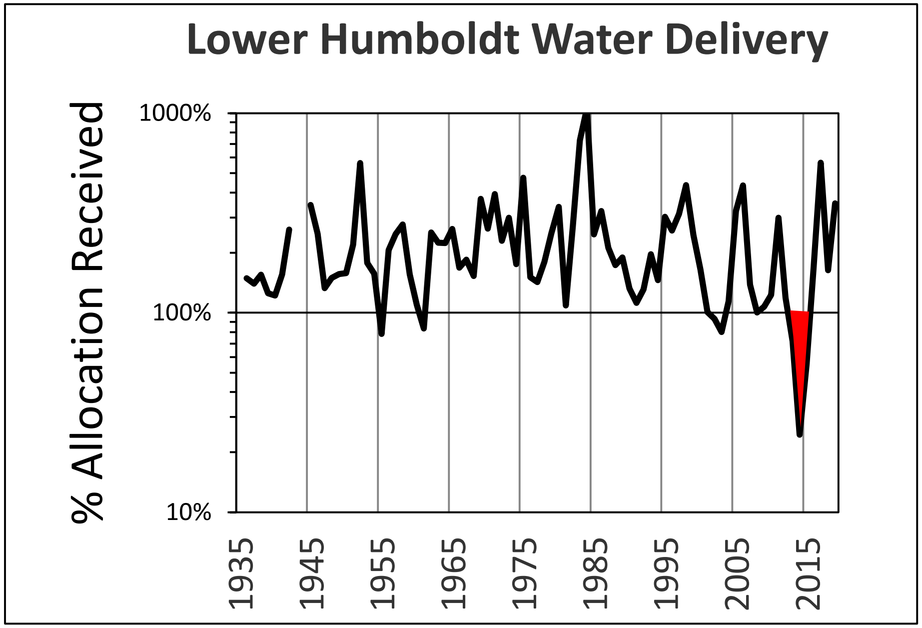


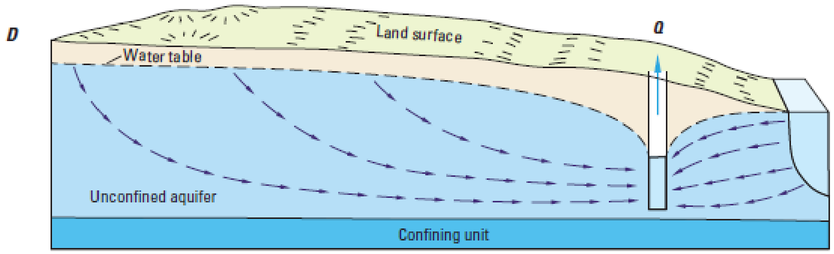
Capture Study Overview

NDWR

Problem

- Humboldt River is fully appropriated, surface water rights are senior to groundwater rights
- Downstream senior surface water right holders got very little water in 2013-2015 period and point to groundwater pumping as causing conflict
- Existing studies indicate that junior groundwater pumping can cause depletion of Humboldt River
- Extent of depletion caused by pumping and magnitude of conflict with senior surface water rights is not known…



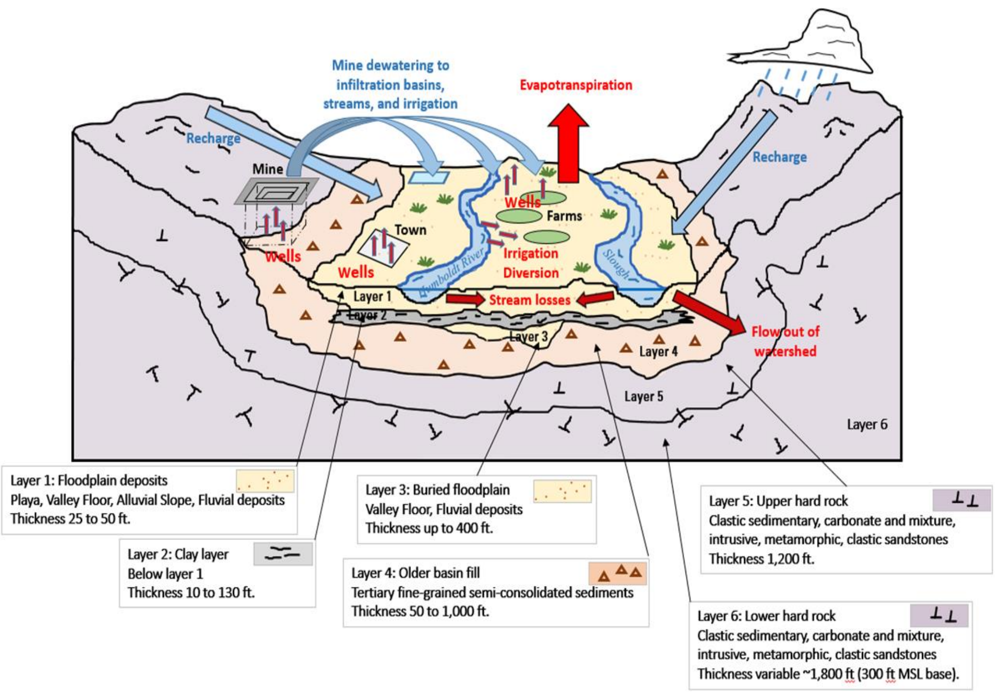


… NEED APPROPRIATE TOOLS AND SUPPORTING DATA TO MEASURE/MANAGE CONFLICT

Hydrogeologic Model of the Humboldt River Basin

- Simulate the natural system
- Use existing models and geology data
- Calibrate to historical flow records, water levels, etc.
- Quantify how much surface water is captured by pumping
- Develop capture map showing distribution of capture % (potential capture) for model area
- Use models as tool to manage problem

Humboldt River Conceptual Model

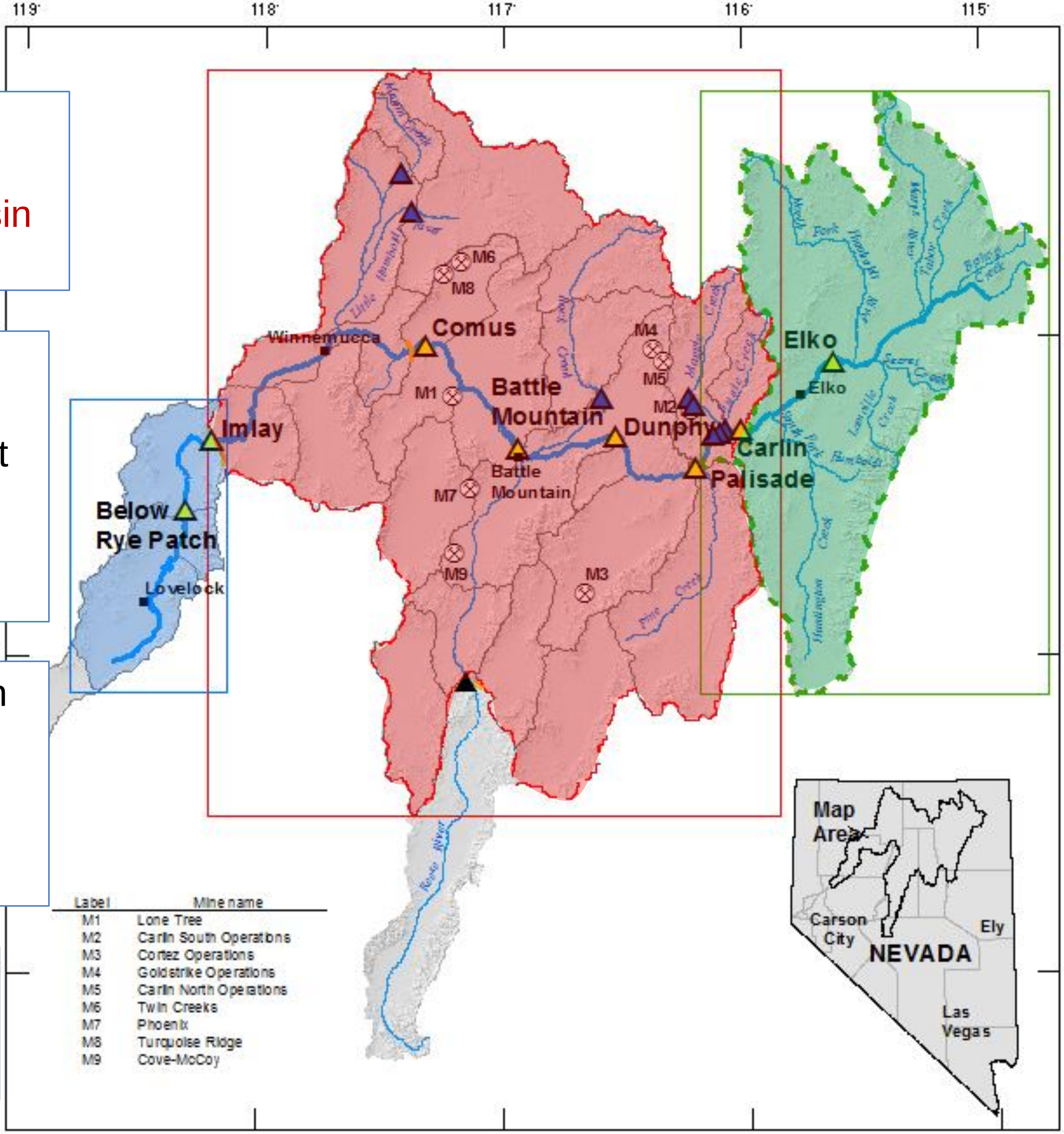


Model Areas
- DRI Upper Basin
- USGS Middle Basin
- Joint Lower Basin

DRI ET Study
- Covers all Basins
- Needed to support model water budgets and calibrate models

UNR Water Valuation Study
- Needed to Understand Economic Impact

FOCUS ON PRELIMINARY RESULTS



Stream Capture Concepts

USGS

Stream capture and capture maps:
Stakeholder meeting

Update 2020-01-14

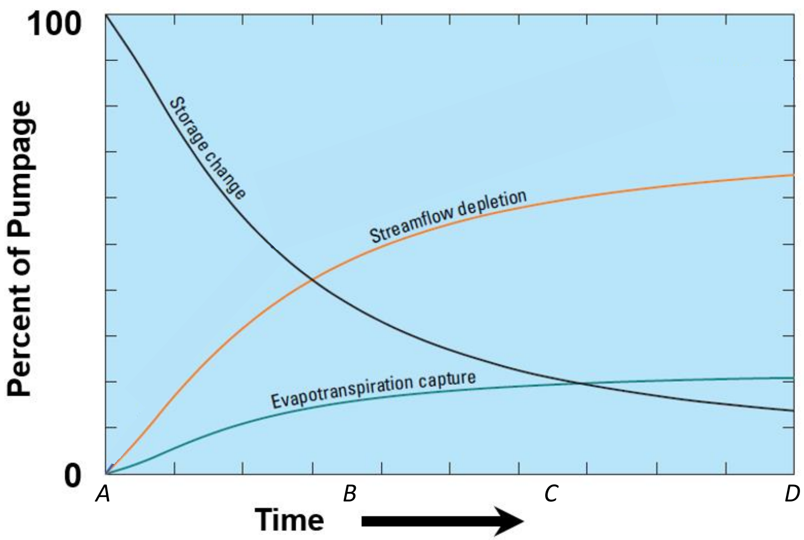
USGS NVWSC

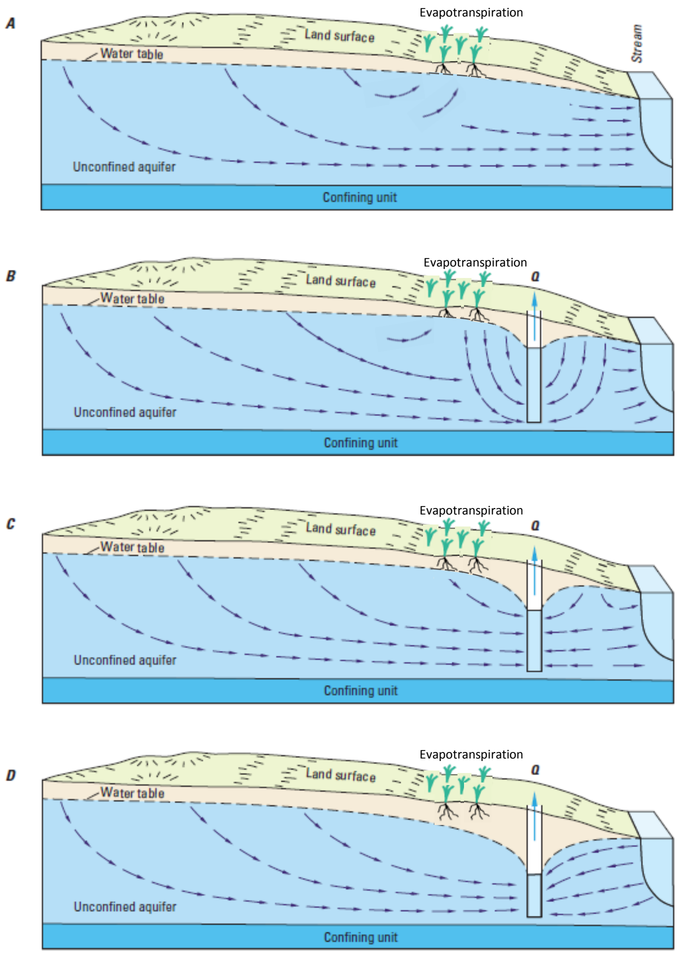
Sources of Water to Wells

Storage change

Streamflow capture

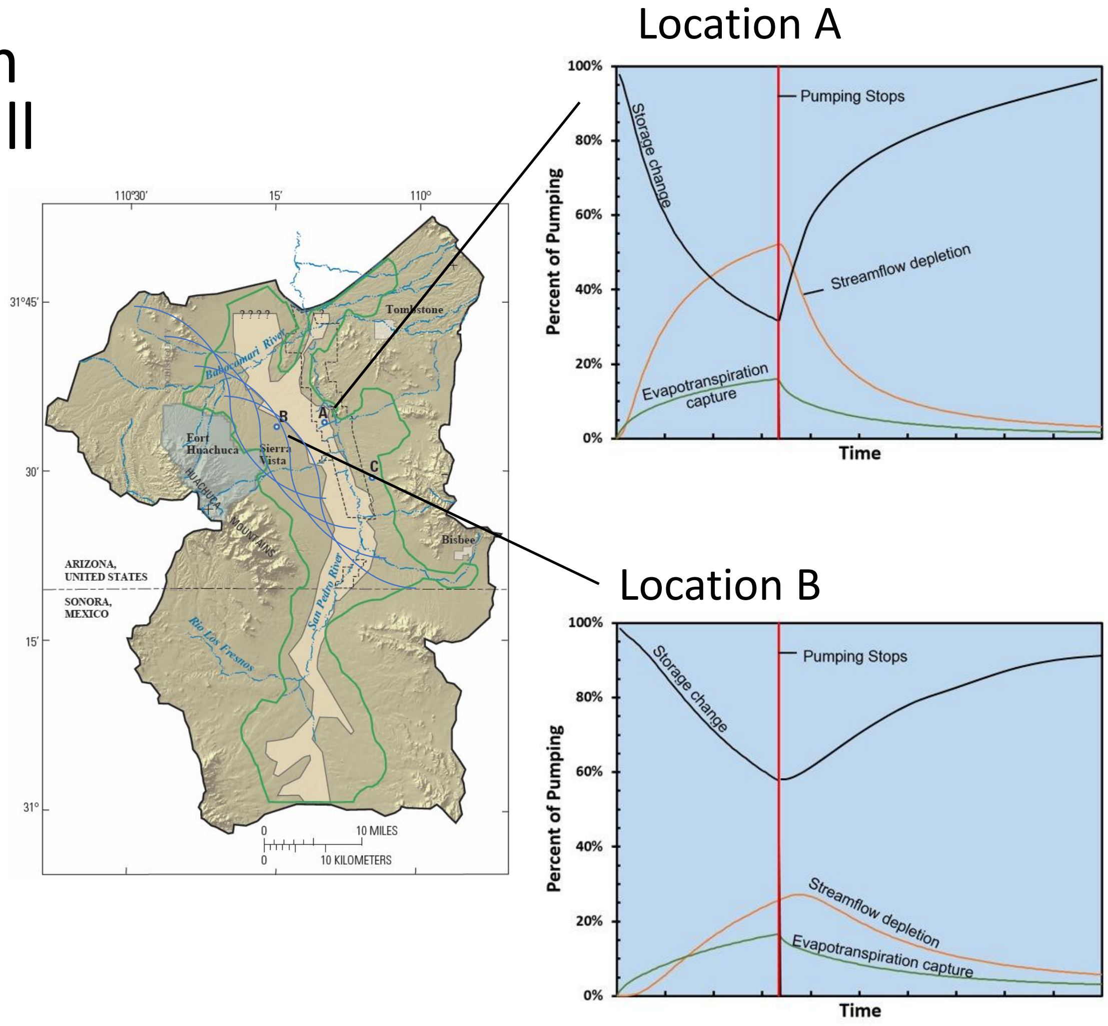
Evapotranspiration capture





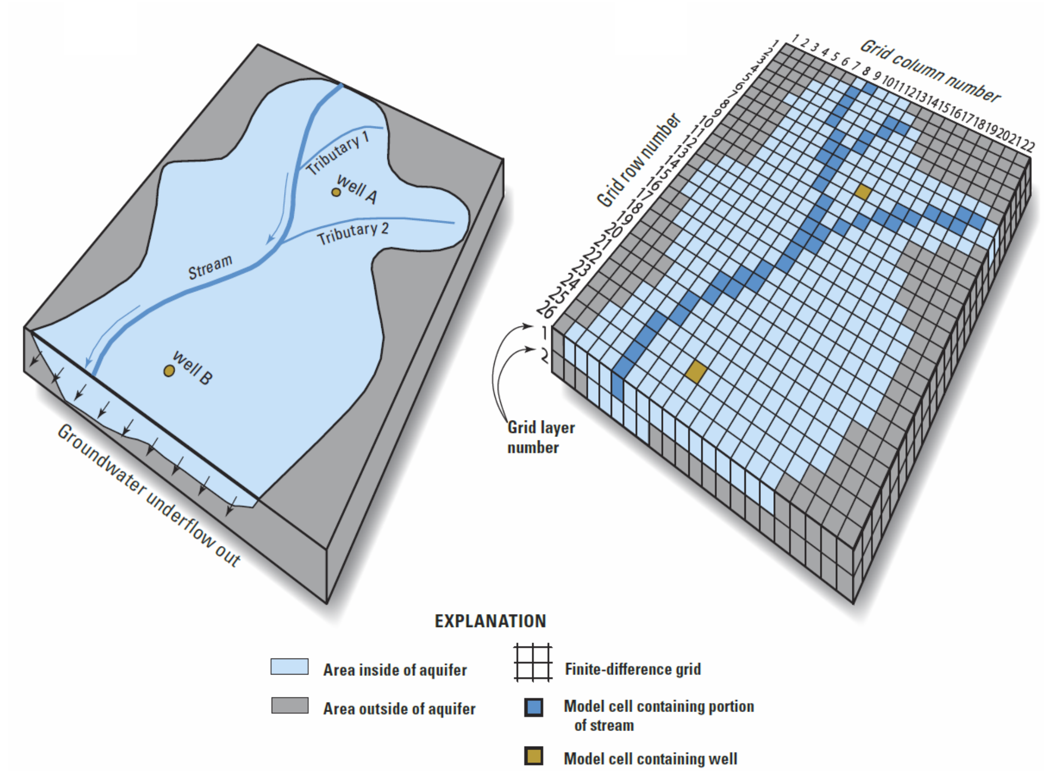
Stream Capture Analysis

An estimate of stream capture response at all locations of interest



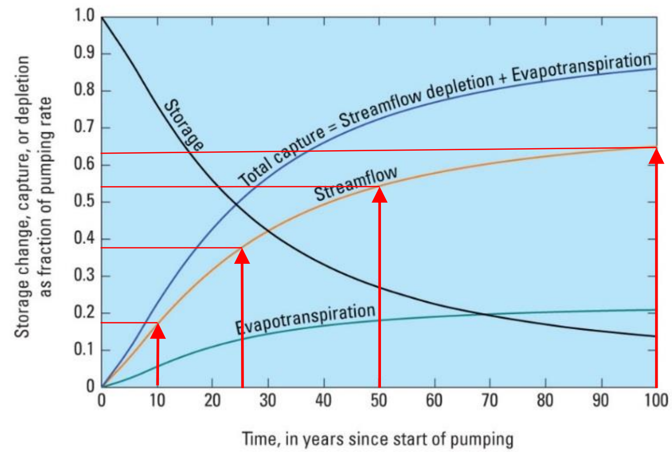
Models are needed for capture analysis when systems are complex and have varying properties

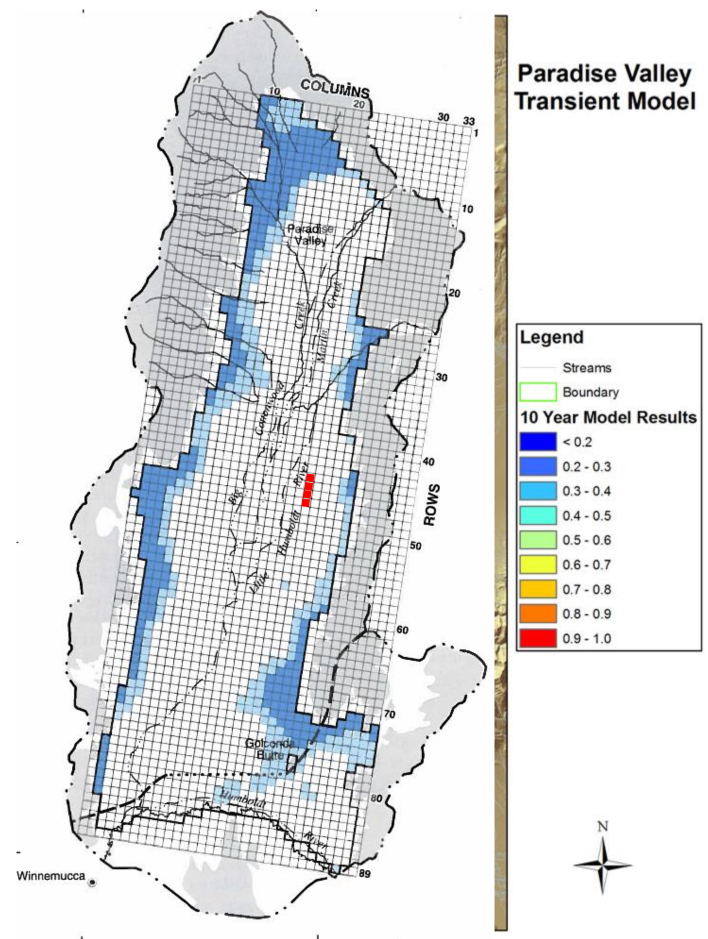
Models simulate hydrologic systems based on principles, aquifer properties, and boundary conditions



How models are used to develop capture maps

- Start with reference scenario.
- Systematically pump one model cell at a time.
- Evaluate change in streamflow (stream capture) as result of pumping.
- Develop a contour map of stream depletion for each pumping duration evaluated (capture map)

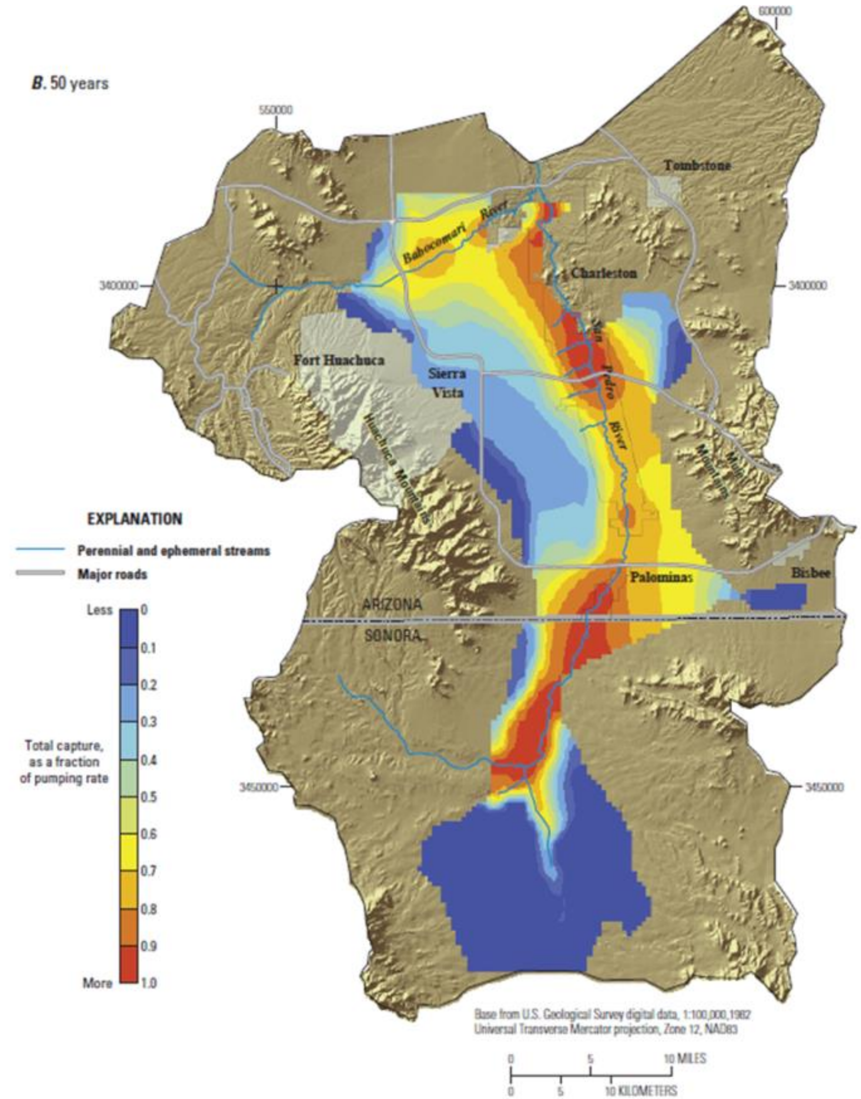




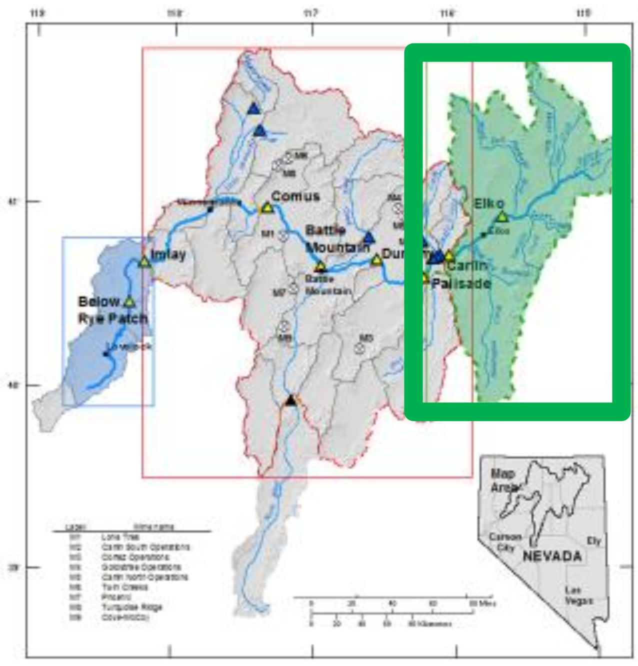
How to interpret Capture Maps

- Warmer colors indicate more efficient capture.
  - Indicate higher ‘connectivity’ of GW with SW.

- Cooler colors indicate less capture.
  - Lower ‘connectivity’ between GW and SW.



Upper Humboldt River Basin Model

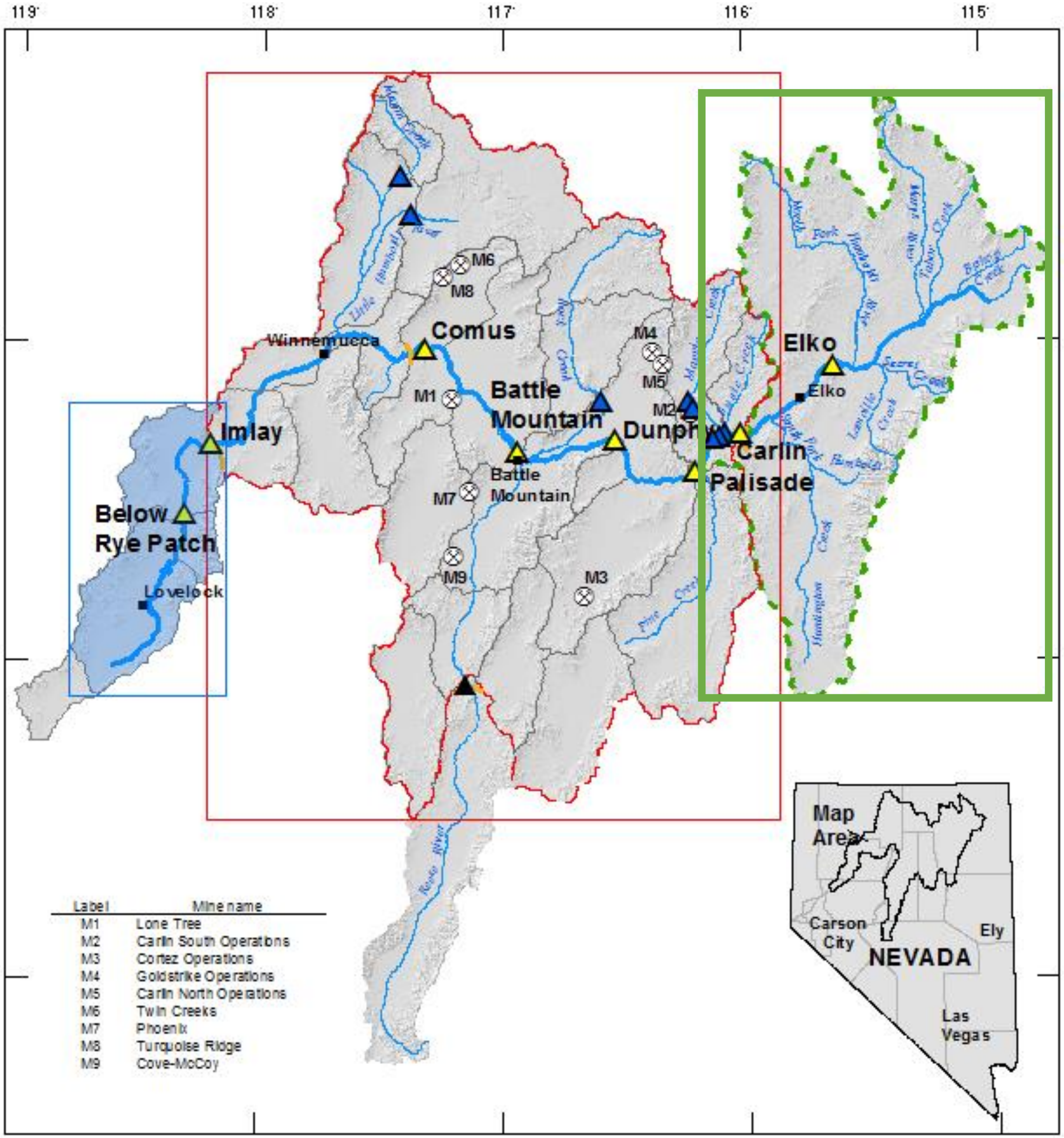


- Upper basin model – DRI
- Middle basin model – USGS
- Lower basin Model – USGS/DRI

DRI

Upper Humboldt Basin Groundwater Modeling Update

Rosemary WH Carroll
January 14-15, 2020
DRI

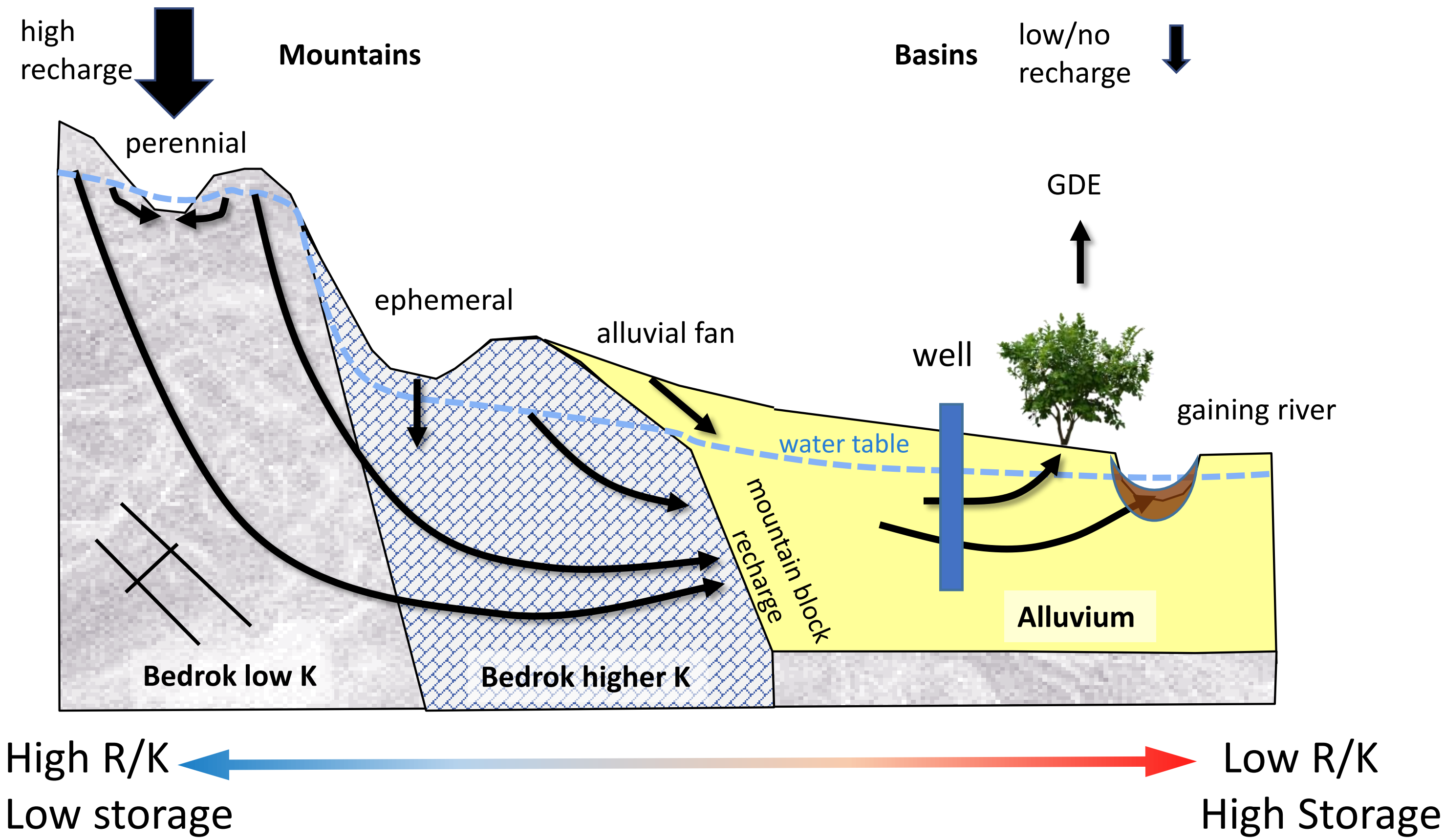


- Upper basin model - DRI
- Middle basin model - USGS
- Lower basin Model – USGS/DRI

Outline

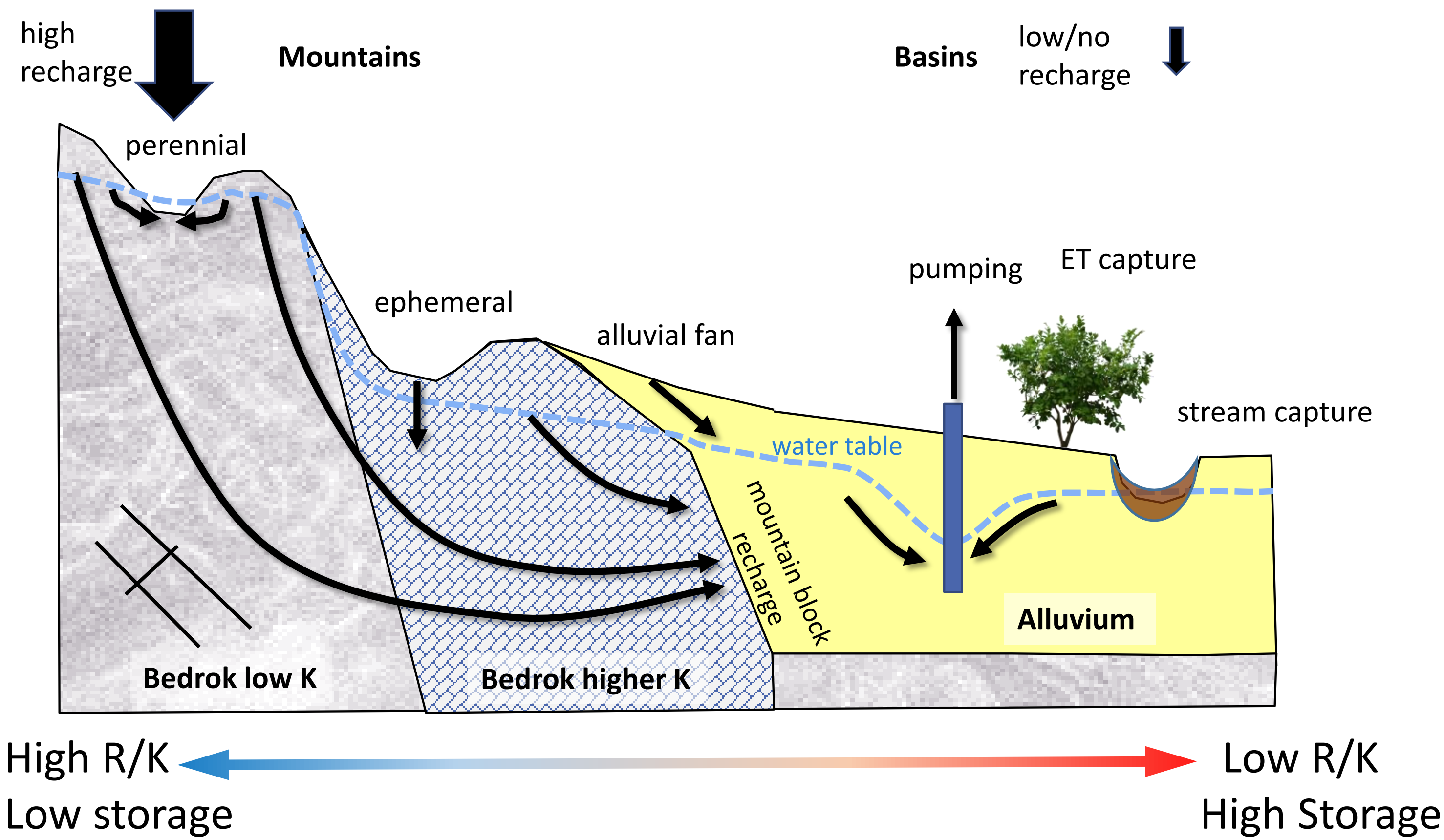
- Conceptual Model
- Calibration Strategies
- Model Overview
  - Steady State Model (changes)
  - Transient Model
- Capture Analysis (preliminary)

Pre-Groundwater Development (Steady State Calibration)



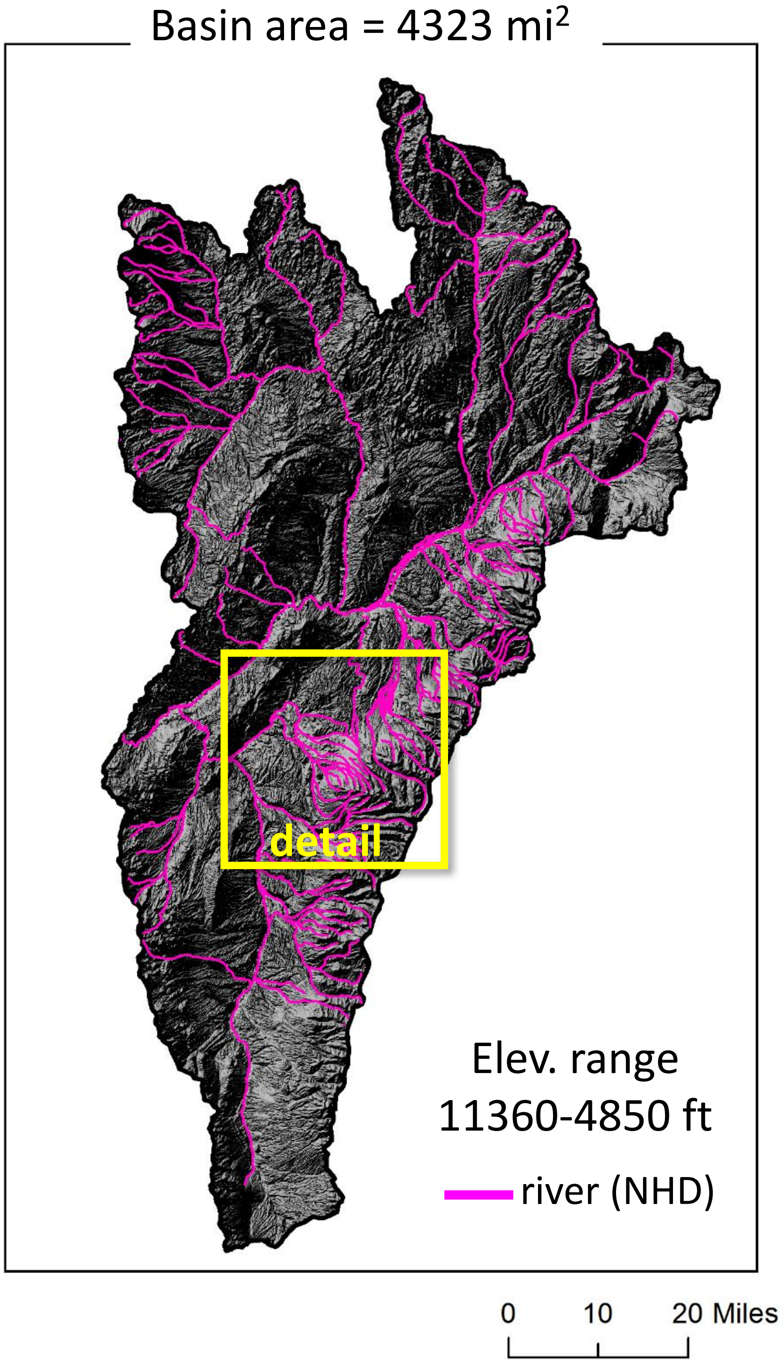
Constrain R, K and river conductance using observed borehole data, water levels, ET and stream flow

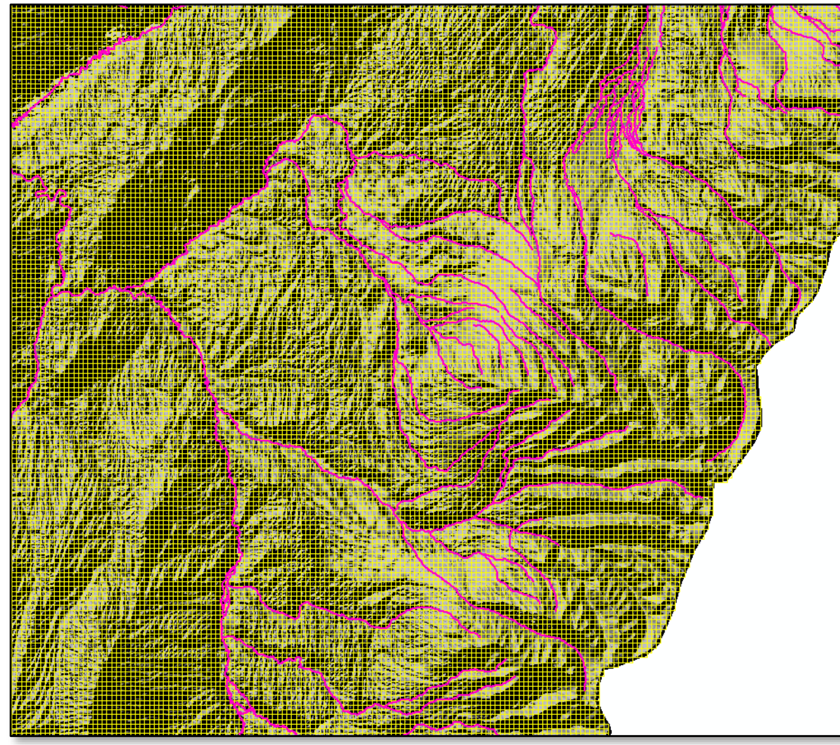
Transient Groundwater Model (1960-2016)



Storage parameters adjusted to match observed water levels over time

Numeric Representation
(MODFLOW NWT)





<u>NWT Grid Improves over USG</u>:

- Numeric stability
- Computational speed
- Wet/dry & unconfined conditions

Cells 900 ft x 900 ft ~half a million active cells

Geologic Units (new)

Ca = Carbonates
Qas = Alluvial Slope
Ts = Older Basin Fill
S = Siliceous and sedimentaryLake Deposits

I = Intrusive & Metamorp.
Qf = Fluvial Units
V = Volcanic

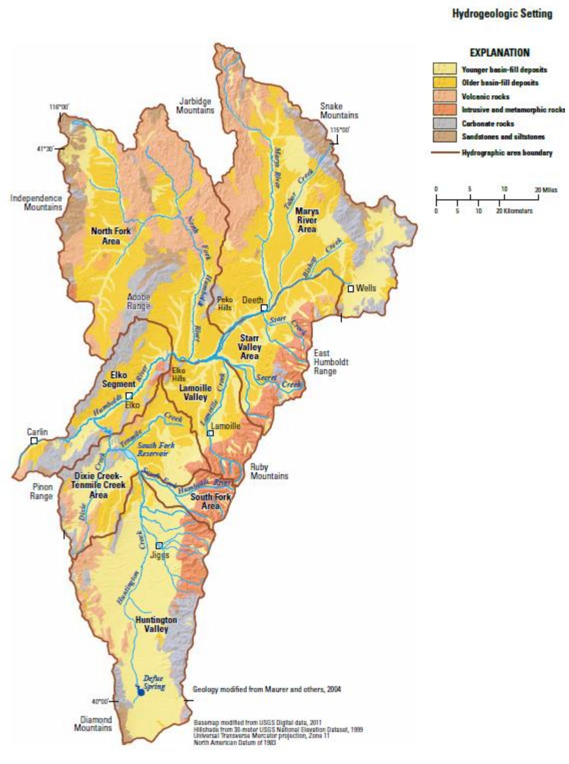


Figure 2. Hydrogeologic map of the upper Humboldt River basin, northeastern Nevada.

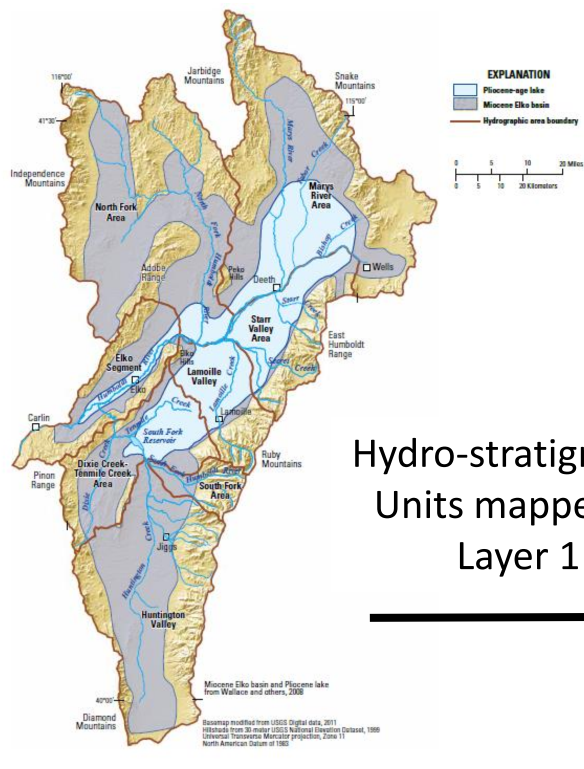
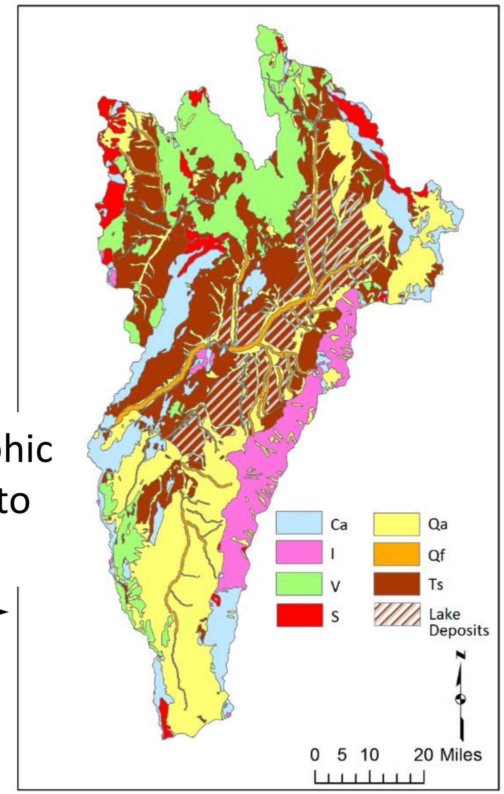


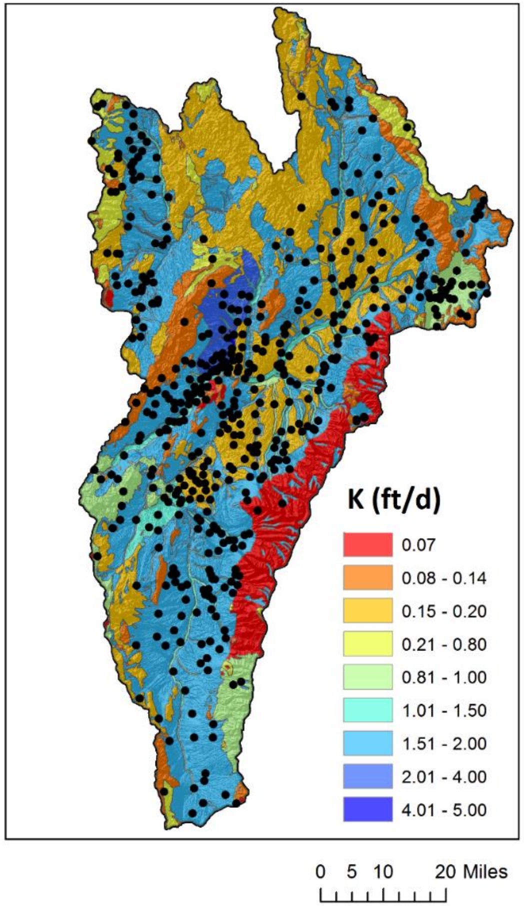
Figure 3. Extent of Miocene Elko basin and Pliocene lake, upper Humboldt River basin, northeastern Nevada.

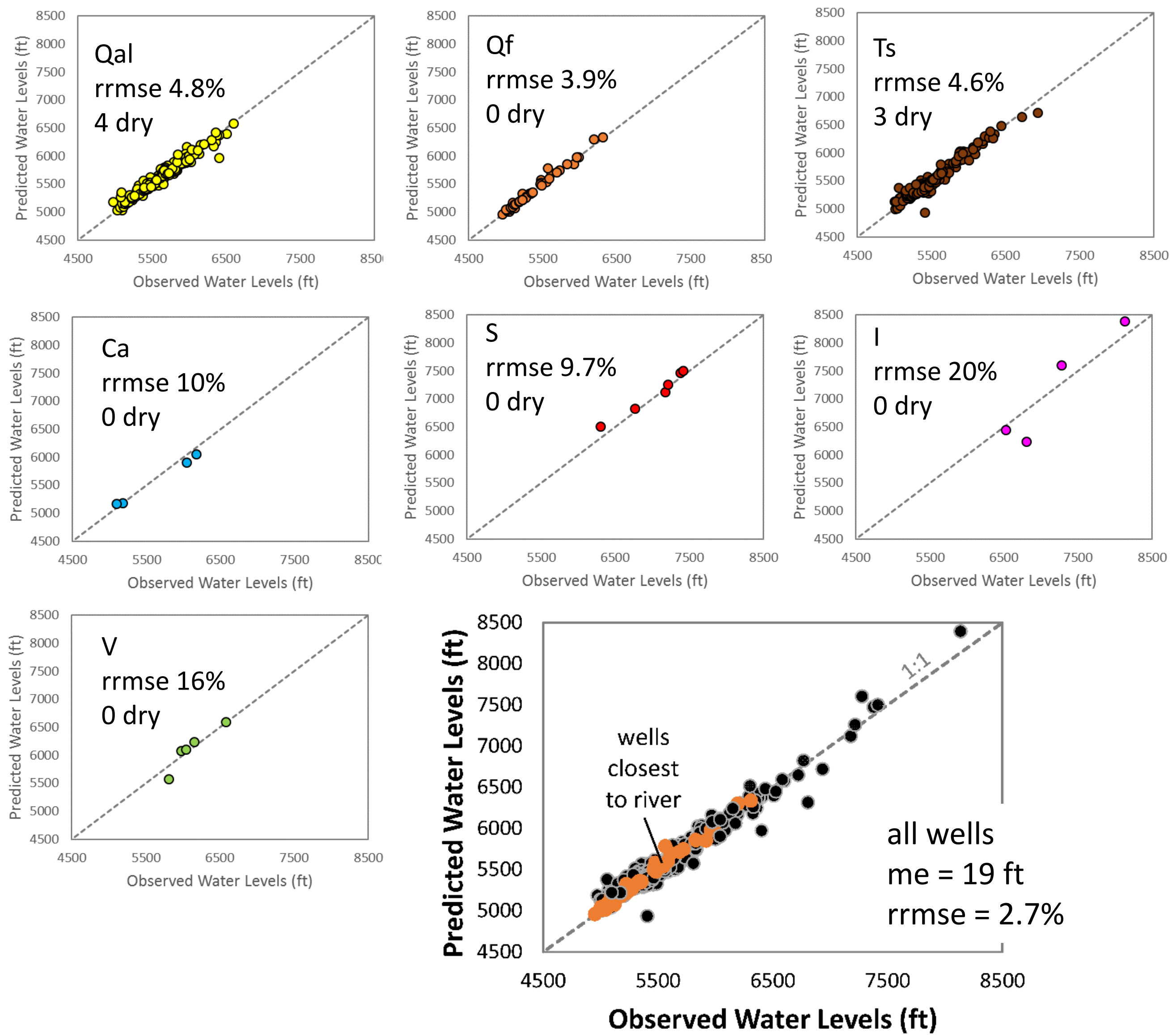
Hydro-stratigraphic Units mapped to Layer 1



Plume and Smith (2013)

Hydraulic Conductivity (re)Calibration

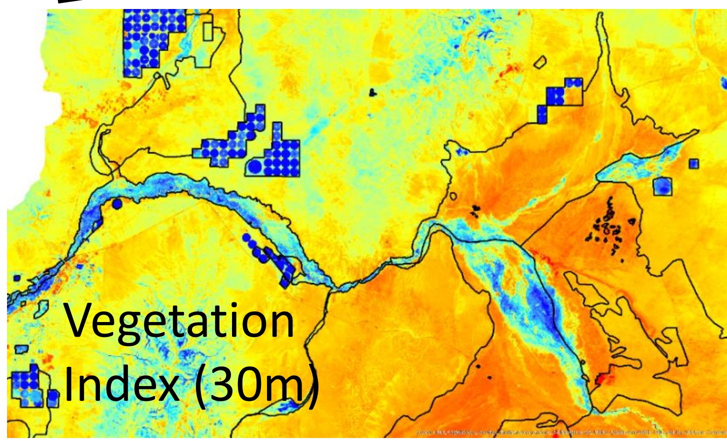


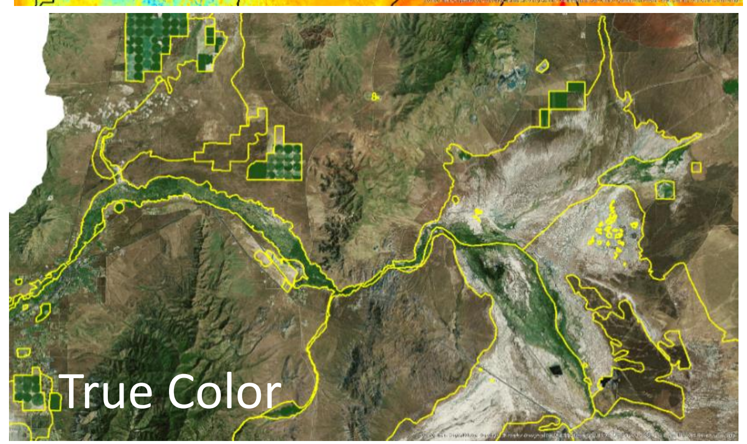


Remote Sensing of ET

Groundwater ET rates based on:

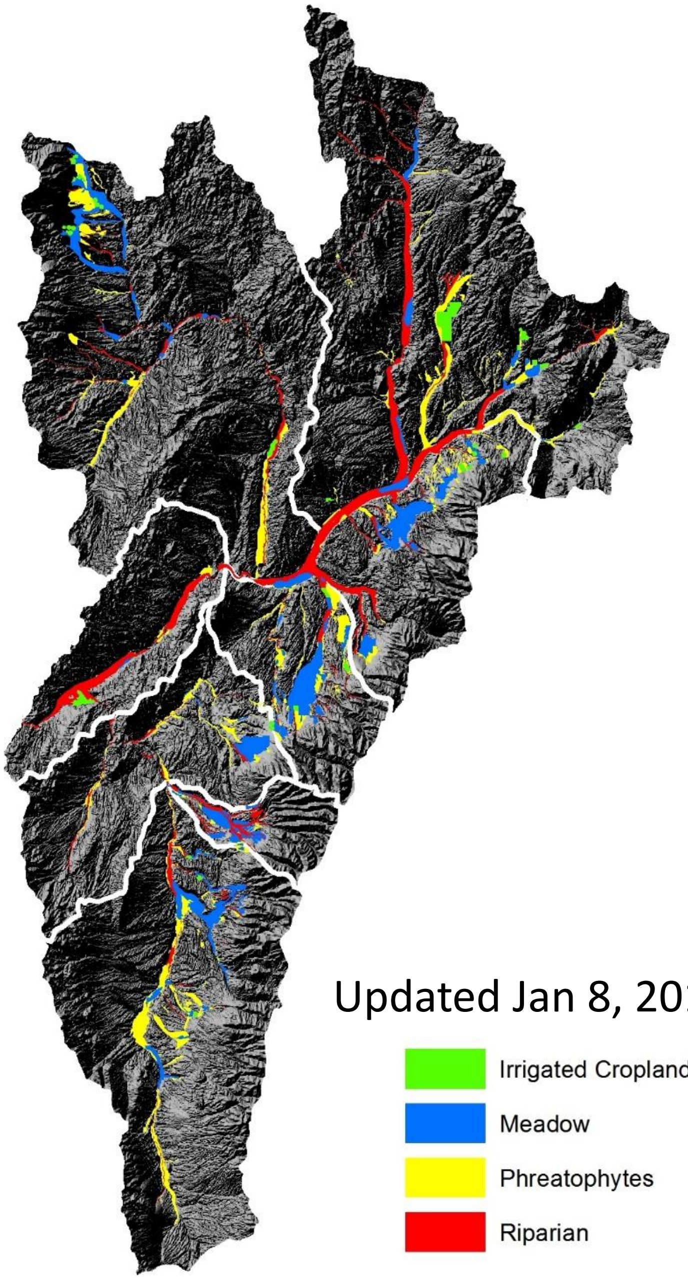
- Published regression model Based on 40 site years of measured ET from phreatophytes in Nevada
- Landsat satellite images of vegetation vigor (greenness) from 1985-2015
- Gridded weather data from **1985-2015**
  - Potential ET (PET)
  - Precipitation (PPT)



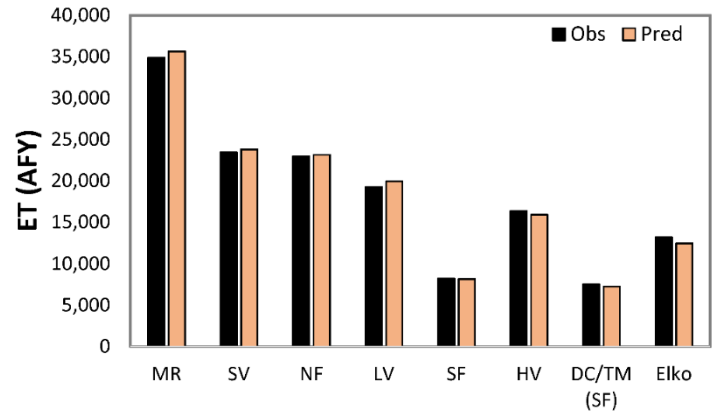


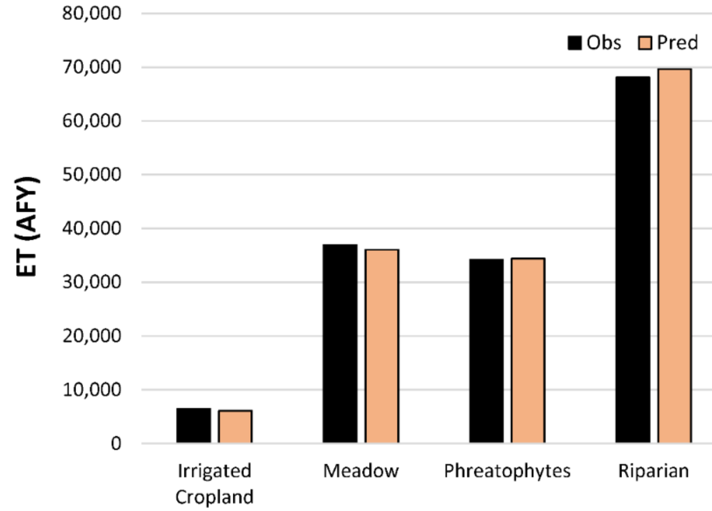
Data Processing

Google Earth Engine



Updated Jan 8, 2019

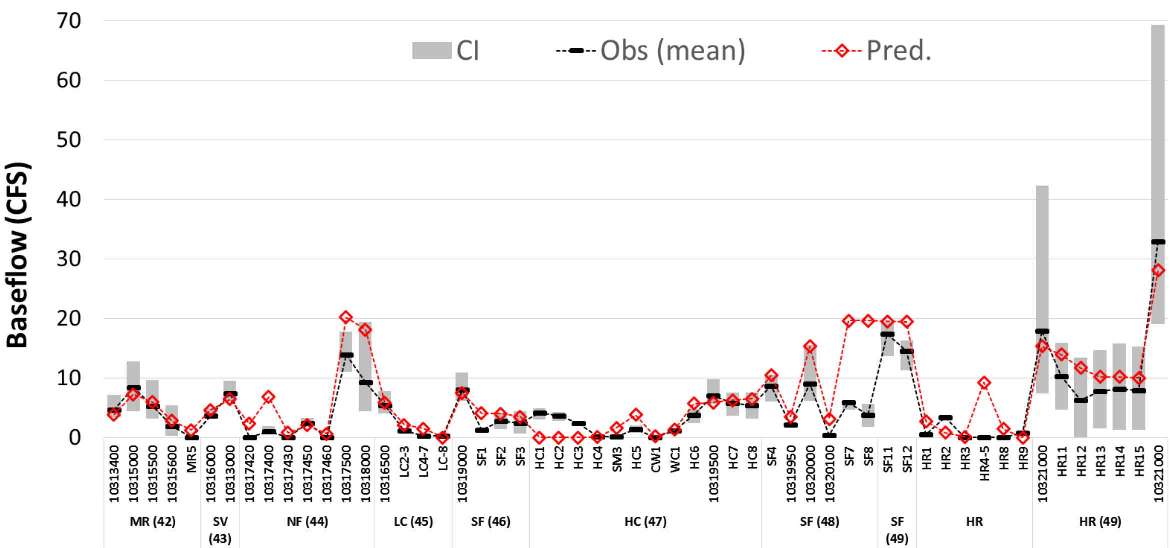


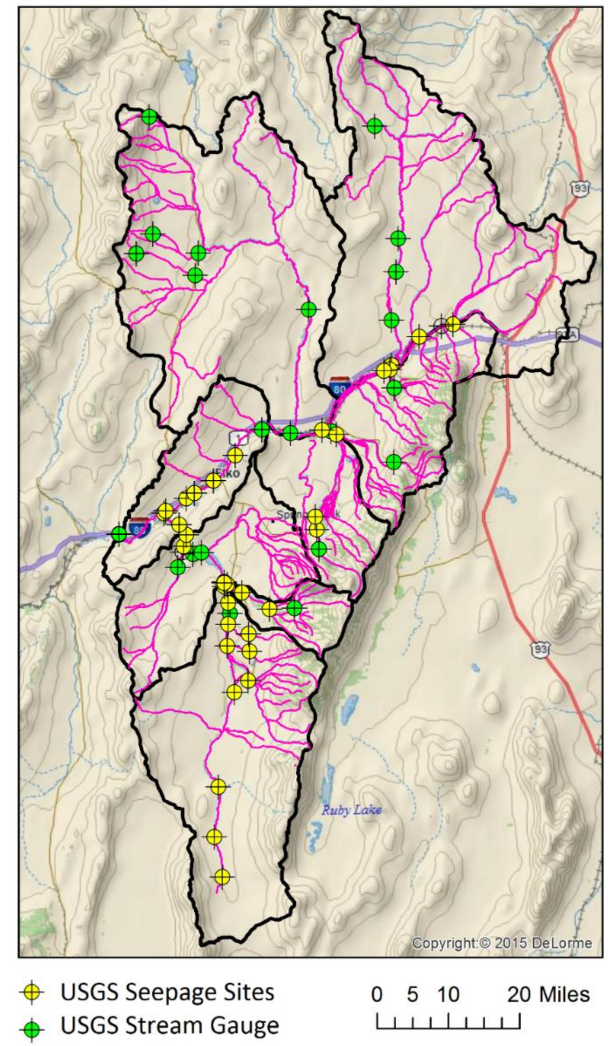


Total observed = 145,618 AFY
Total predicted = 146,190 AFY

Steady State Streamflow

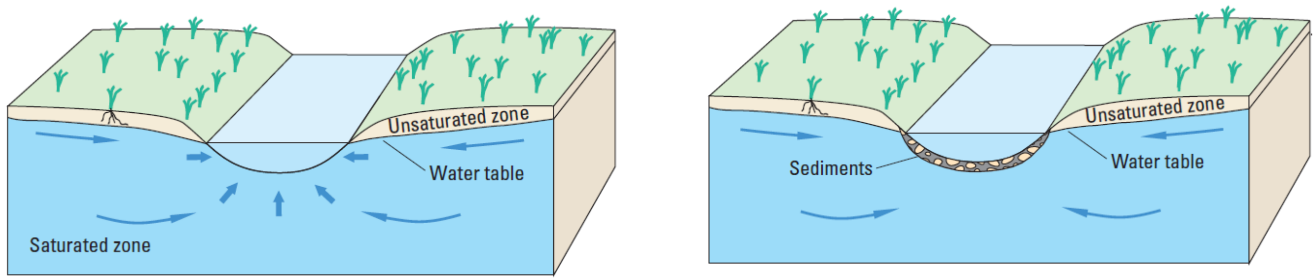
Stream Discharge POR: October – November Flows
Seepage Runs (Oct-Nov, 2008 and 2009)





Stream conductance adjusted by “reach”

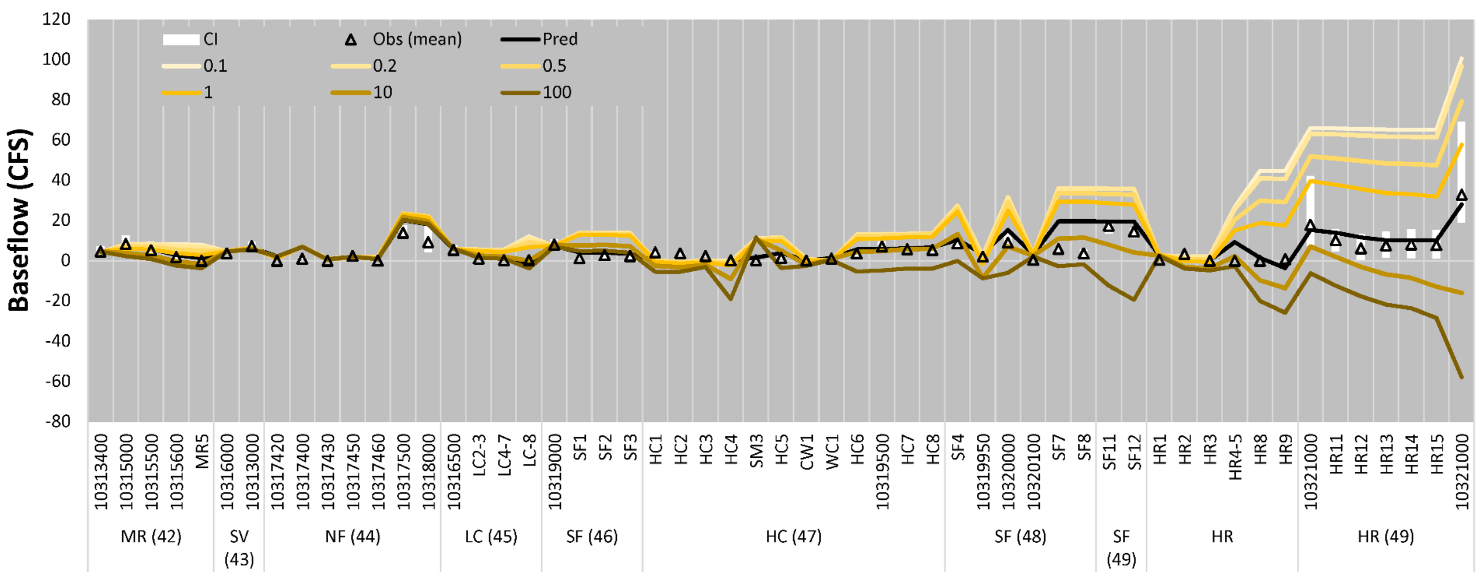
Steady State
Streamflow Sensitivity to River Conductance



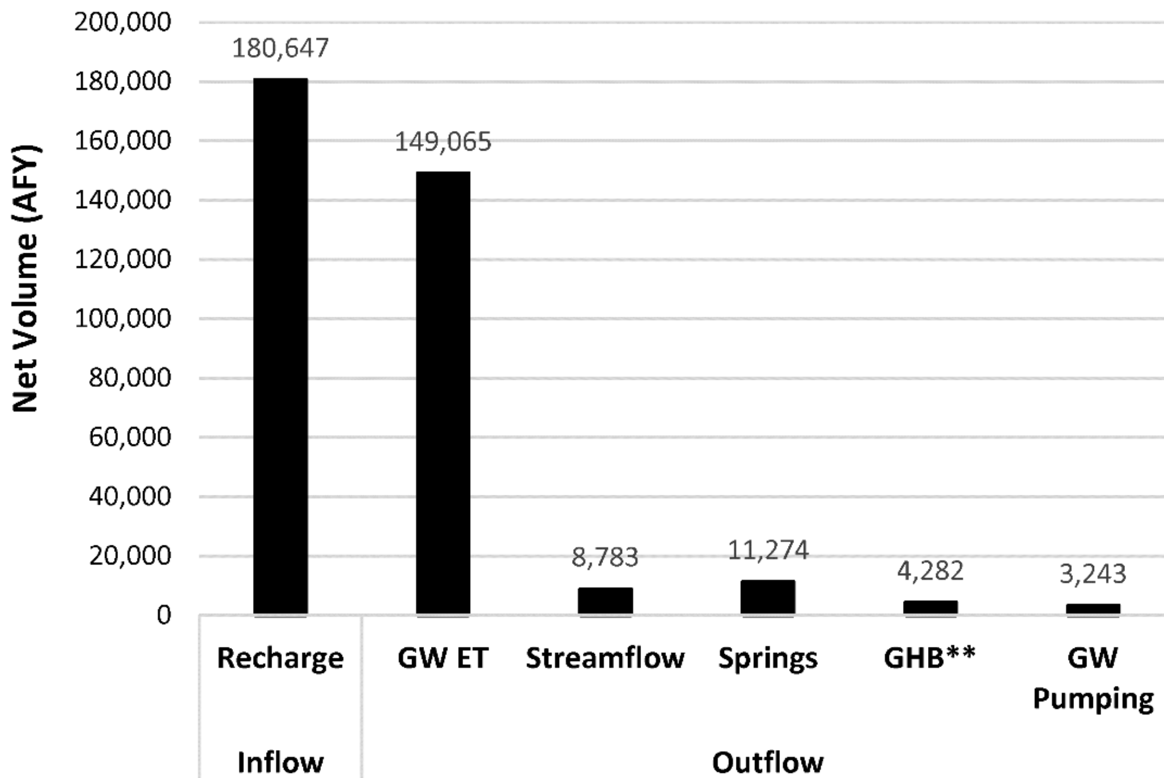
Stream with streambed and streambank sediments the same as the aquifer sediments.

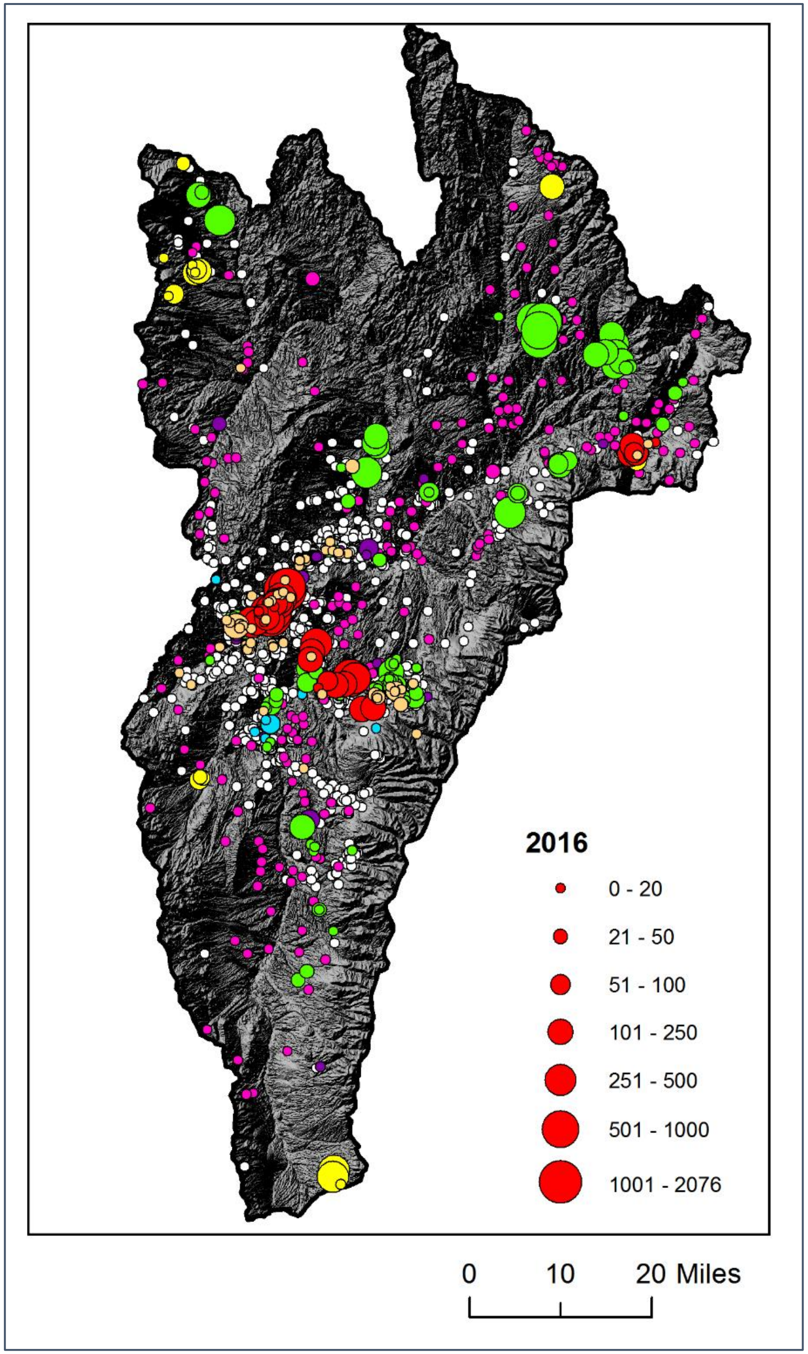
Stream with streambed and streambank sediments less permeable than surrounding aquifer sediments.

Barlow and Leake, 2012

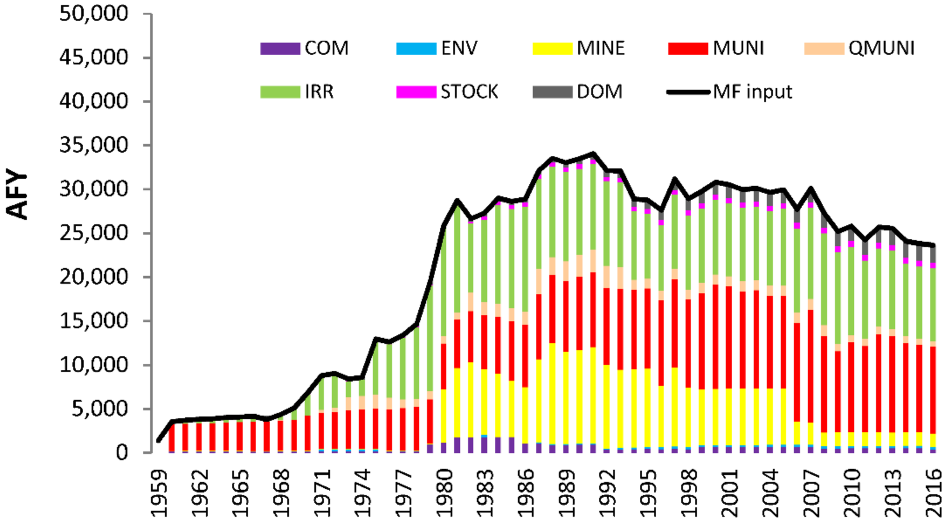


Simulated SS Water Budget

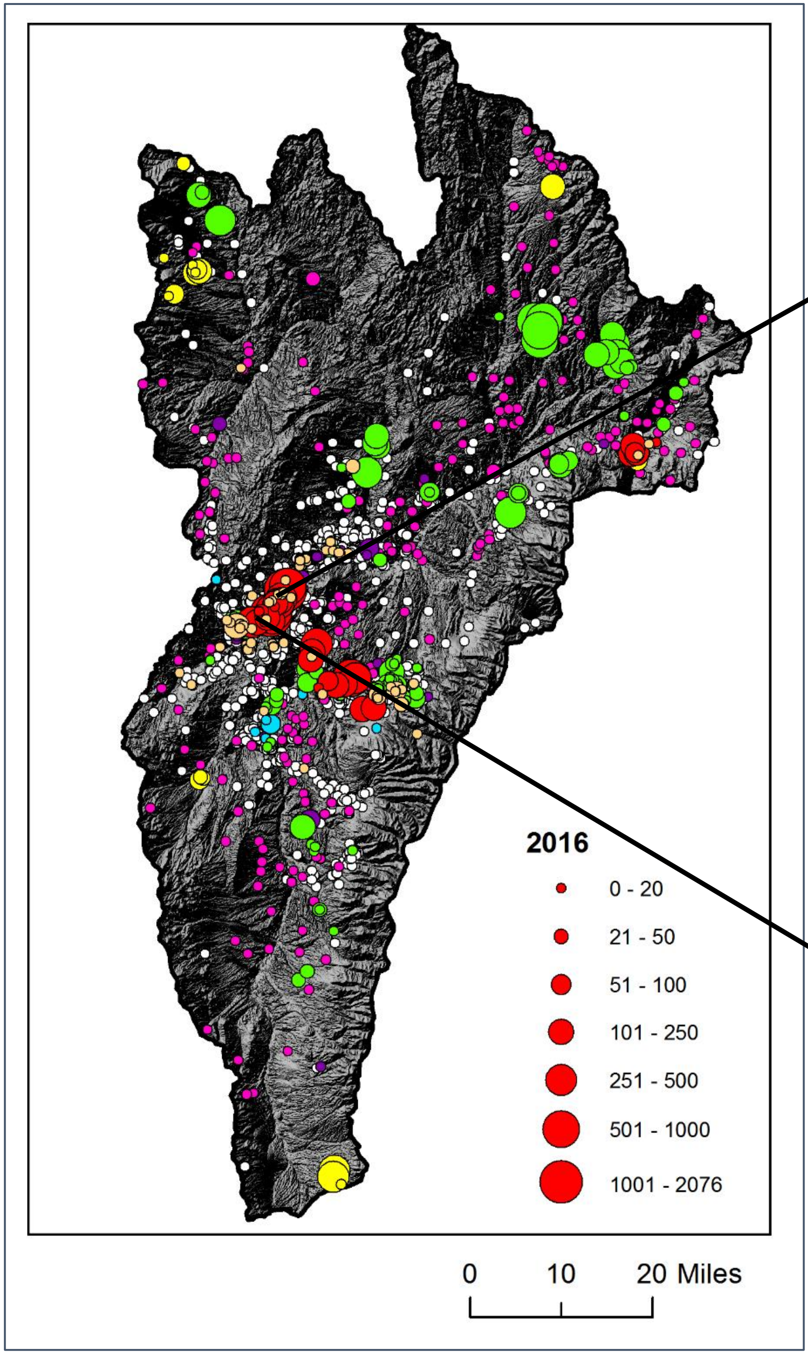


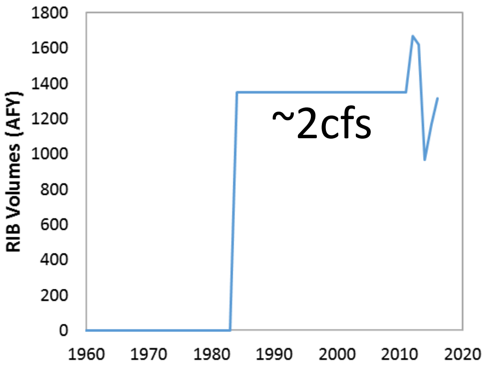


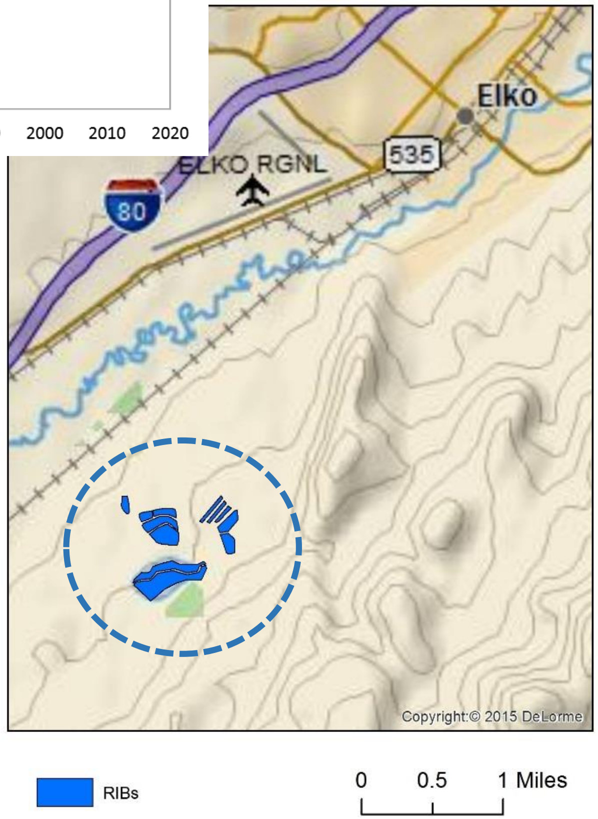
Groundwater Pumping (1960 -2016)



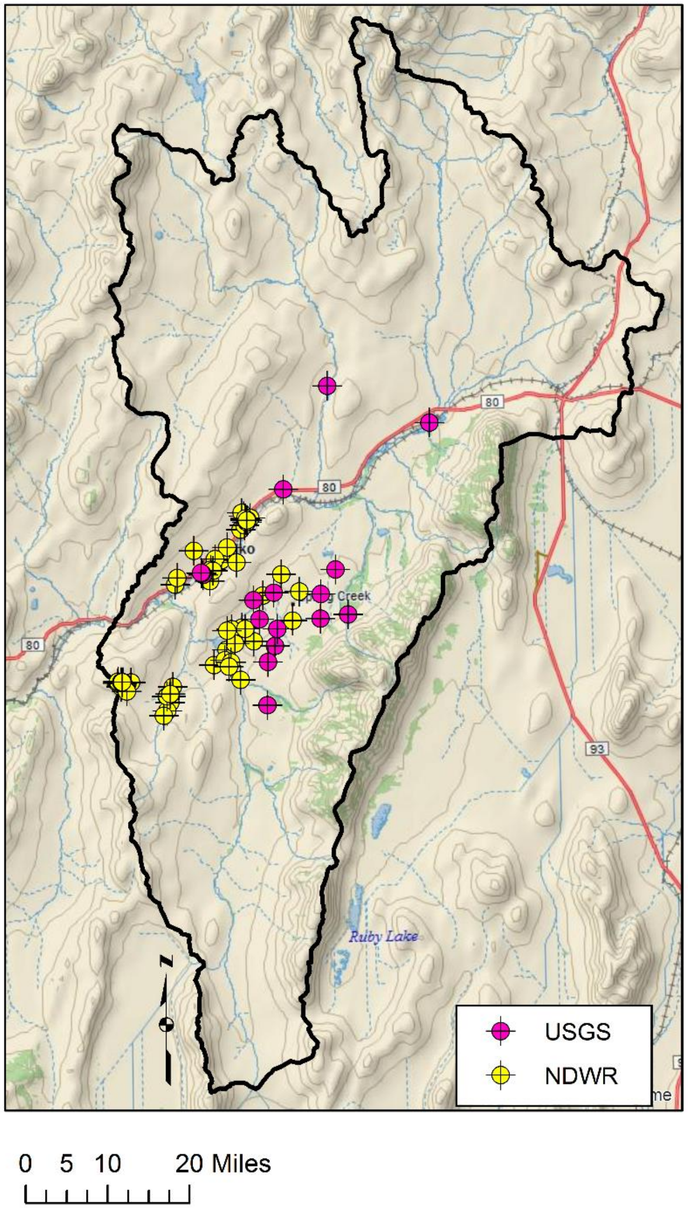
Recharge Infiltration Basins

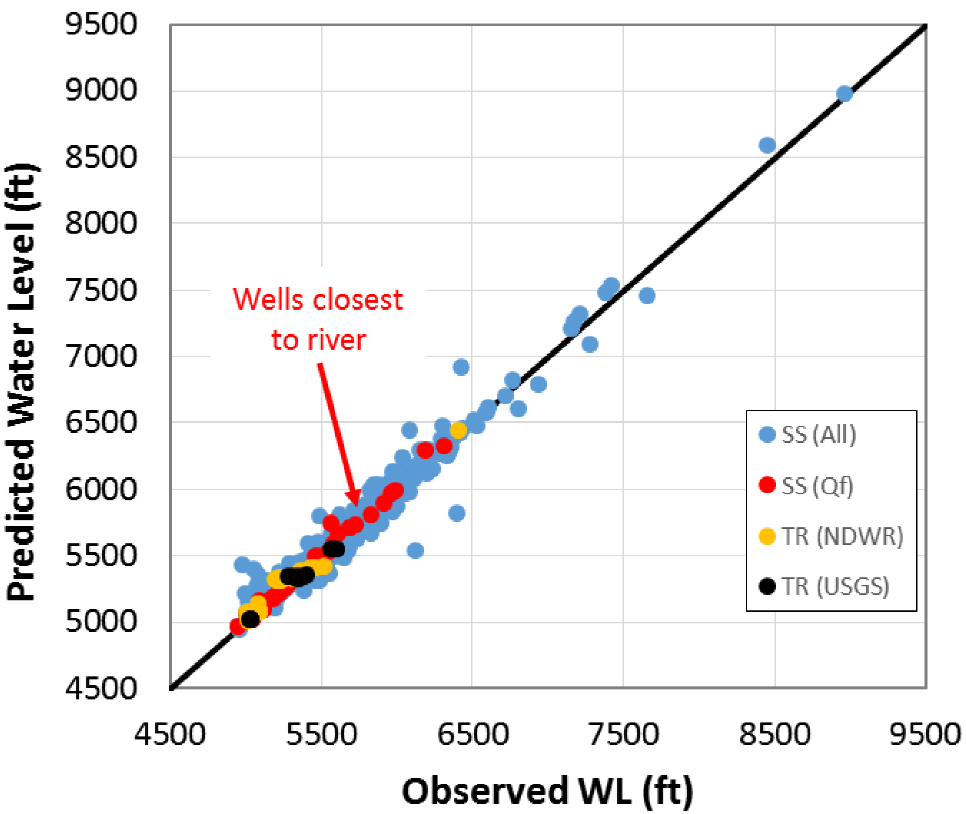






Transient Water Levels

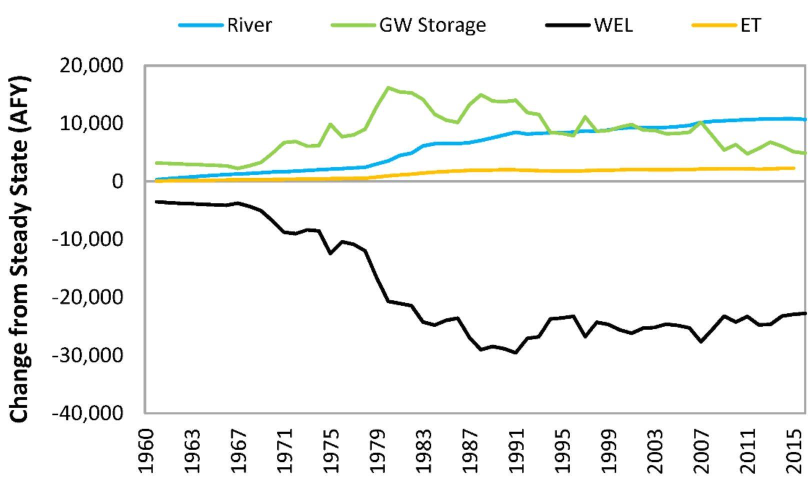




A comparison between steady state (SS) and transient (TR) water levels

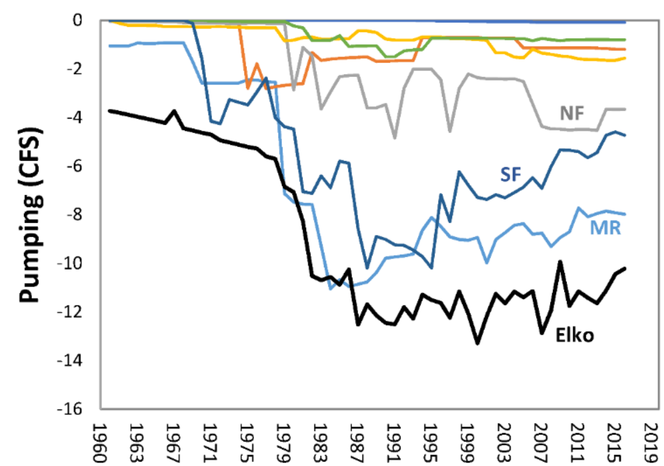
Transient Capture

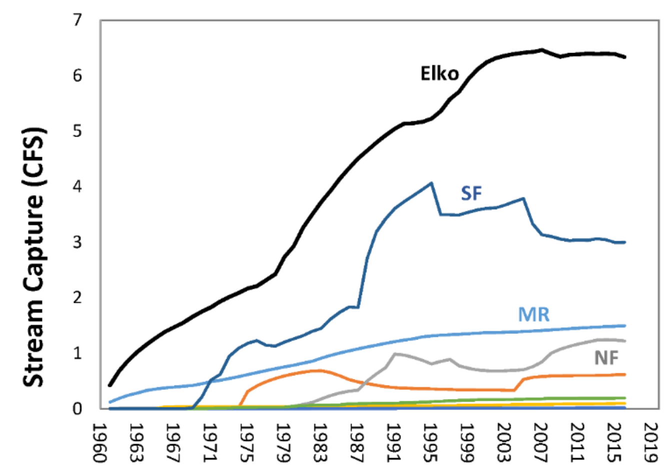
Global



	Max. Change AFY	Sim. End AFY	Max. Change CFS	Sim. End CFS
Wells	-29,572	-22,756	-40.85	-31.43
Springs	45	45	0.06	0.06
River	10,822	10,681	14.95	14.75
ET	2,249	2,182	3.11	3.01
GW Storage	16,155	4,847	22.31	6.70

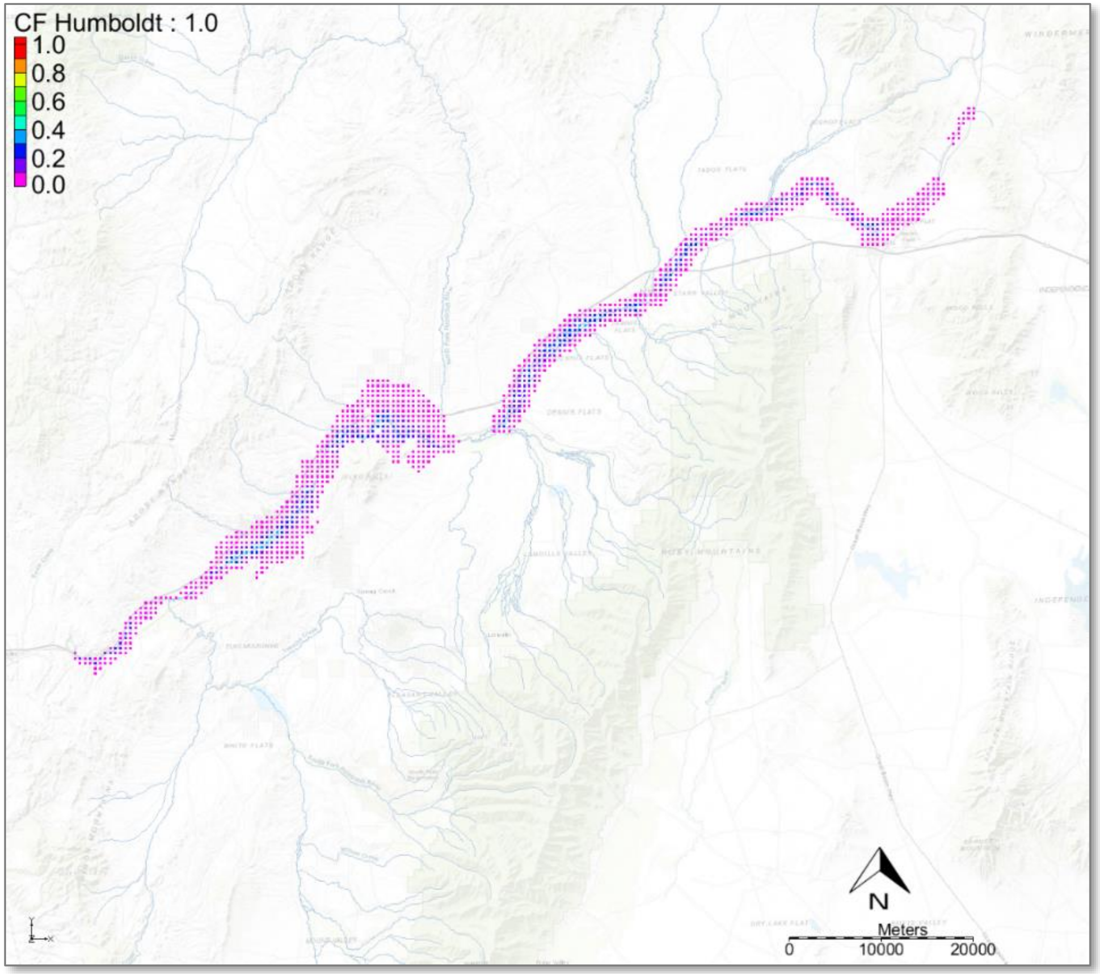
Sub-Basin





Capture Analysis (>0.01)
Humboldt Main Stem & Alluvial Units Only

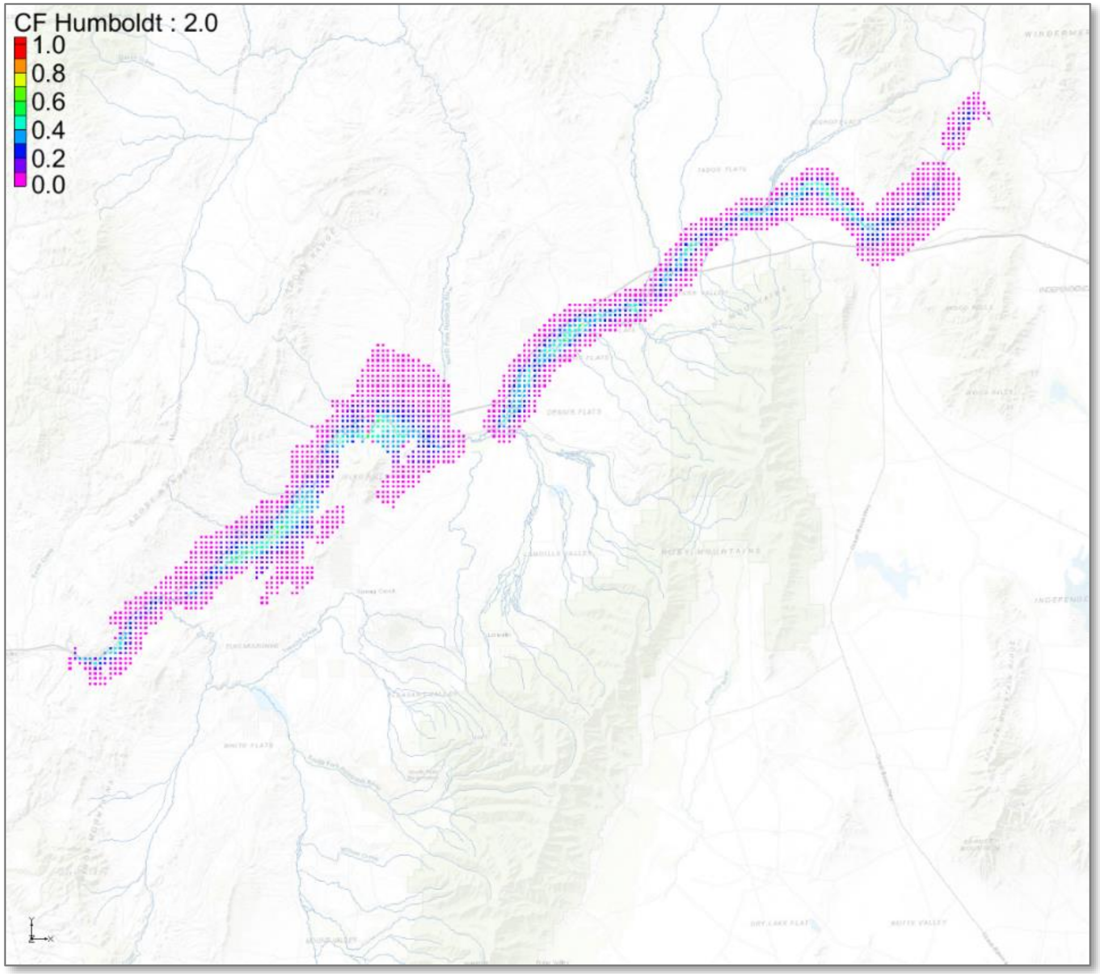
Pumping = 0.23 cfs (100x max model error) - Provisional



1 year

Capture Analysis (>0.01)
Humboldt Main Stem & Alluvial Units Only

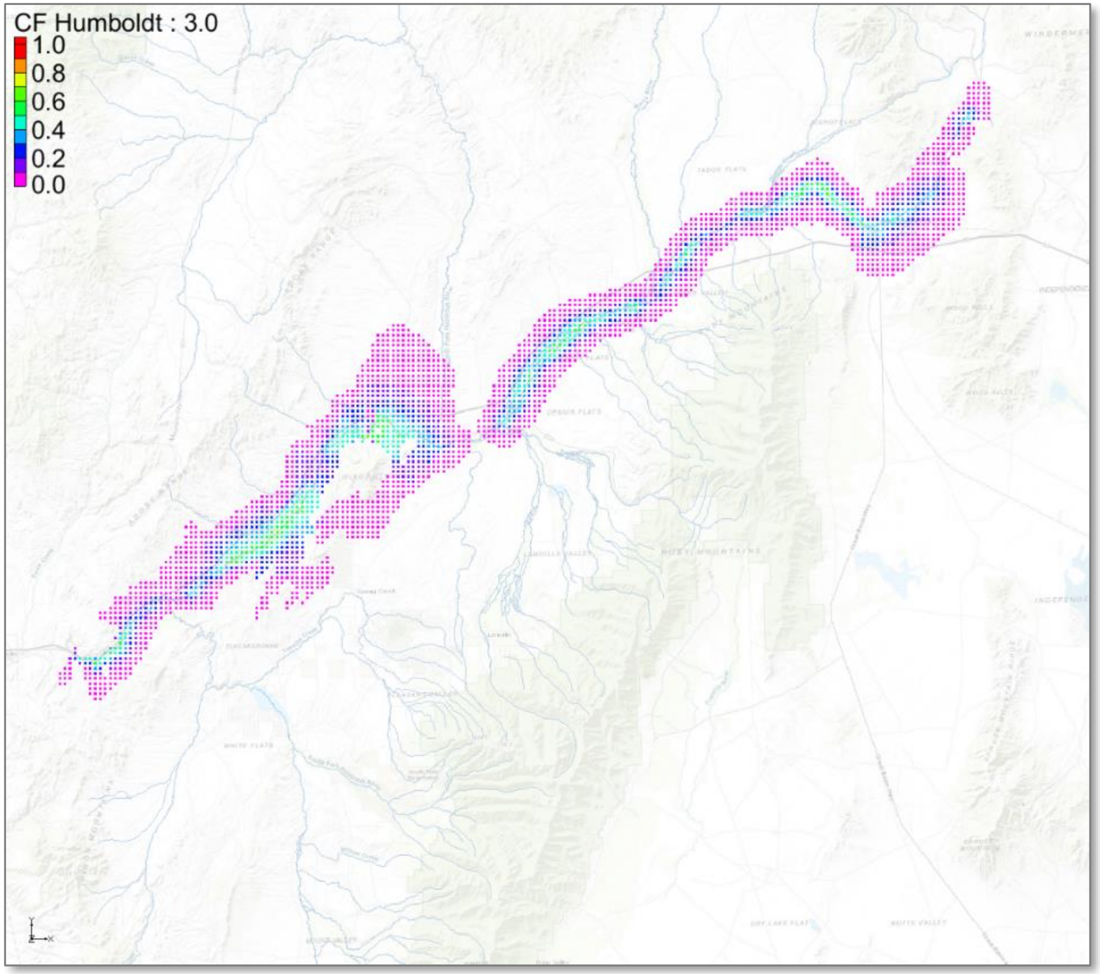
Pumping = 0.23 cfs (100x max model error) - Provisional



5 years

Capture Analysis (>0.01)
Humboldt Main Stem & Alluvial Units Only

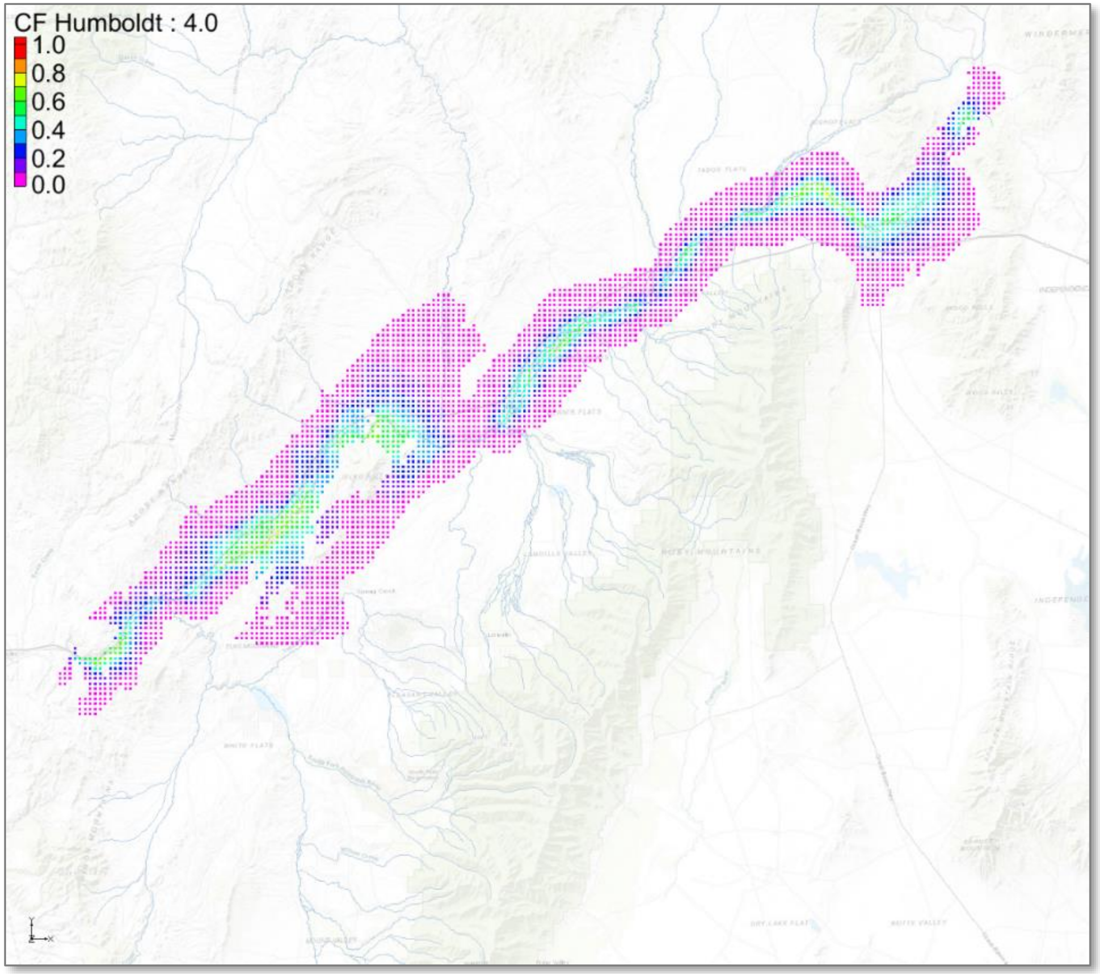
Pumping = 0.23 cfs (100x max model error) - Provisional



10 years

Capture Analysis (>0.01)
Humboldt Main Stem & Alluvial Units Only

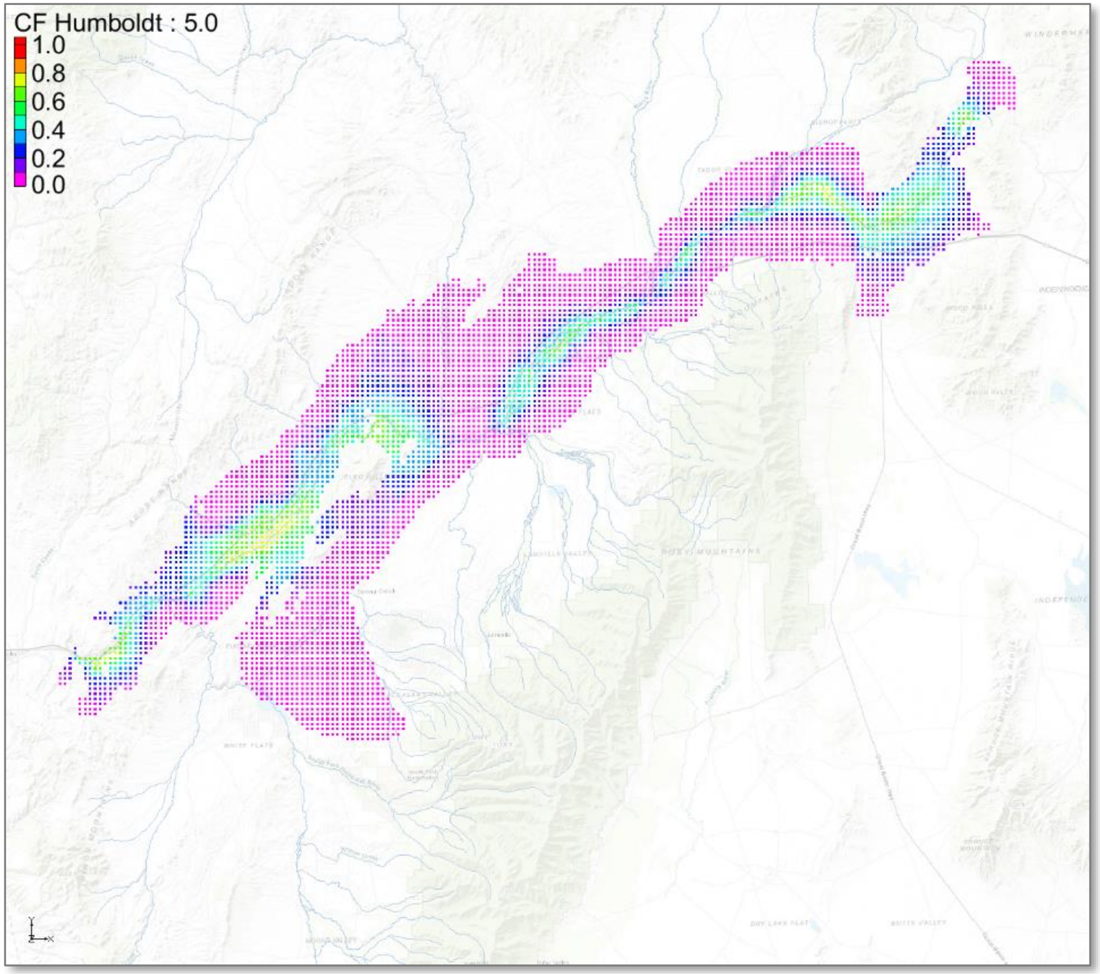
Pumping = 0.23 cfs (100x max model error) - Provisional



25 years

Capture Analysis (>0.01)
Humboldt Main Stem & Alluvial Units Only

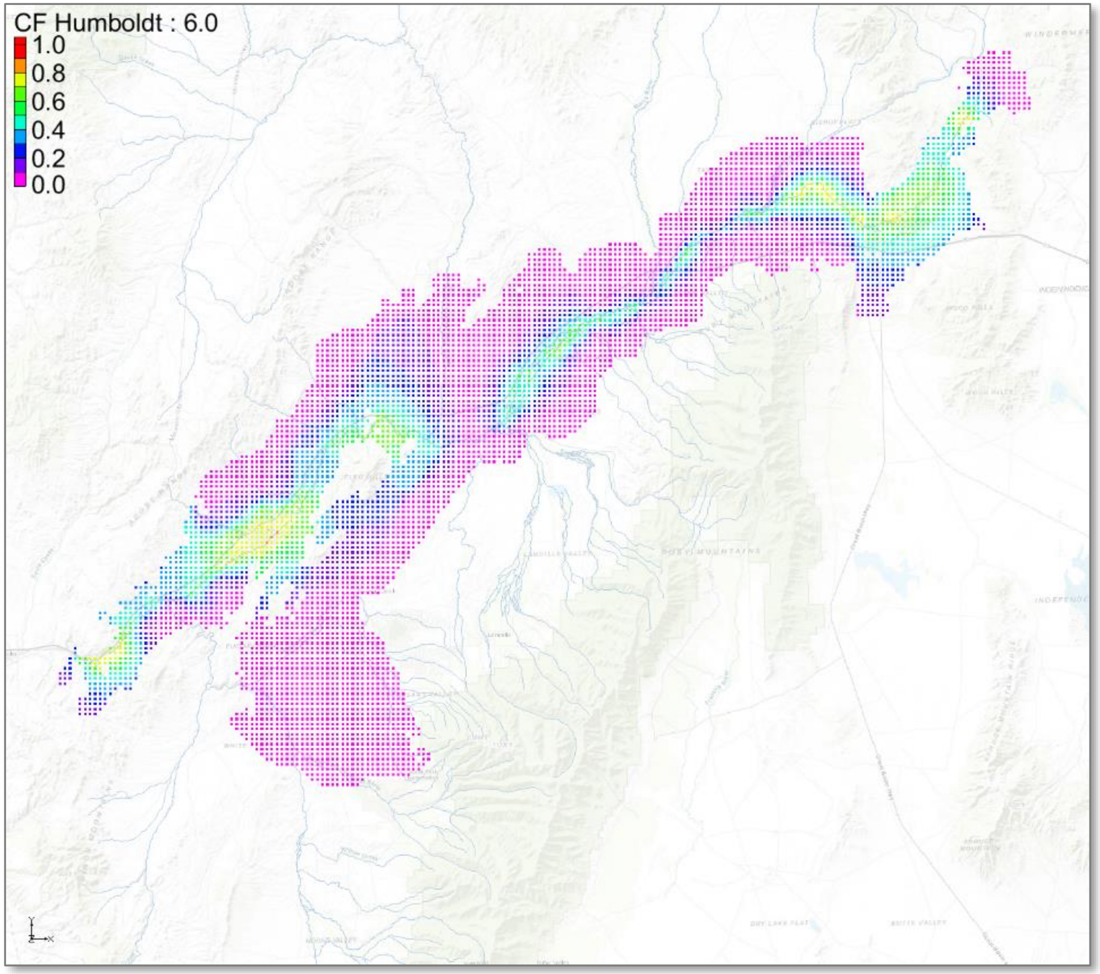
Pumping = 0.23 cfs (100x max model error) - Provisional



50 years

Capture Analysis (>0.01)
Humboldt Main Stem & Alluvial Units Only

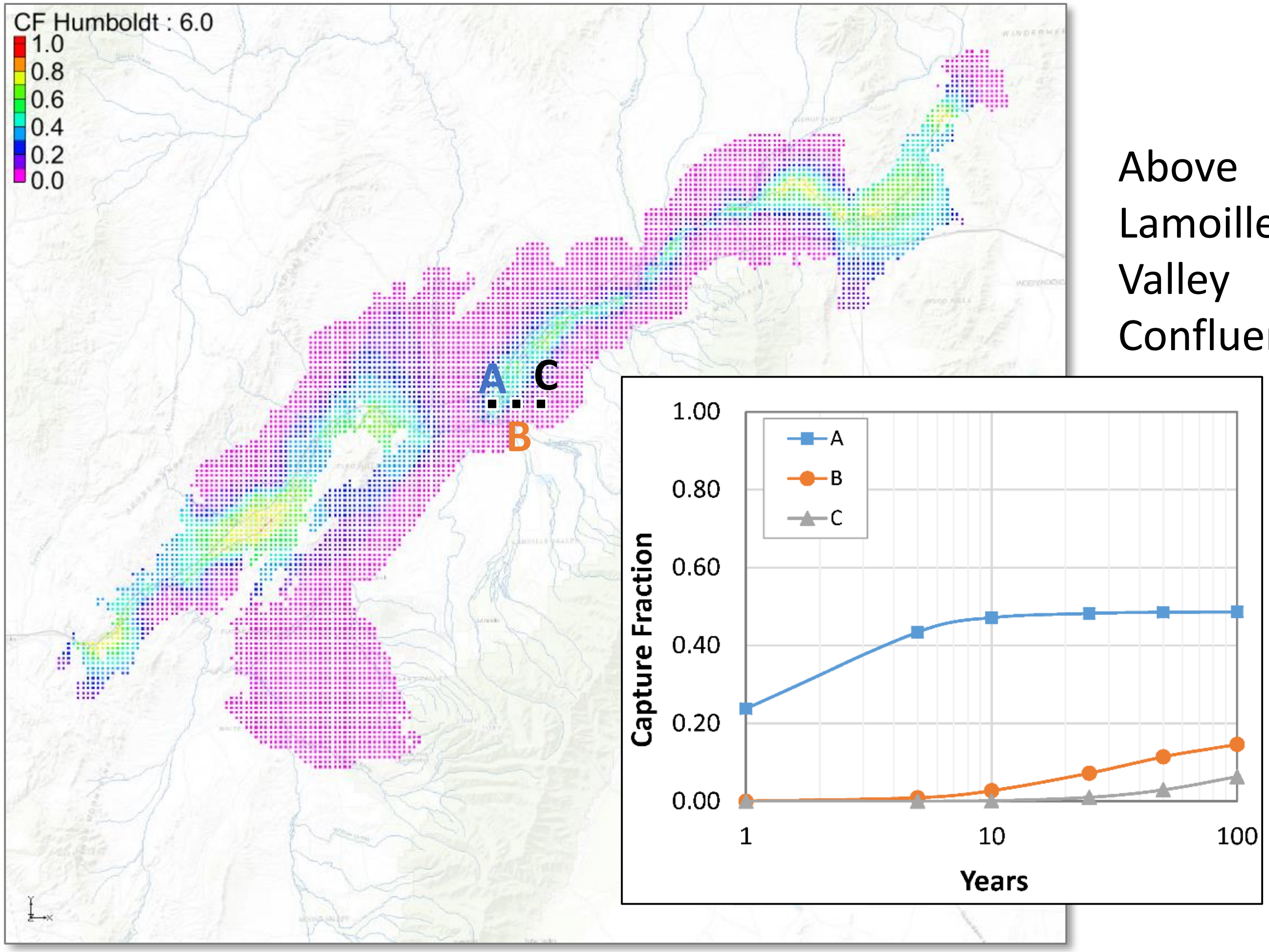
Pumping = 0.23 cfs (100x max model error) - Provisional



100 years

Capture Analysis (>0.01)
Humboldt Main Stem & Alluvial Units Only

Pumping = 0.23 cfs (100x max model error) - Provisional

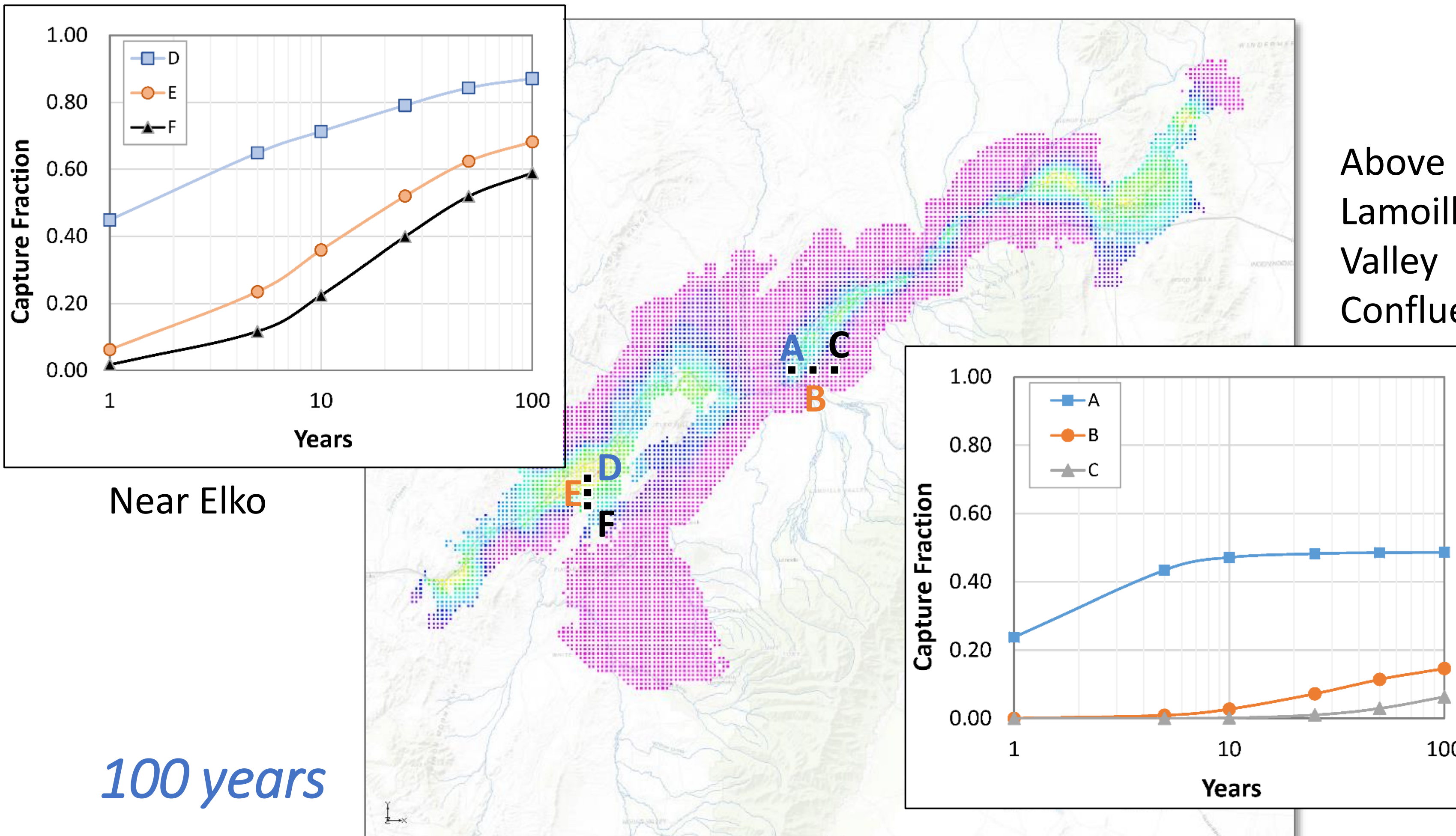


Above Lamoille Valley Confluence

100 years

Capture Analysis (>0.01)
Humboldt Main Stem & Alluvial Units Only

Pumping = 0.23 cfs (100x max model error) - Provisional

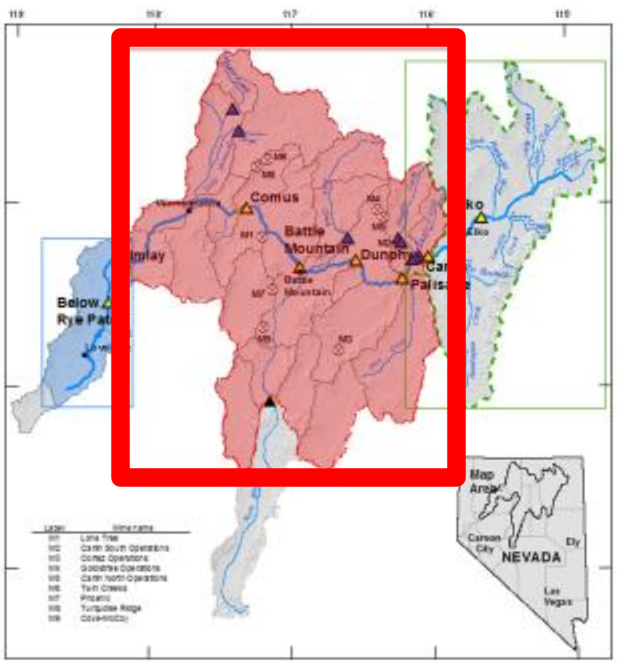


Near Elko

Above Lamoille Valley Confluence

100 years

Middle Humboldt River Basin Model



- Upper basin model – DRI
- Middle basin model – USGS
- Lower basin Model – USGS/DRI

USGS

Middle Humboldt River capture groundwater flow model: Stakeholder meeting

Update 2020-01-14

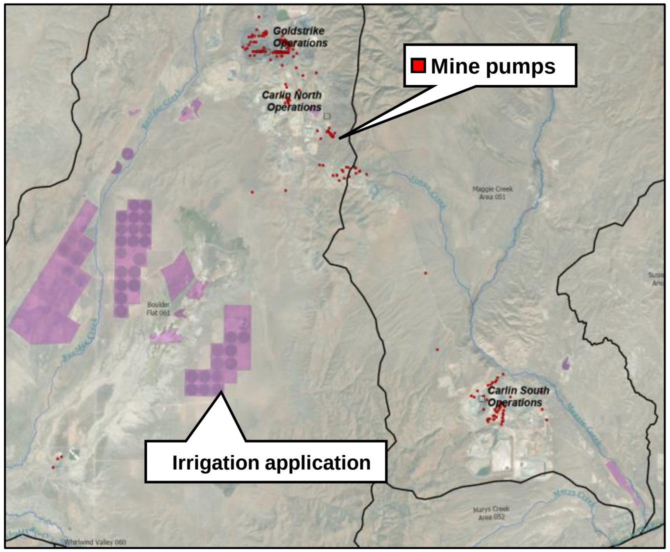
USGS NVWSC

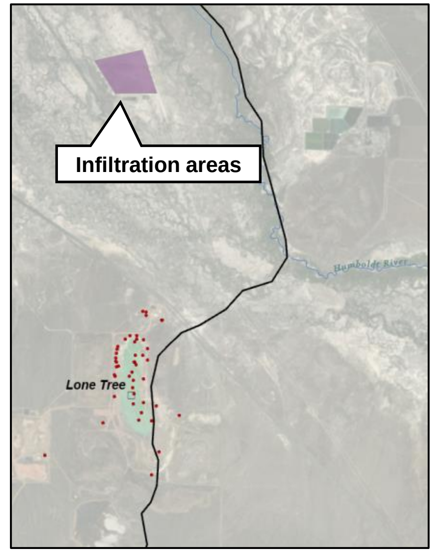
*** Model results are provisional and subject to change as models are finalized ***

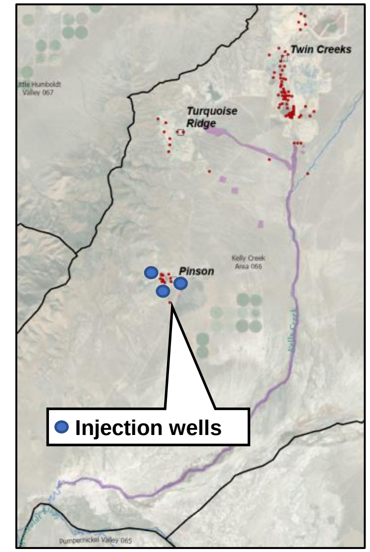
Overview

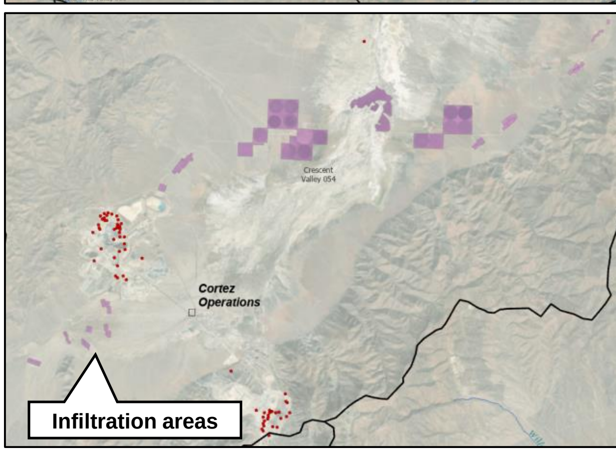
- New model features/additions
- Calibration status
- Provisional capture results
- Next steps

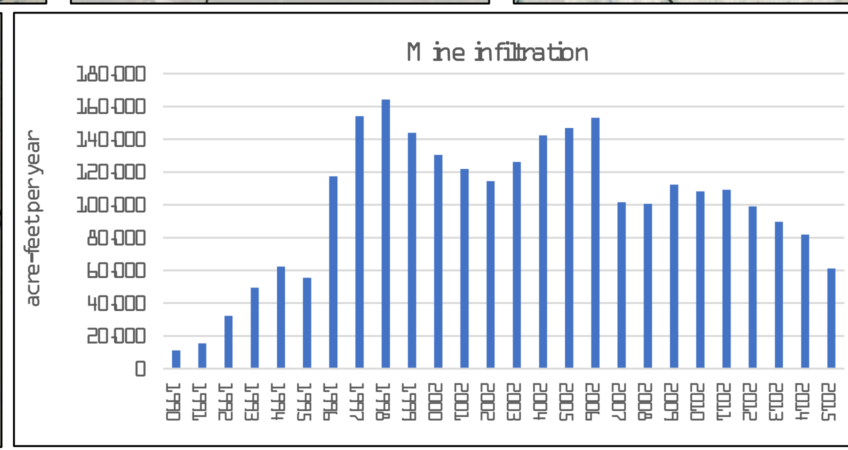
Addition of mine pumping infiltration and irrigation areas





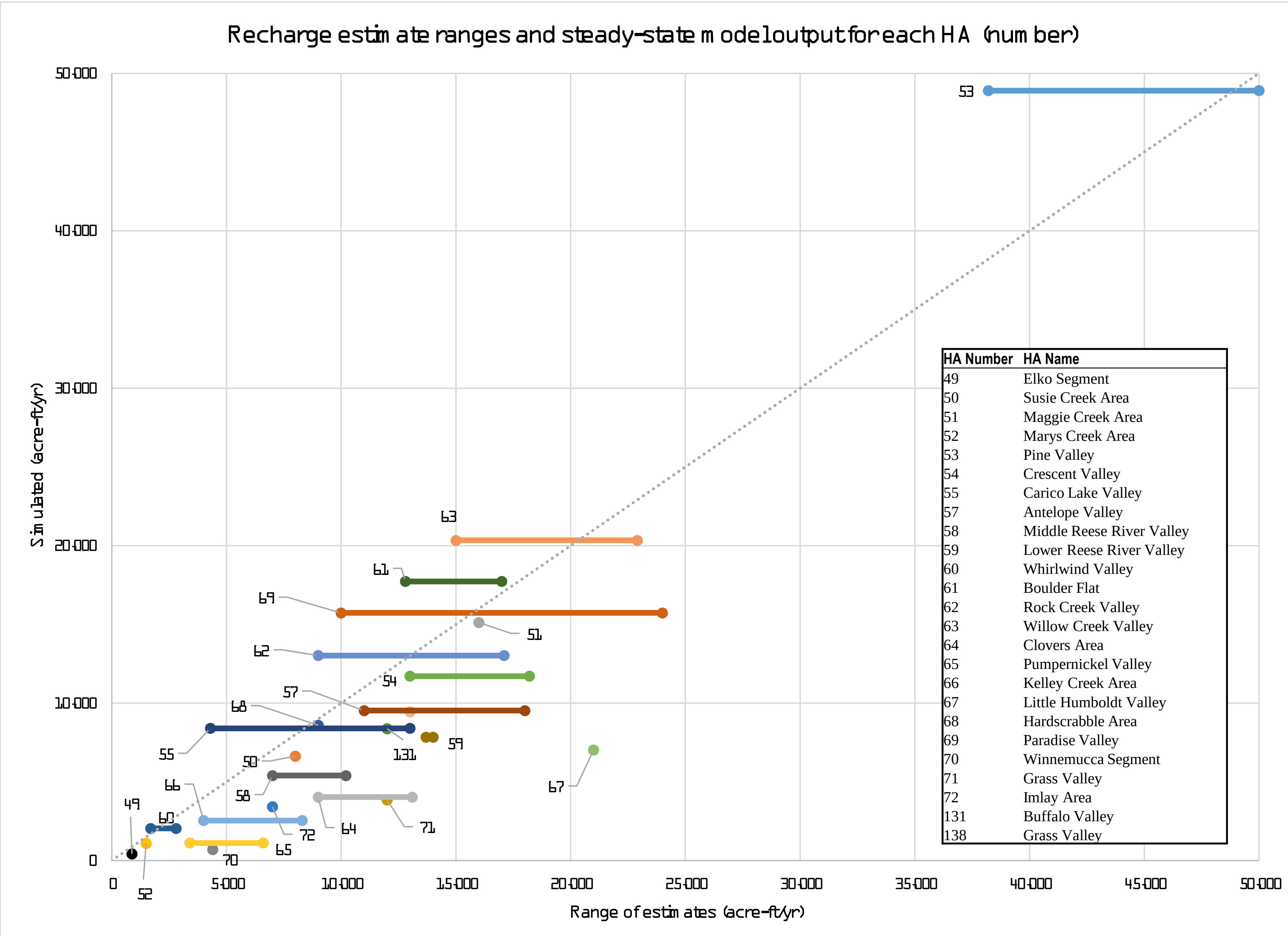






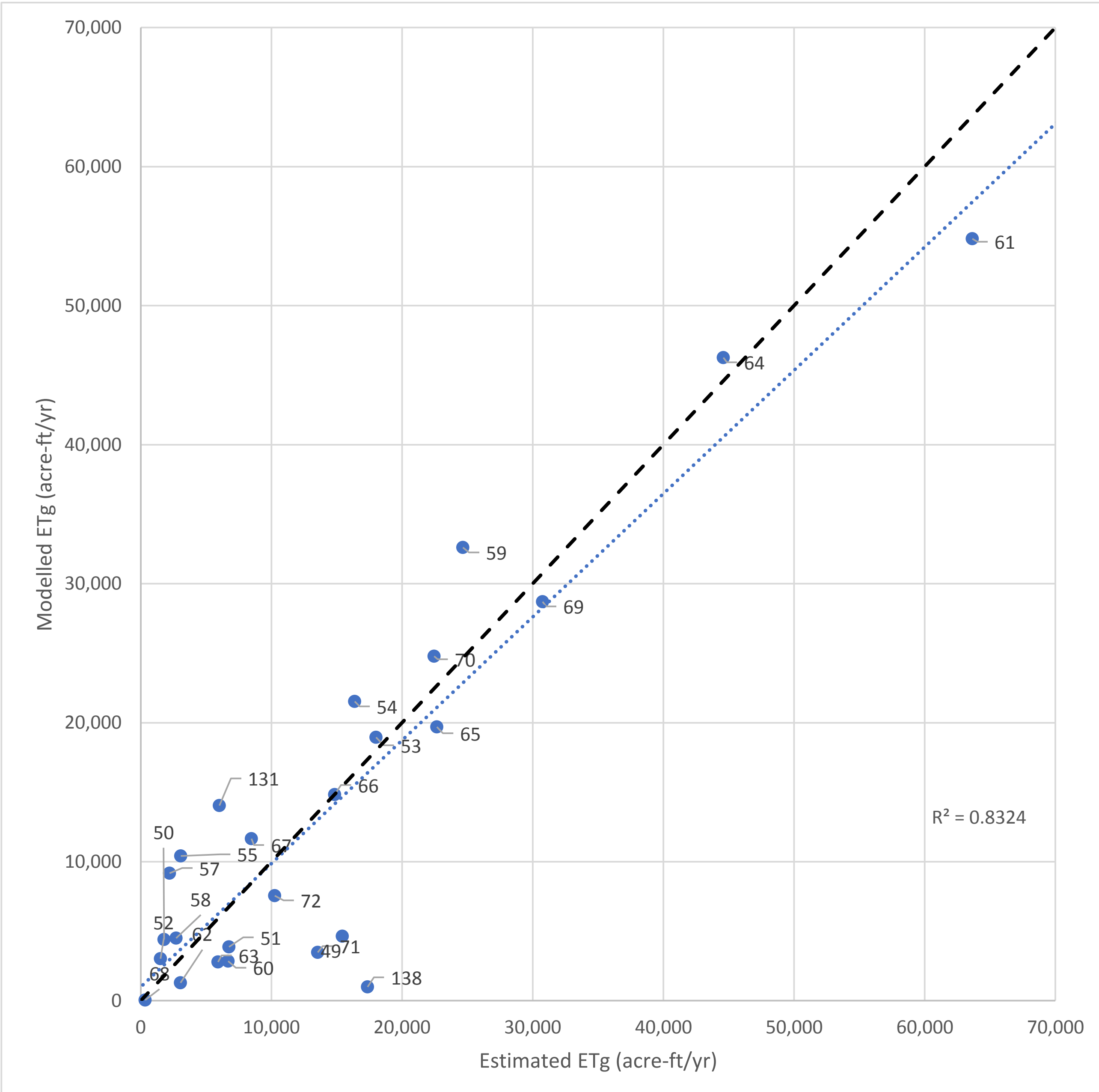
Calibration Status

Simulated precipitation recharge by HA



HA Number	HA Name
49	Elko Segment
50	Susie Creek Area
51	Maggie Creek Area
52	Marys Creek Area
53	Pine Valley
54	Crescent Valley
55	Carico Lake Valley
57	Antelope Valley
58	Middle Reese River Valley
59	Lower Reese River Valley
60	Whirlwind Valley
61	Boulder Flat
62	Rock Creek Valley
63	Willow Creek Valley
64	Clovers Area
65	Pumpernickel Valley
66	Kelley Creek Area
67	Little Humboldt Valley
68	Hardscrabble Area
69	Paradise Valley
70	Winnemucca Segment
71	Grass Valley
72	Imlay Area
131	Buffalo Valley
138	Grass Valley

Simulated groundwater evapotranspiration by HA



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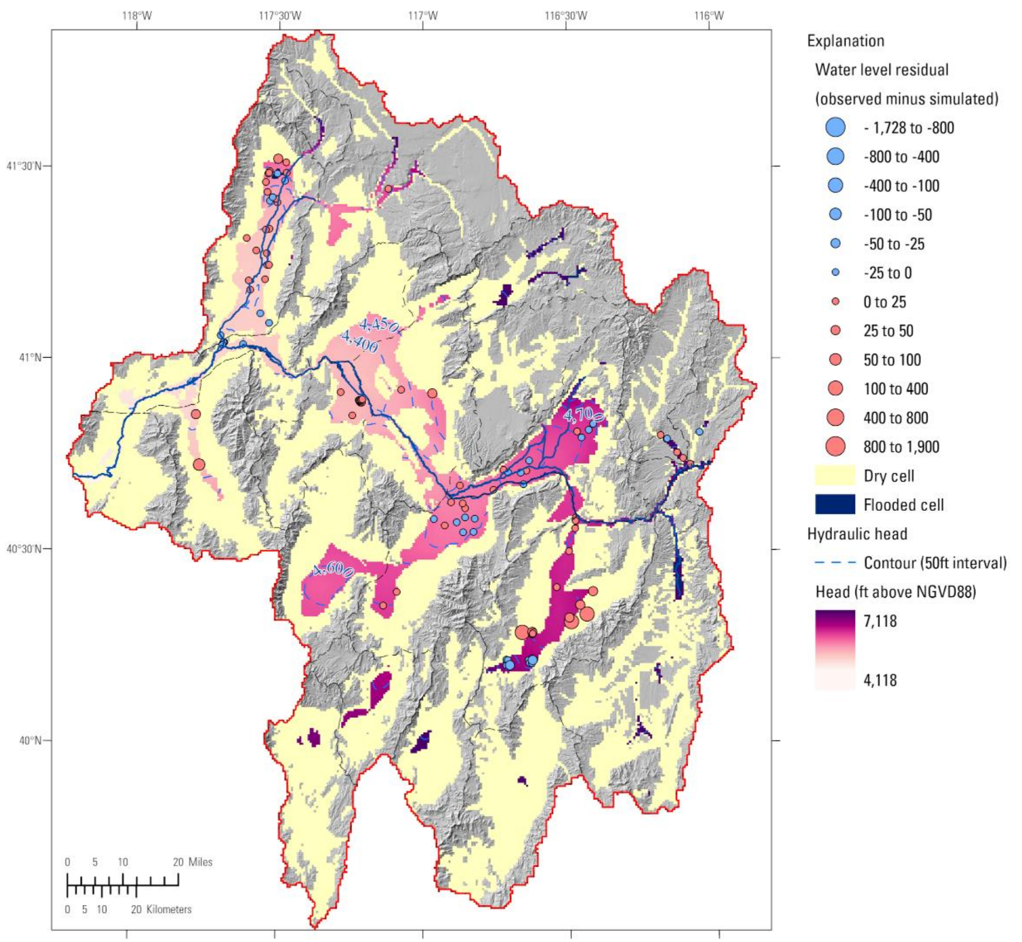
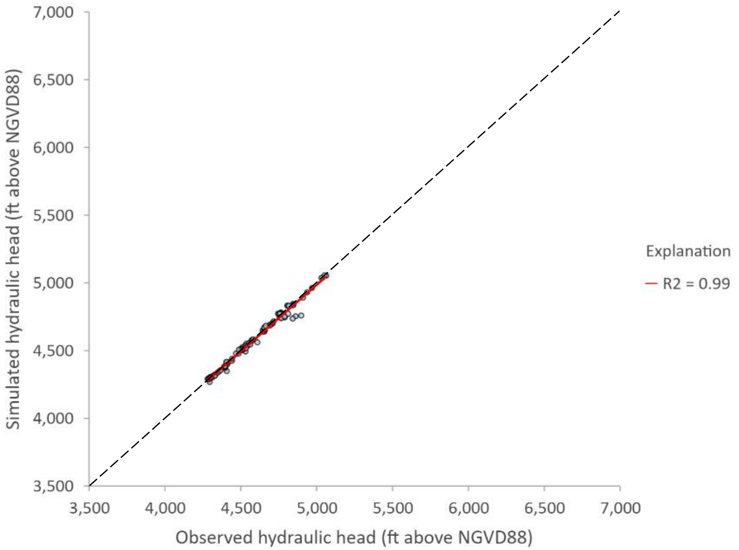
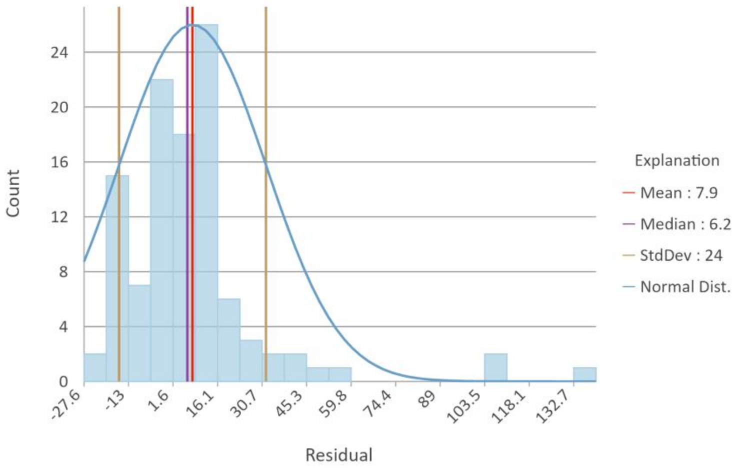
65	Pumpernickel Valley
66	Kelley Creek Area
67	Little Humboldt Valley
68	Hardscrabble Area
69	Paradise Valley
70	Winnemucca Segment
71	Grass Valley
72	Imlay Area
131	Buffalo Valley
138	Grass Valley

Water levels

Hydraulic head targets, layer 1

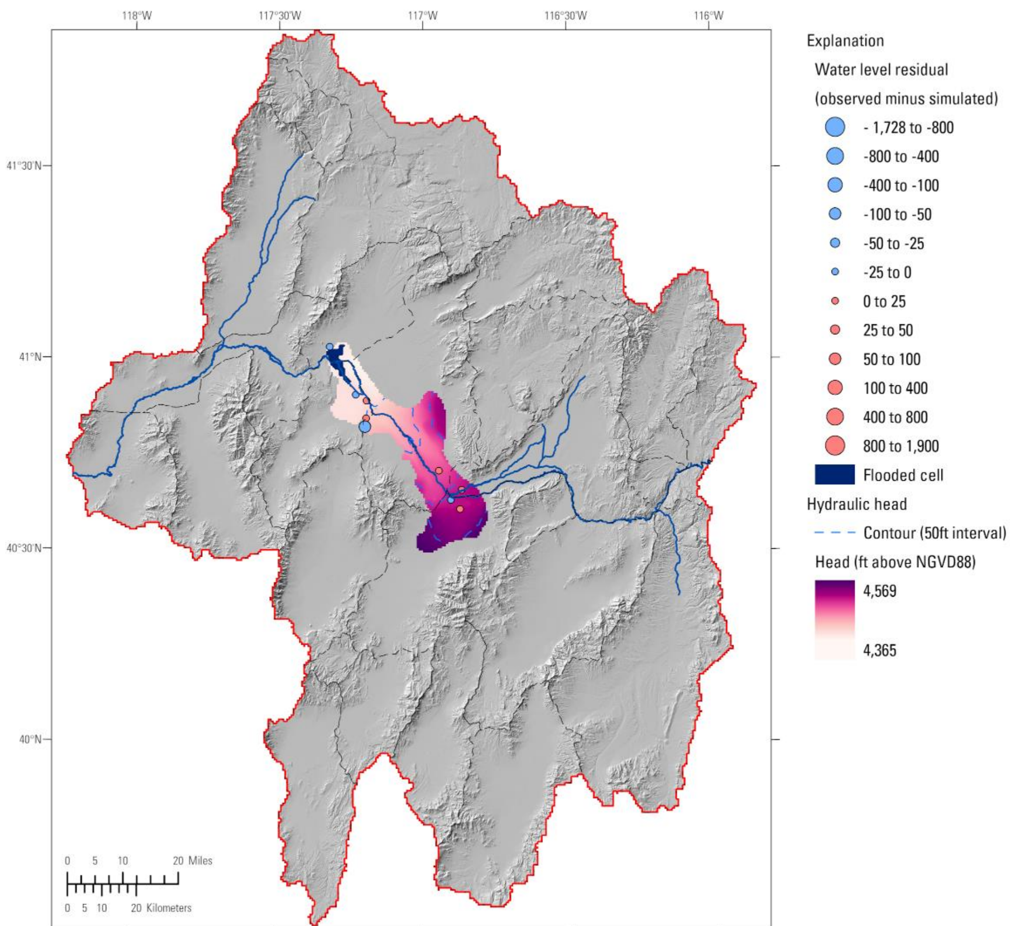


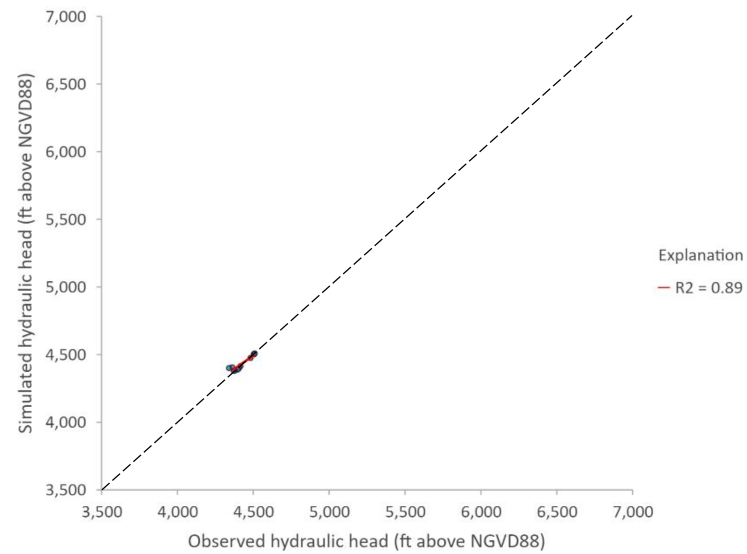


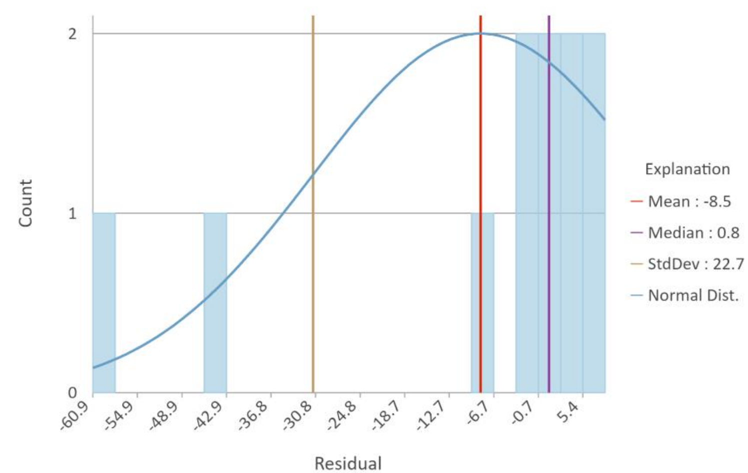


Water levels

Hydraulic head targets, layer 2

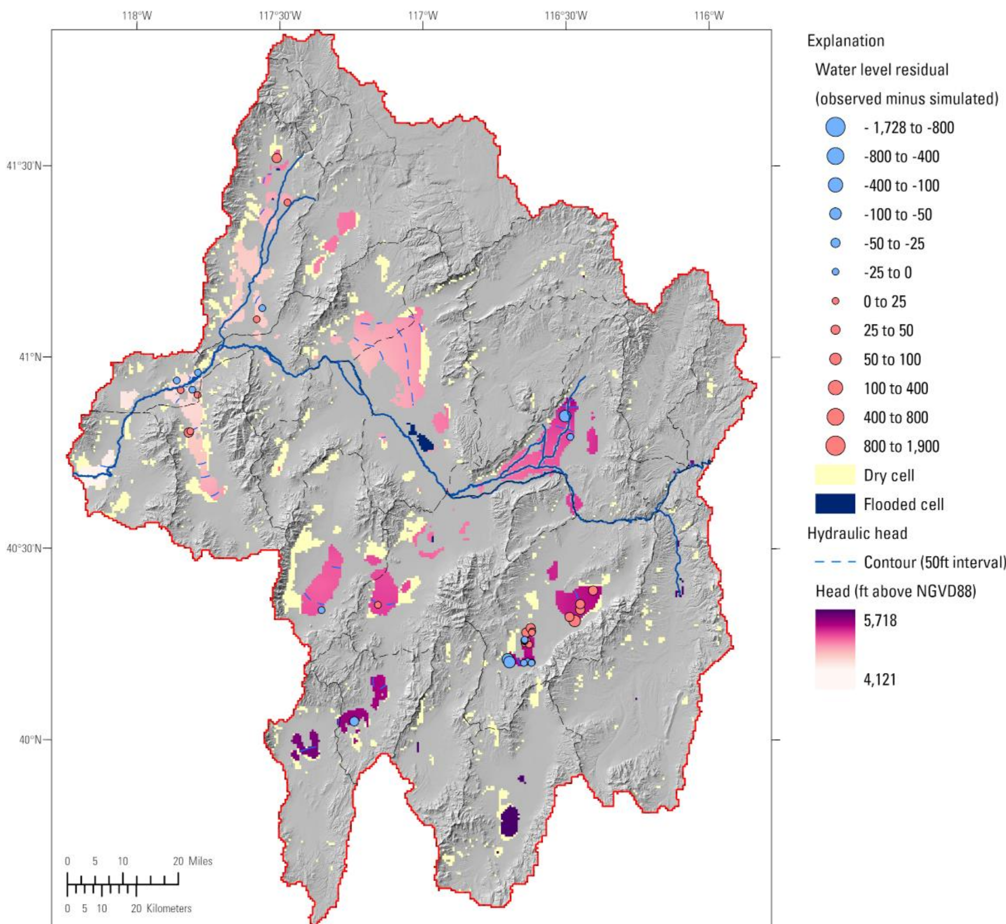


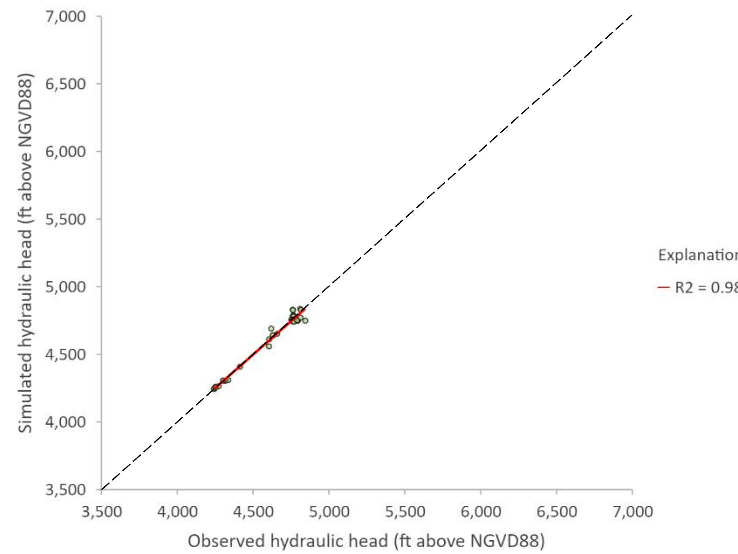


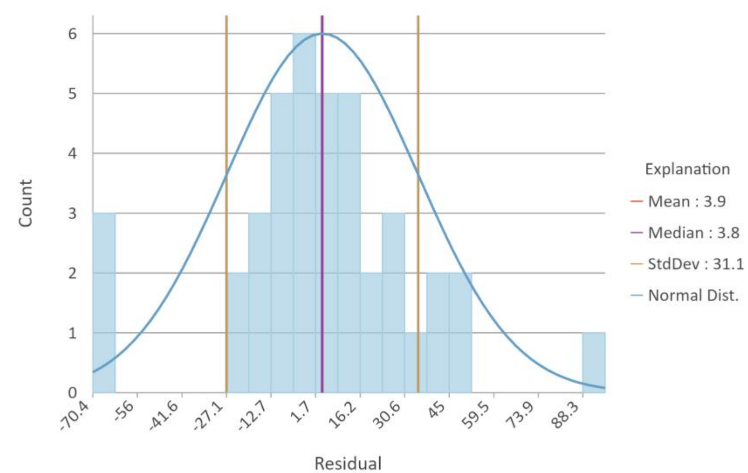


Water levels

Hydraulic head targets, layer 3

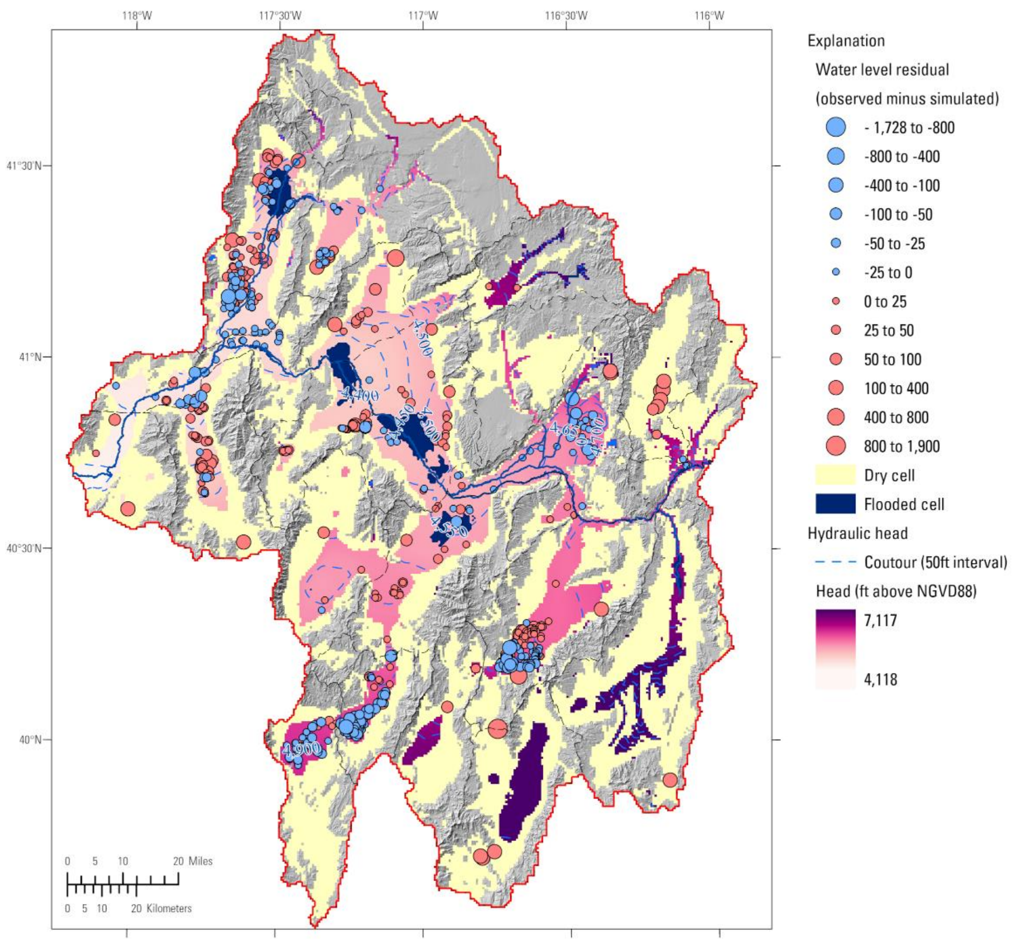


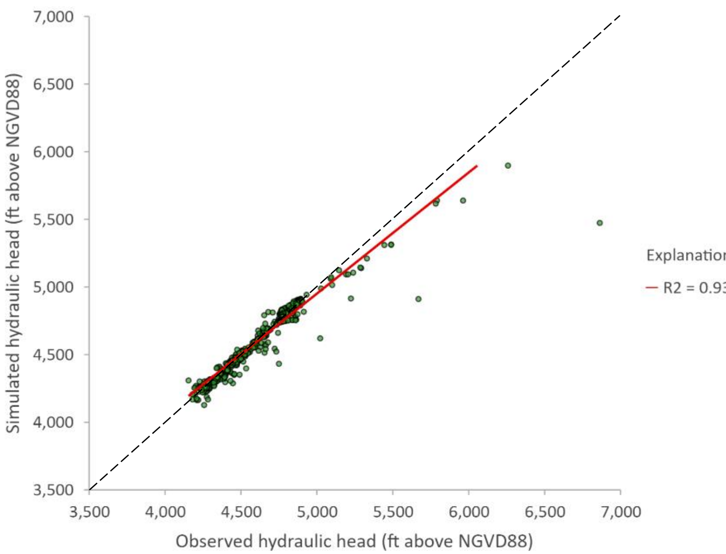


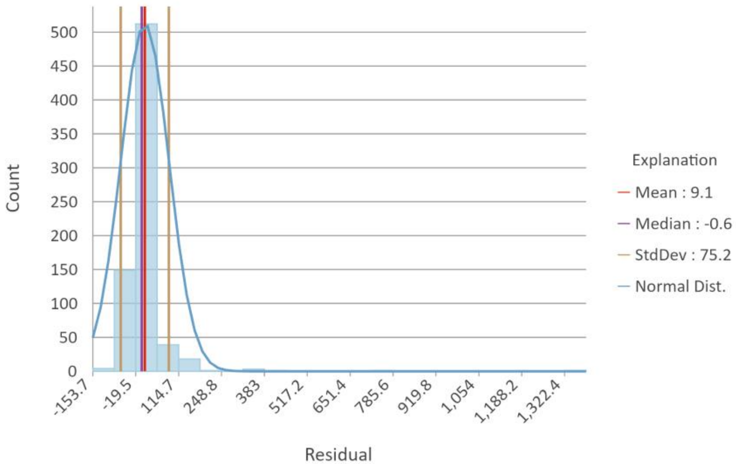


Water levels

Hydraulic head targets, layer 4

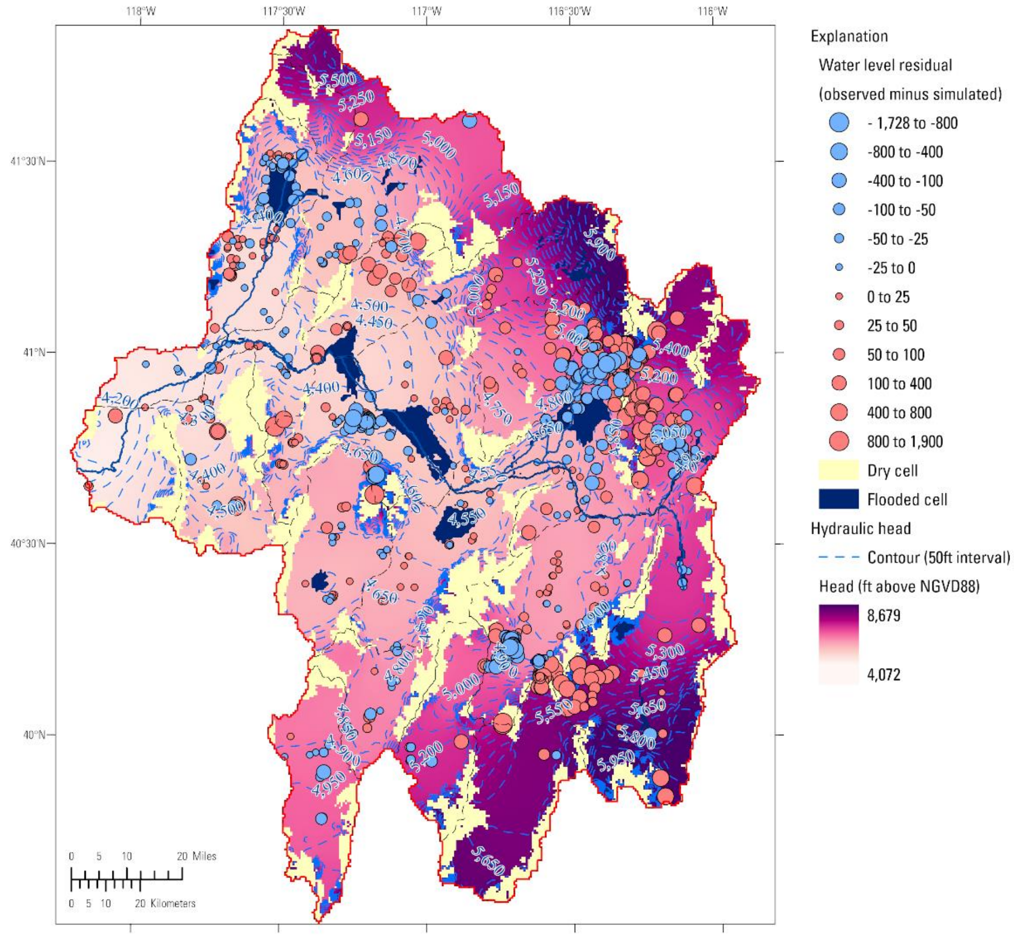


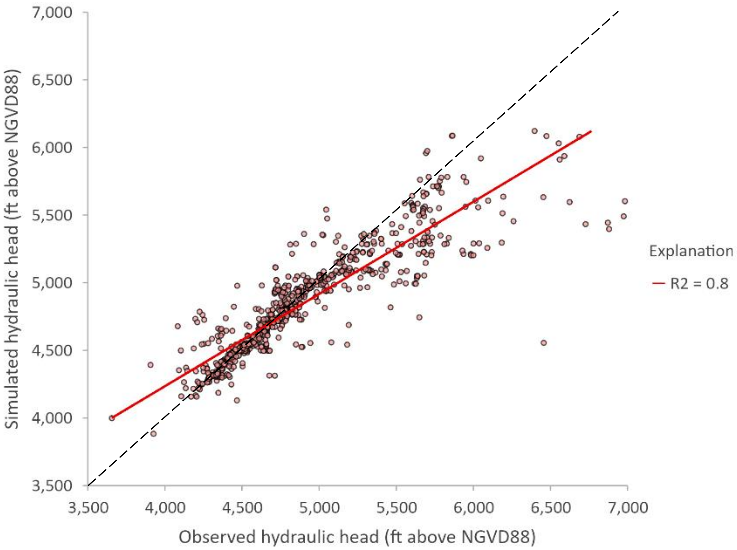


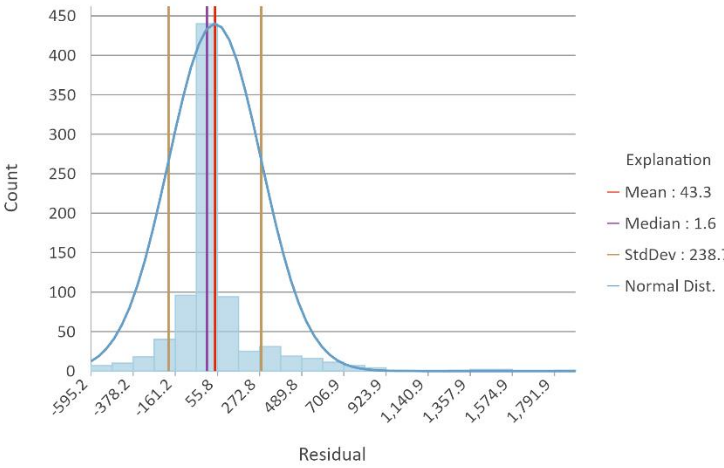


Water levels

Hydraulic head targets, layer 5

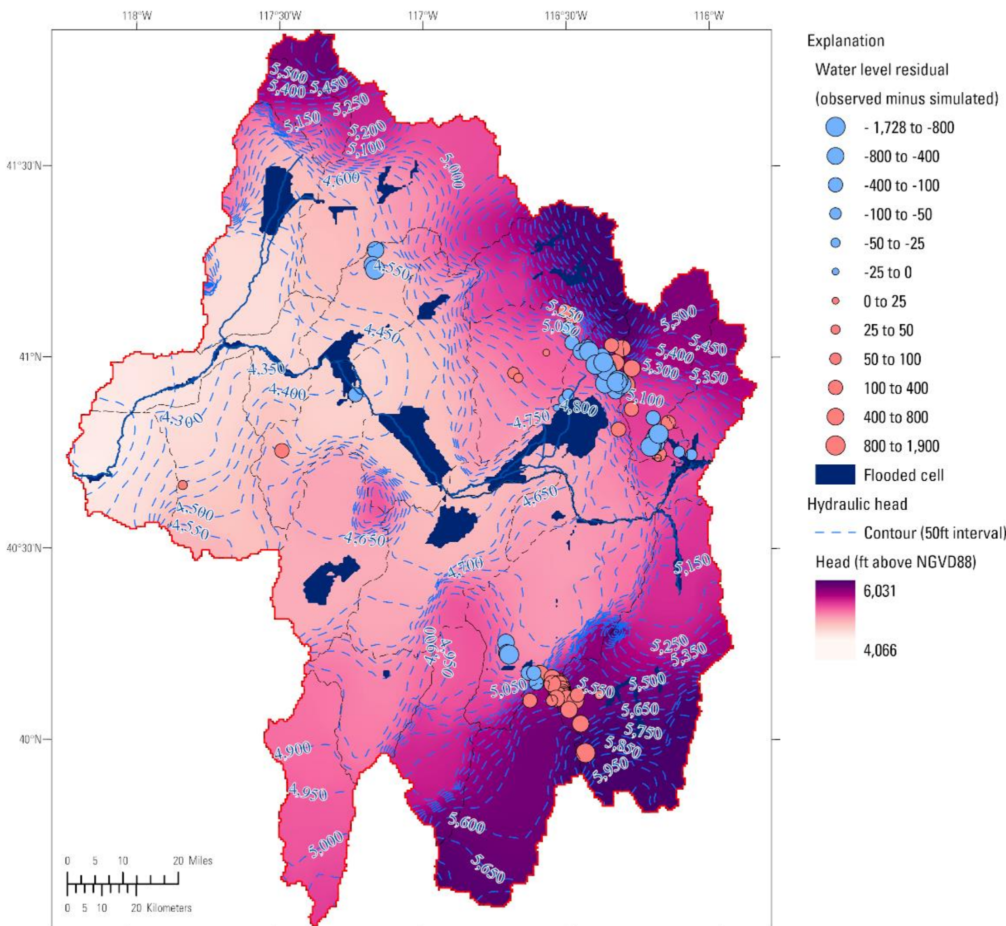


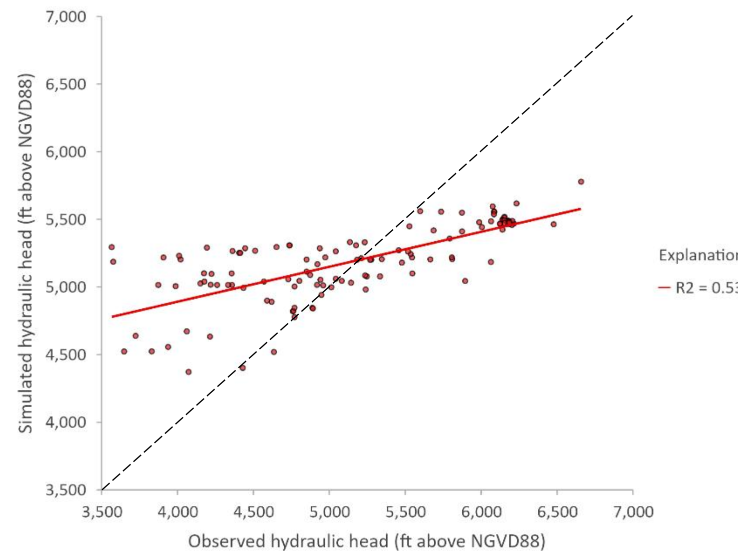


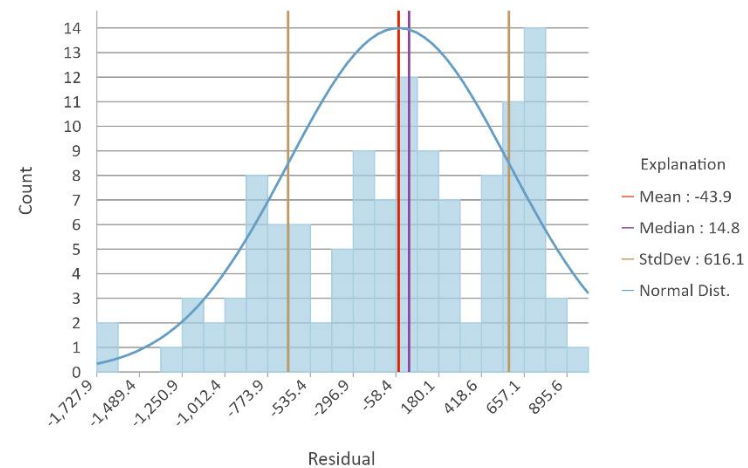


Water levels

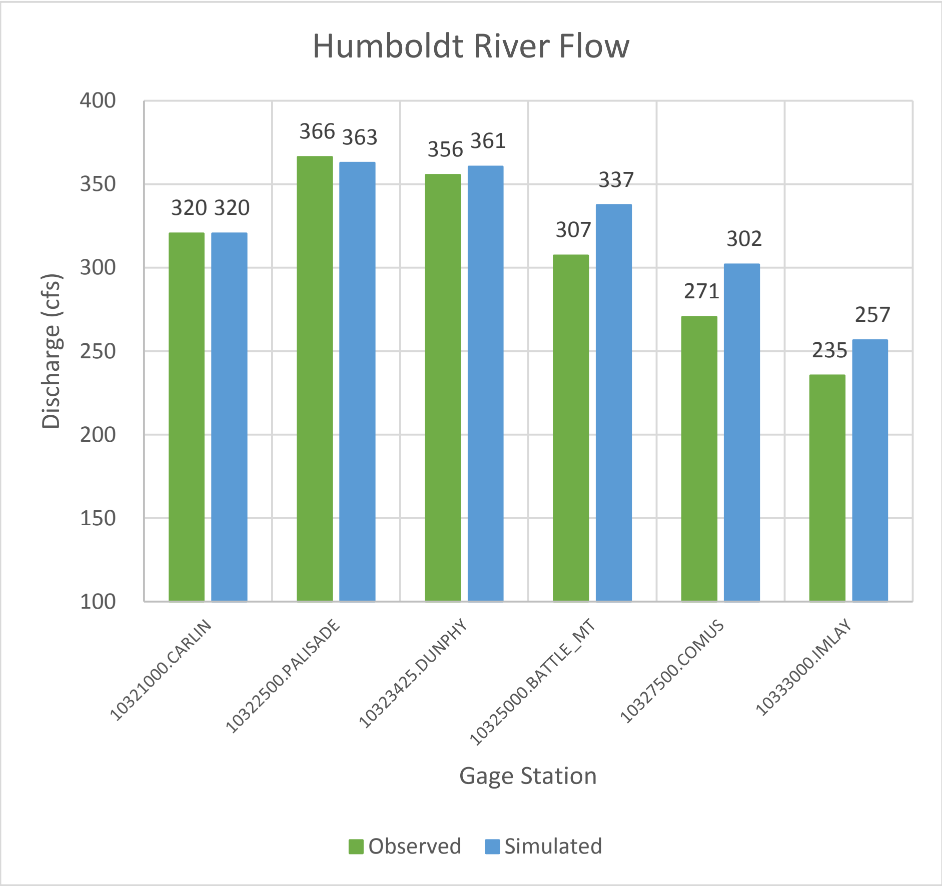
Hydraulic head targets, layer 6

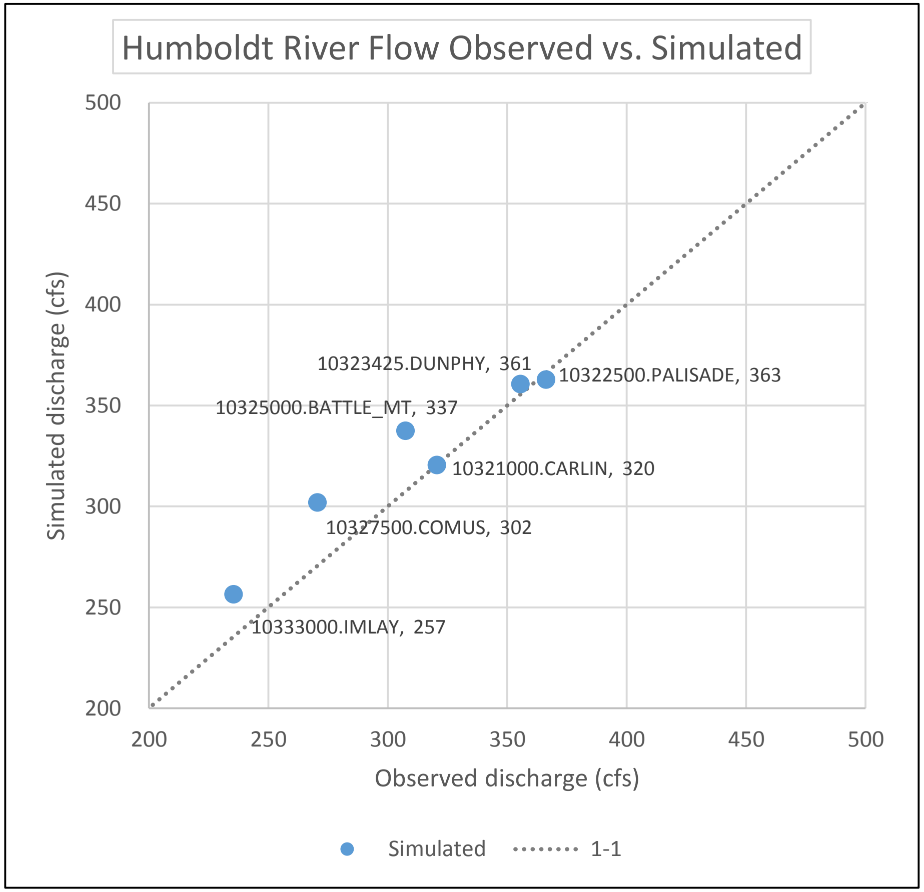




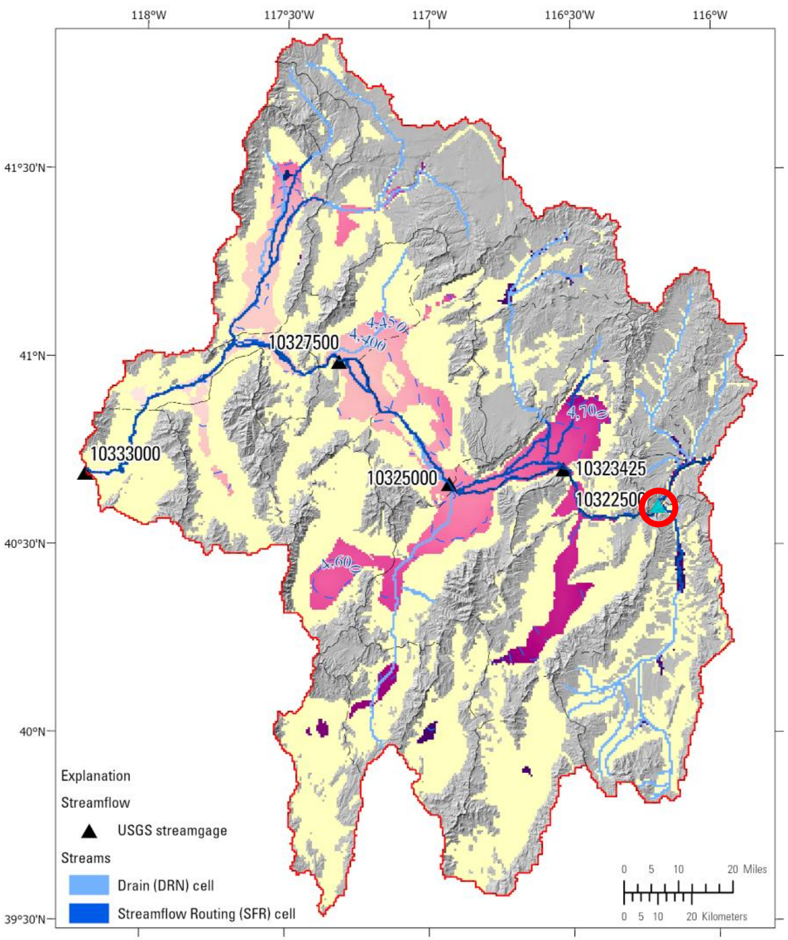


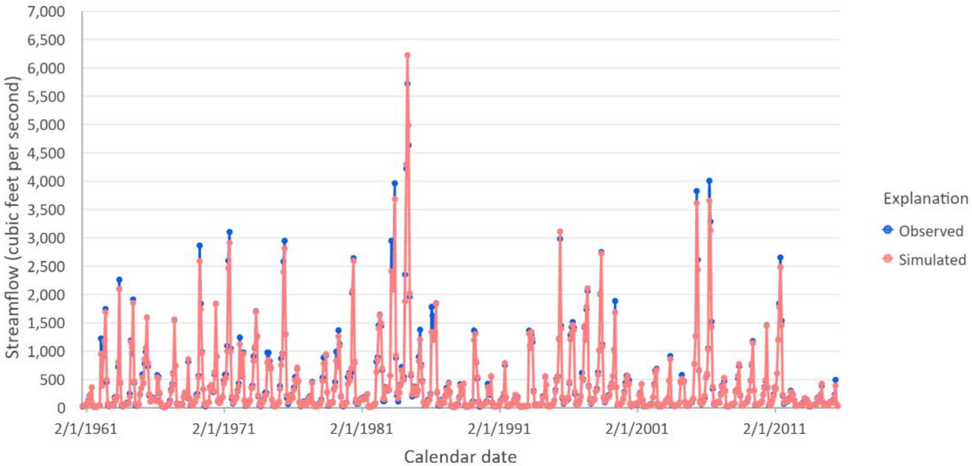
Simulated Steady-State Humboldt River stream flow

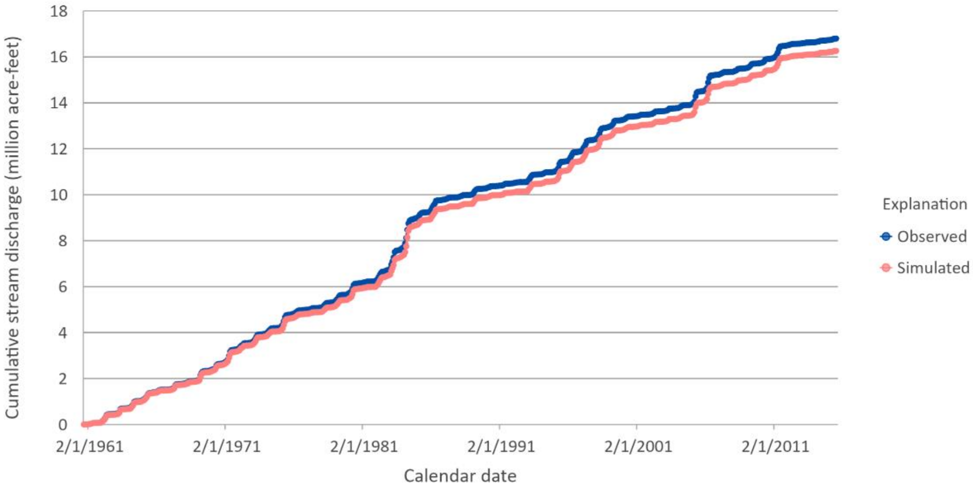




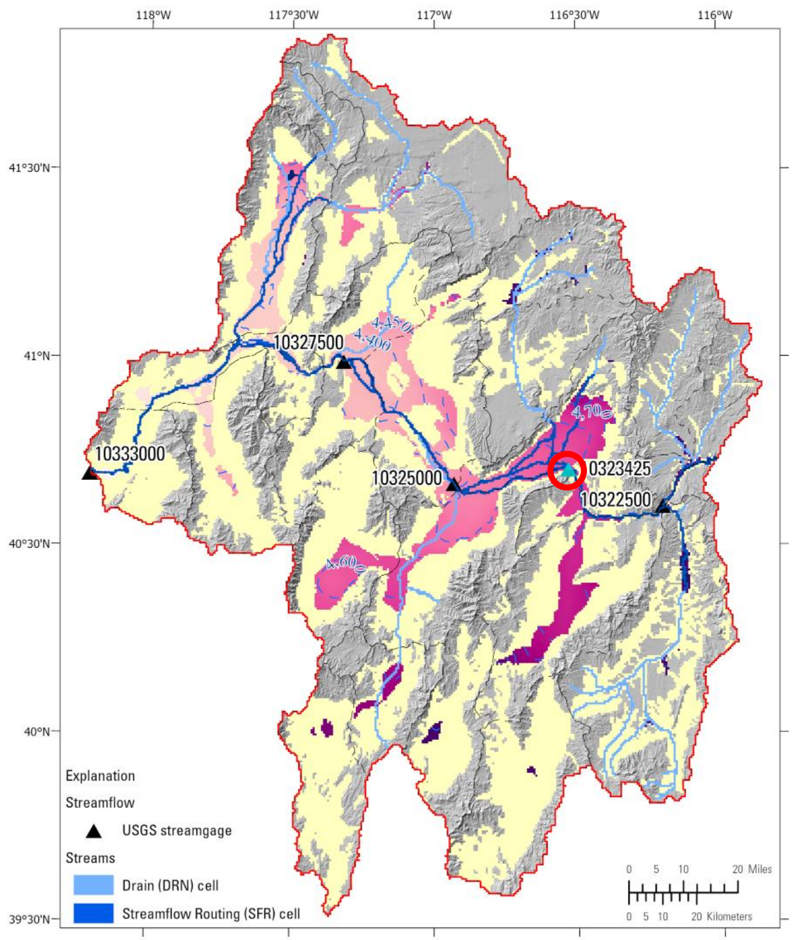
Streamflow and cumulative streamflow Humboldt River at Palisade: USGS-10322500

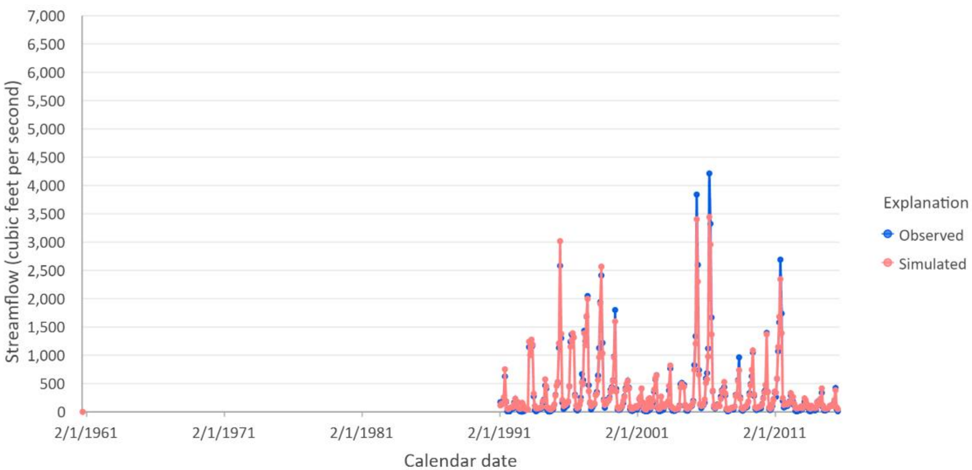


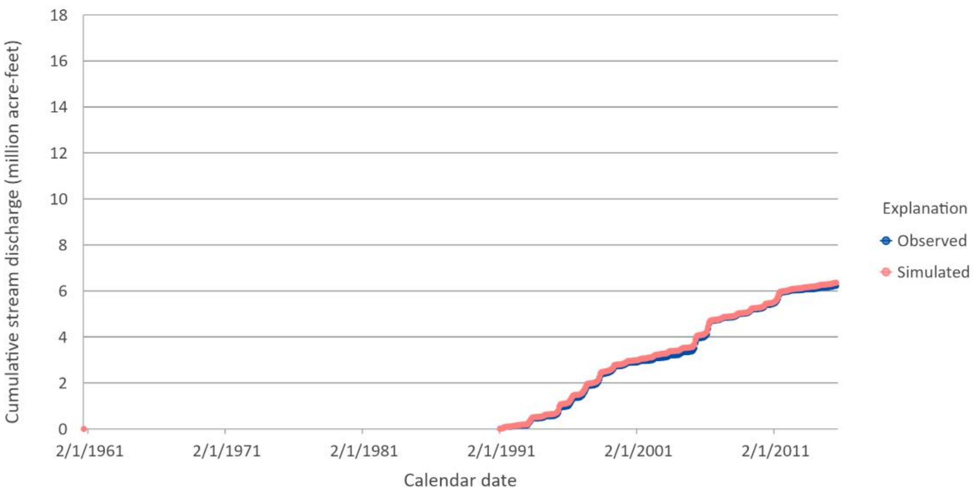




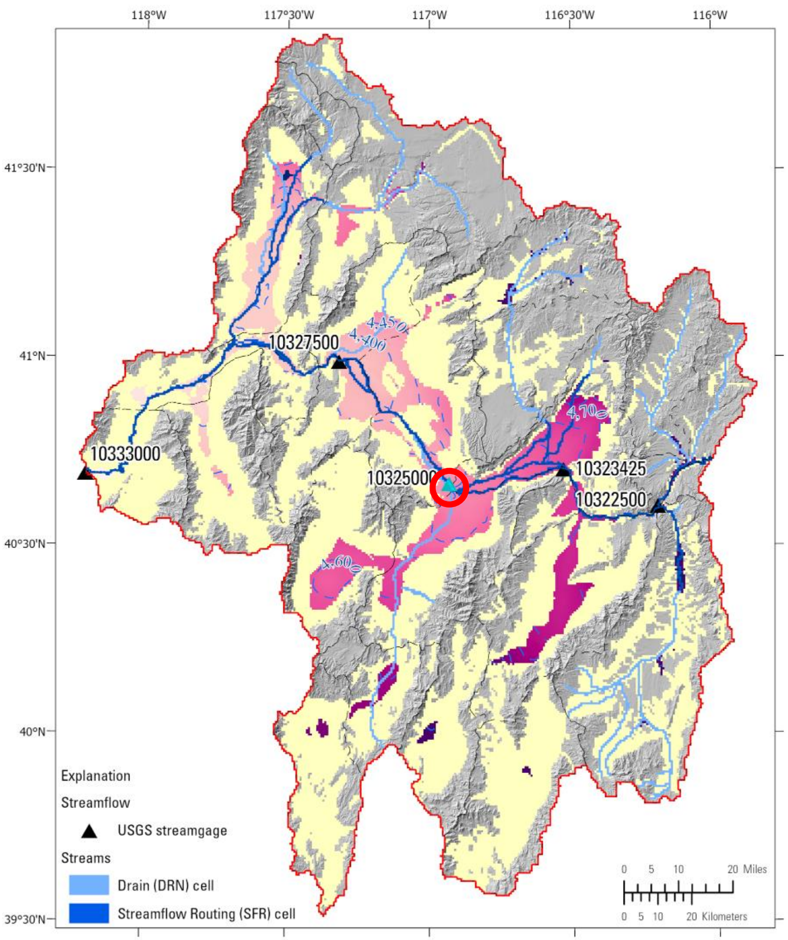
Streamflow and cumulative streamflow Humboldt River at Dunphy: USGS-10323425

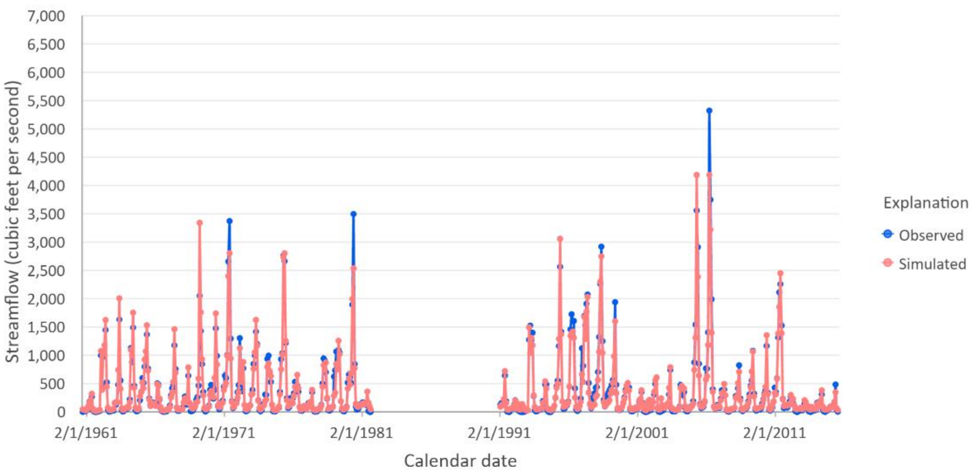


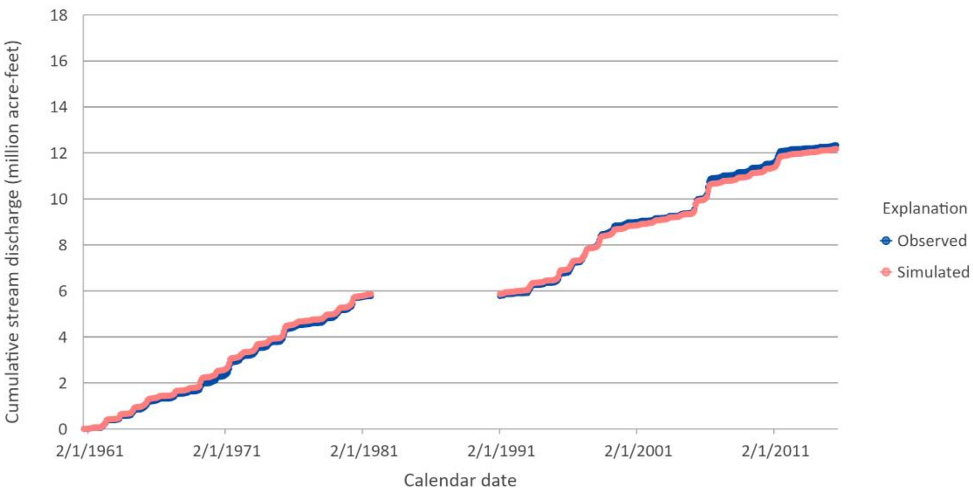




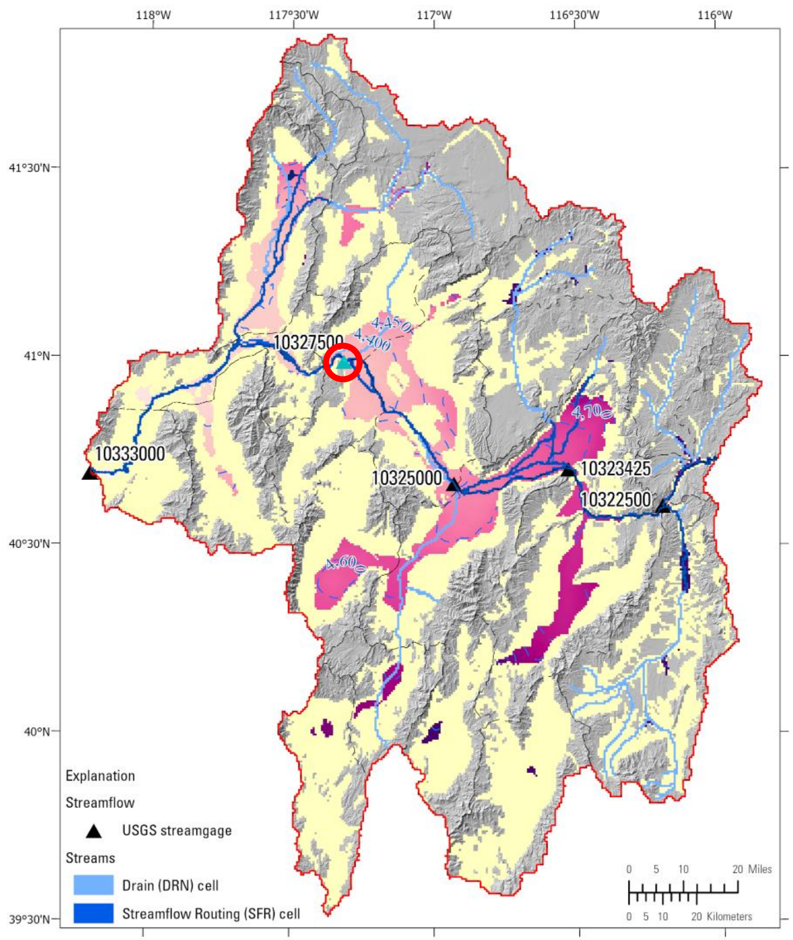
Streamflow and cumulative streamflow Humboldt River at Battle Mt: USGS-10325000

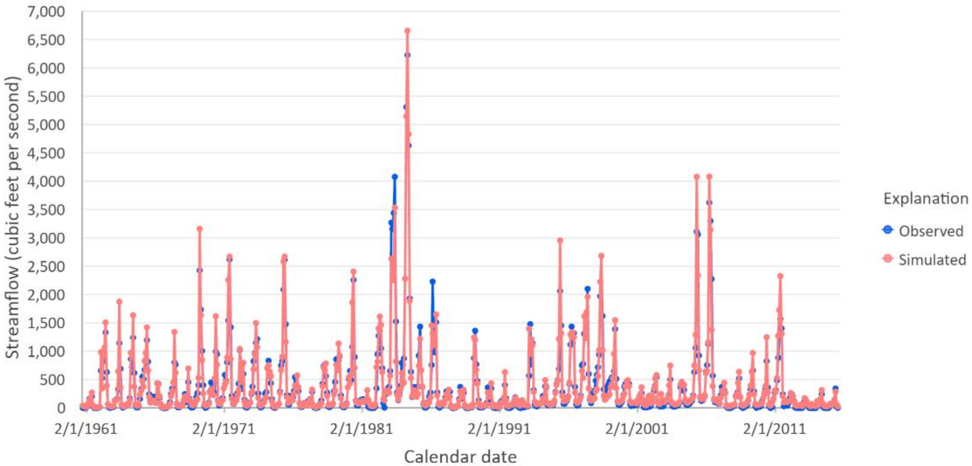


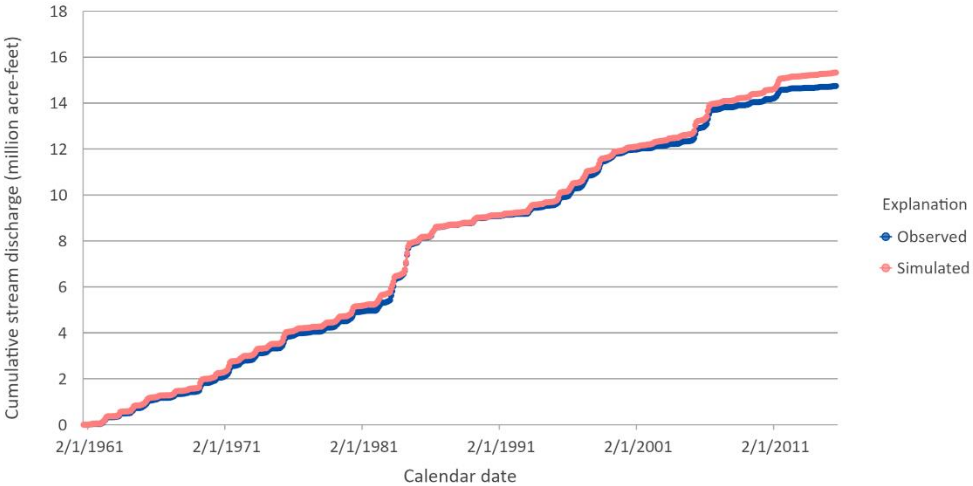




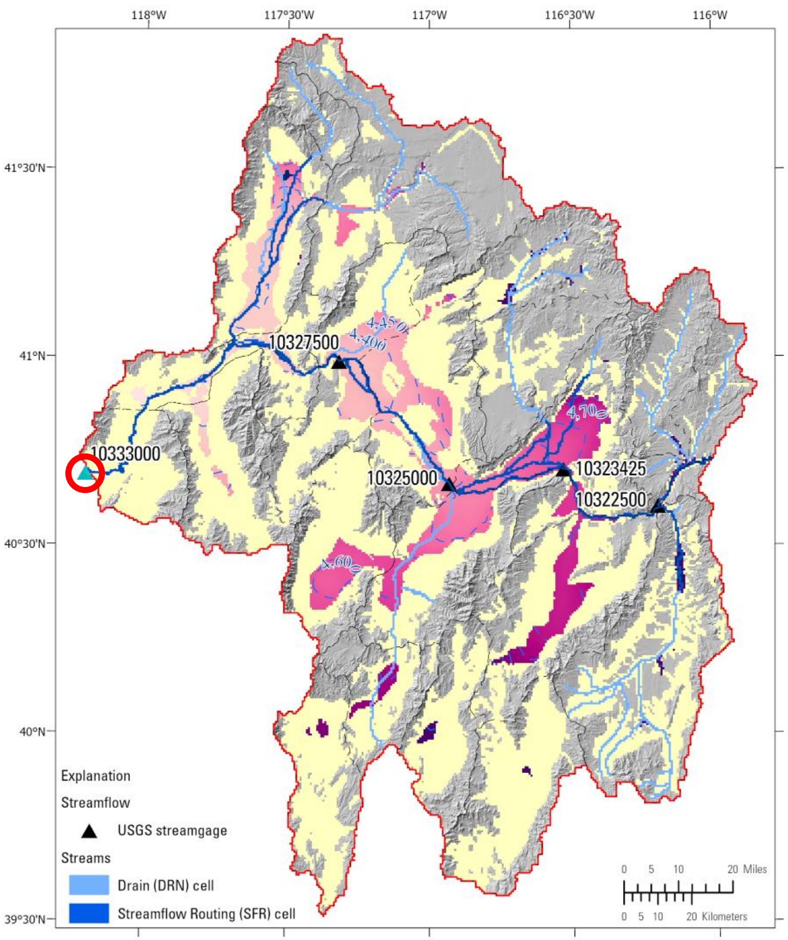
Streamflow and cumulative streamflow Humboldt River at Comus: USGS-10327500

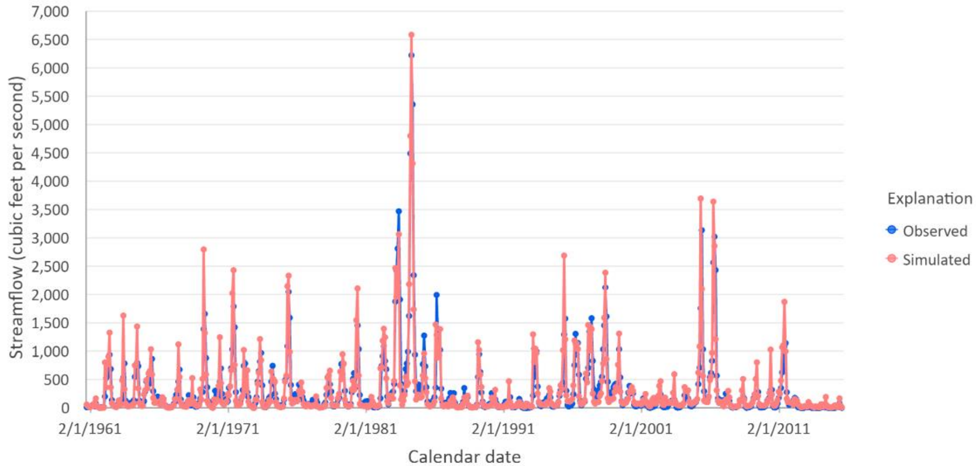


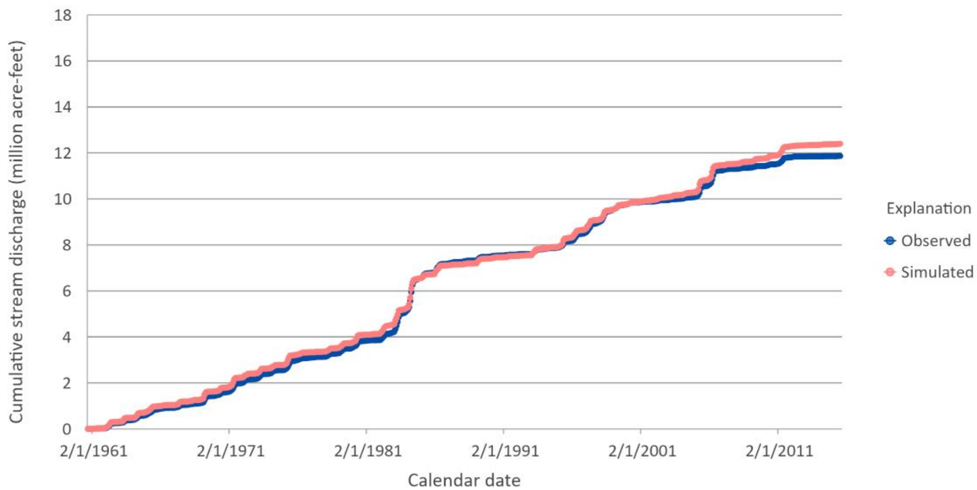




Streamflow and cumulative streamflow Humboldt River at Imlay: USGS-10333000

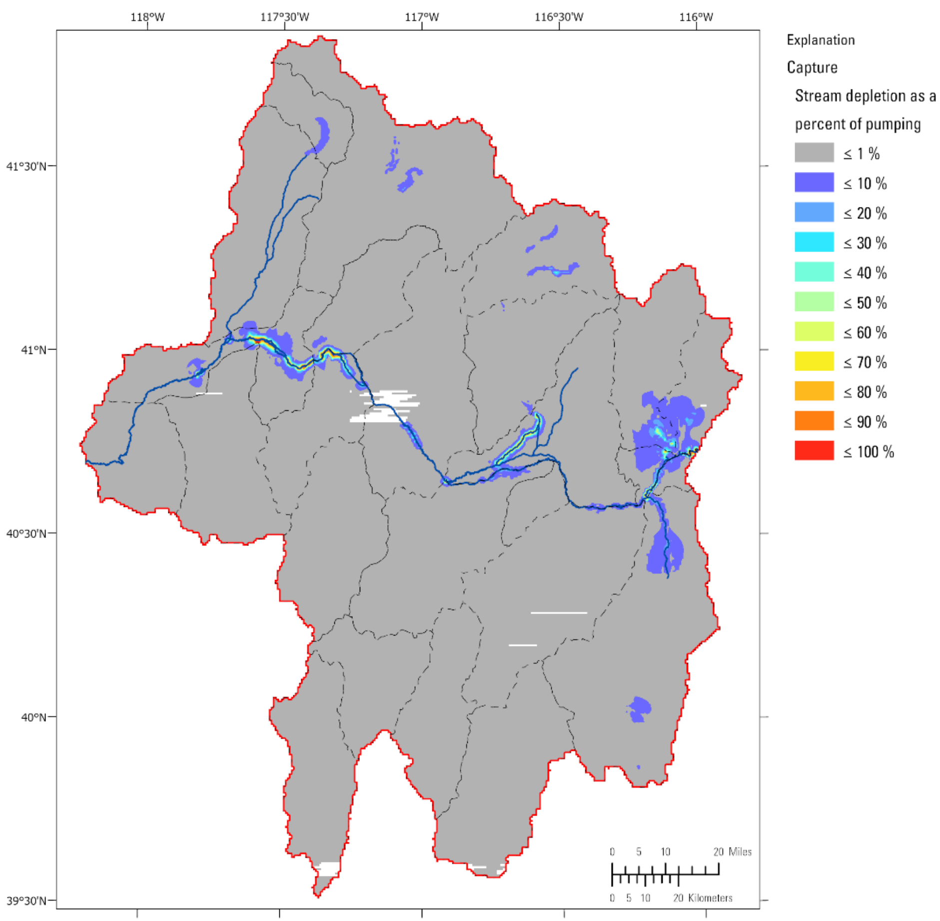




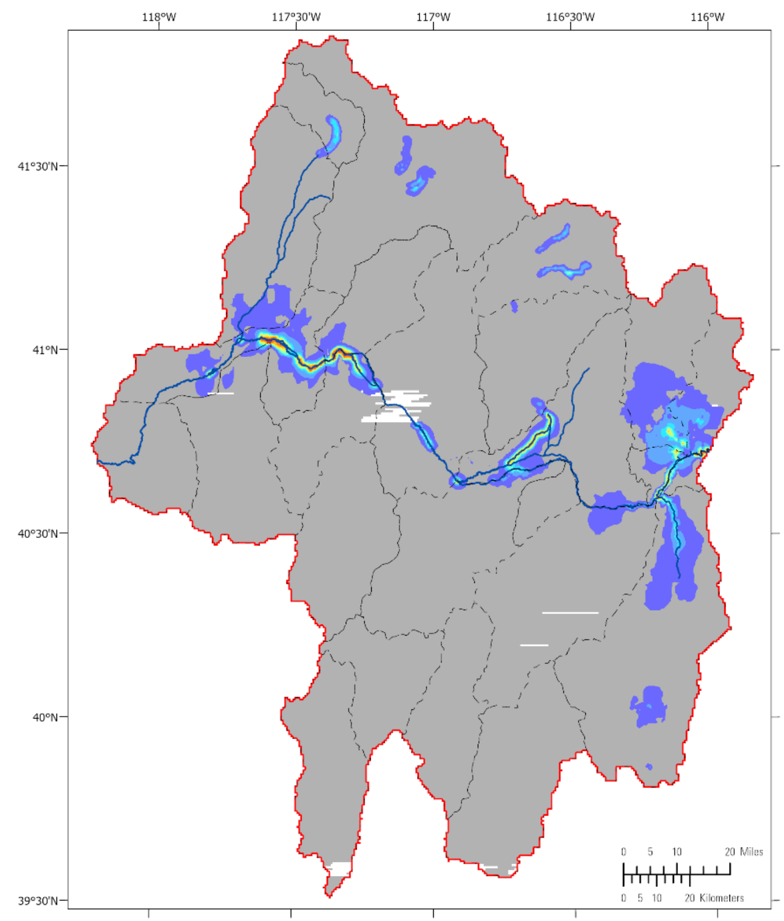


Preliminary Results

Streamflow capture: 1 to 5 years

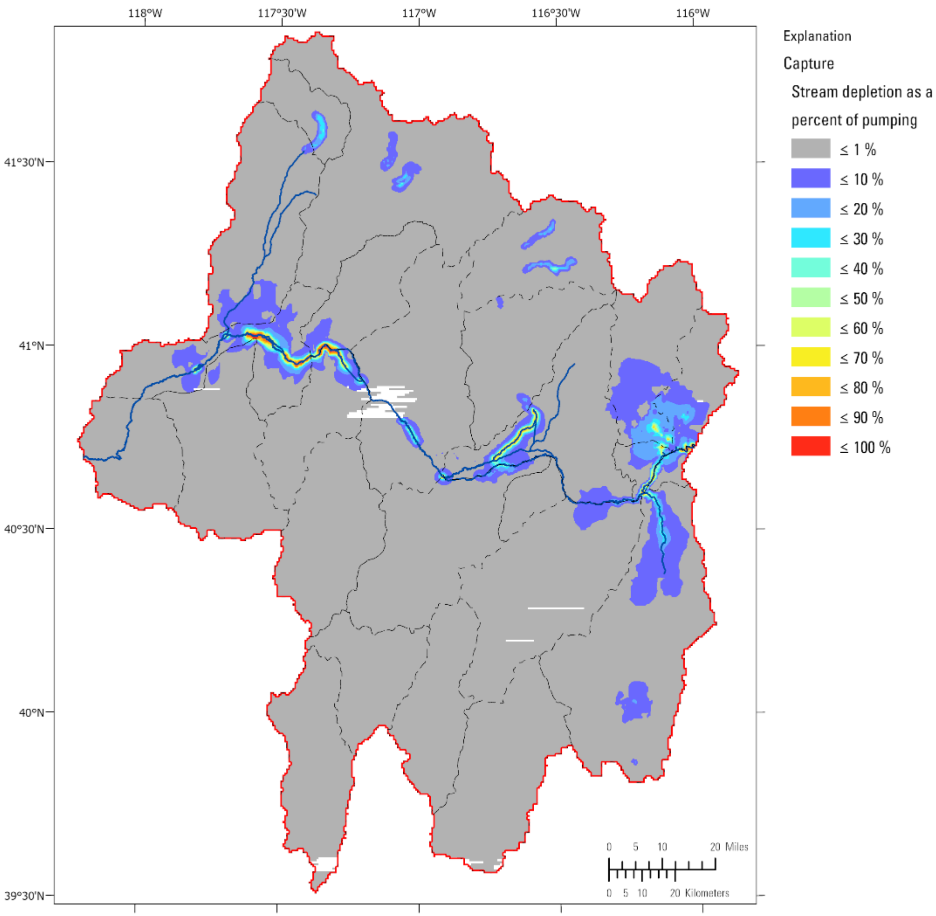


Year 1

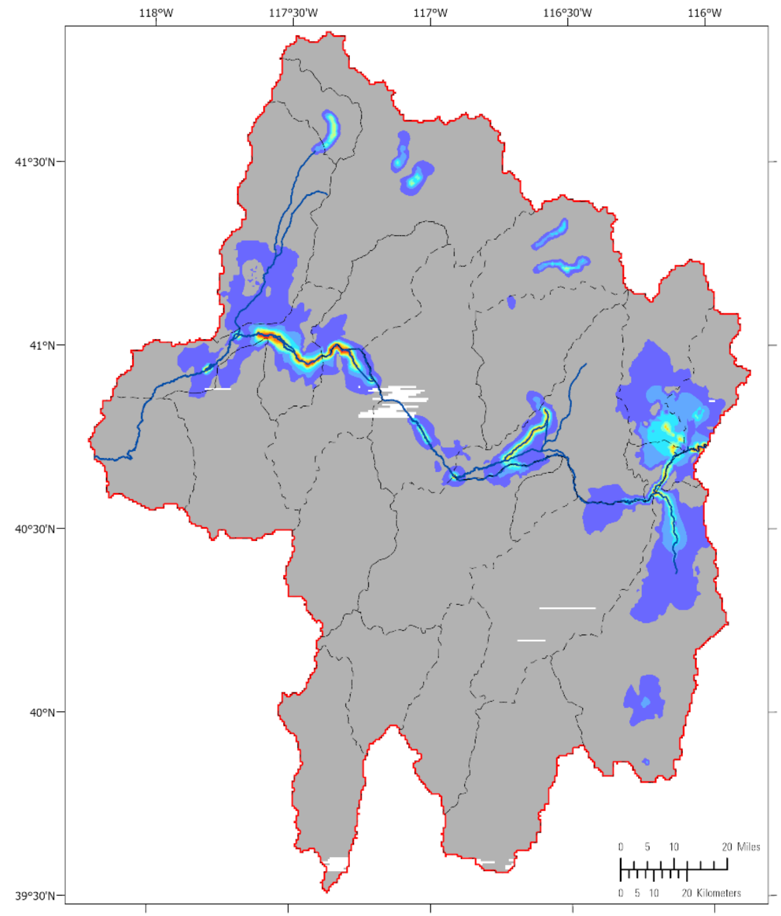


Year 5

Streamflow capture: 5 to 10 years



Year 5



Year 10

Humboldt Capture Query Tool

Legend

- Study Area
- Hydrographic Area
- Humboldt River Basin
- No Data

Step 1: Select Location

Select a location by either clicking within the study area on the map, or by entering the coordinates below:

Latitude (decimal degrees):

enter latitude

example: 40.635409

Longitude (decimal degrees):

enter longitude Locate

example: -116.944957

Step 2: Select Depth

The maximum depth in feet for this location is:

Depth below surface:

enter depth

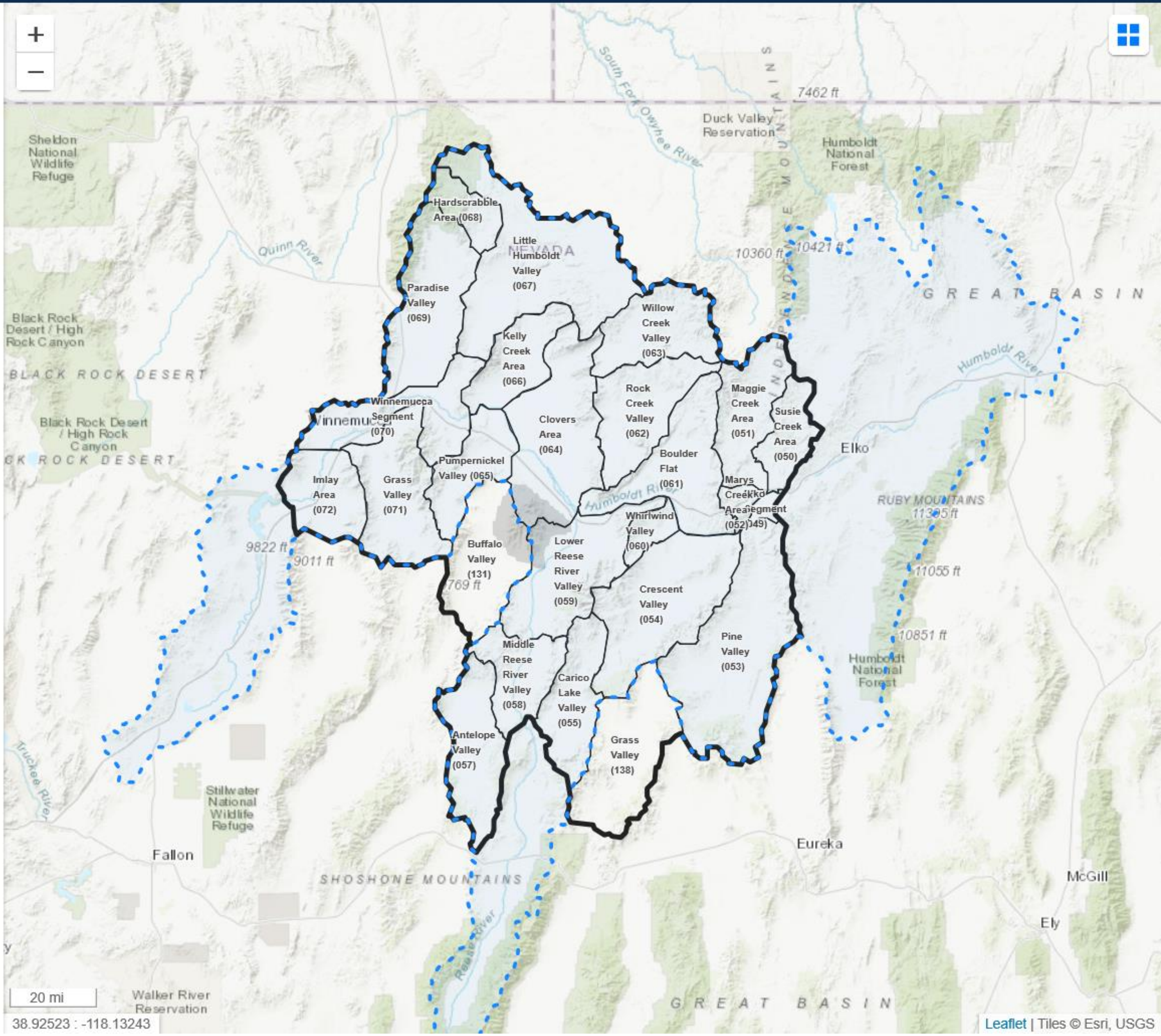
example: 500

Step 3: Select Years

Number of years pumping (1-100):

1 year

Results



Capture: streamflow dominated

Humboldt Capture Query Tool

Legend

- Study Area
- Hydrographic Area
- Humboldt River Basin
- No Data

Step 1: Select Location

Select a location by either clicking within the study area on the map, or by entering the coordinates below:

Latitude (decimal degrees):

40.981203

example: 40.635409

Longitude (decimal degrees):

-117.307486 Locate

example: -116.944957

Step 2: Select Depth

The maximum depth in feet for this location is: **4078**

Depth below surface:

5

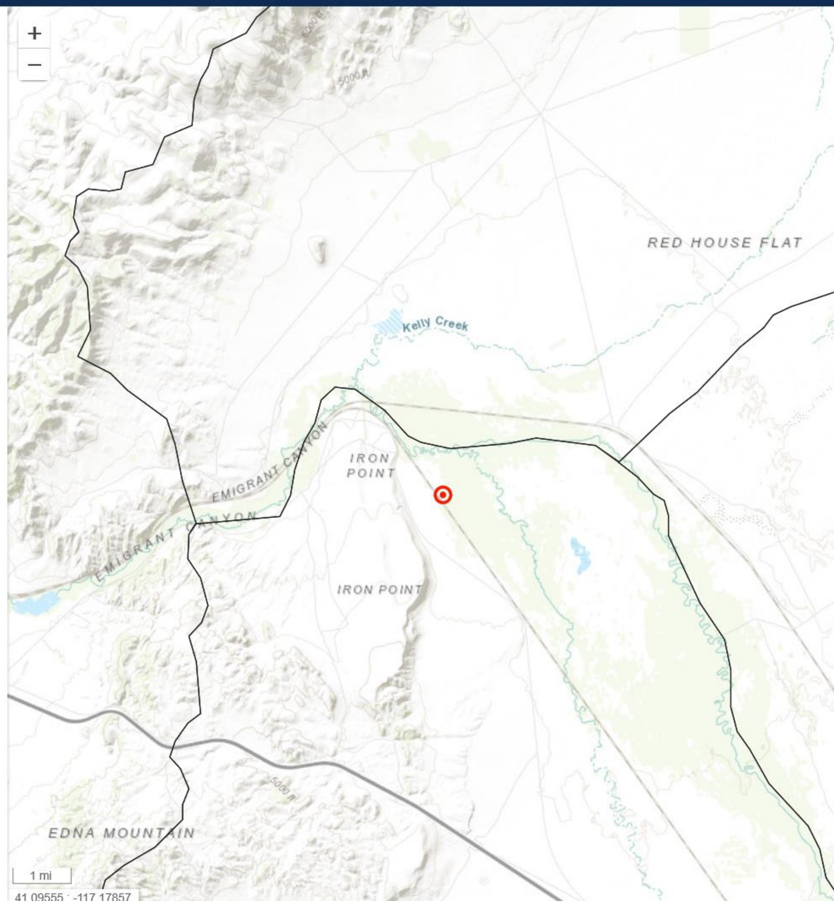
example: 500

Step 3: Select Years

Number of years pumping (1-100):

1 year

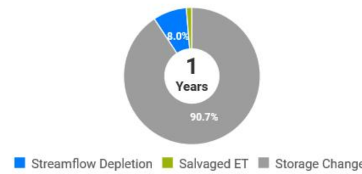
Results

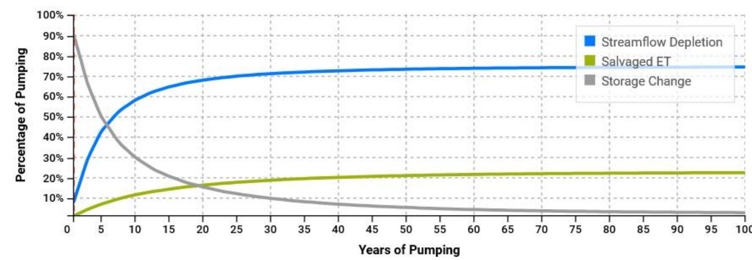


Humboldt Capture Query Tool Results

Print

After **1 years** of pumping at location **40.981203**, **-117.307486**, at a depth of **5 feet** below land surface, groundwater is derived from the following sources:





Summary | All Years

Years of Pumping	Streamflow Depletion	Salvaged ET	Storage Change
1	8.0%	1.3%	90.7%
5	42.6%	7.0%	50.4%
10	58.2%	11.6%	30.2%
20	68.1%	16.4%	15.5%
25	70.1%	17.8%	12.2%
50	73.5%	21.1%	5.4%
75	74.3%	22.2%	3.5%
100	74.6%	22.5%	2.8%

Capture: salvaged ET dominated

Humboldt Capture Query Tool

Legend

- Study Area
- Hydrographic Area
- Humboldt River Basin
- No Data

Step 1: Select Location

Select a location by either clicking within the study area on the map, or by entering the coordinates below:

Latitude (decimal degrees): 40.784181

example: 40.635409

Longitude (decimal degrees): -117.357131 Locate

example: -116.944957

Step 2: Select Depth

The maximum depth in feet for this location is: 4810

Depth below surface: 5

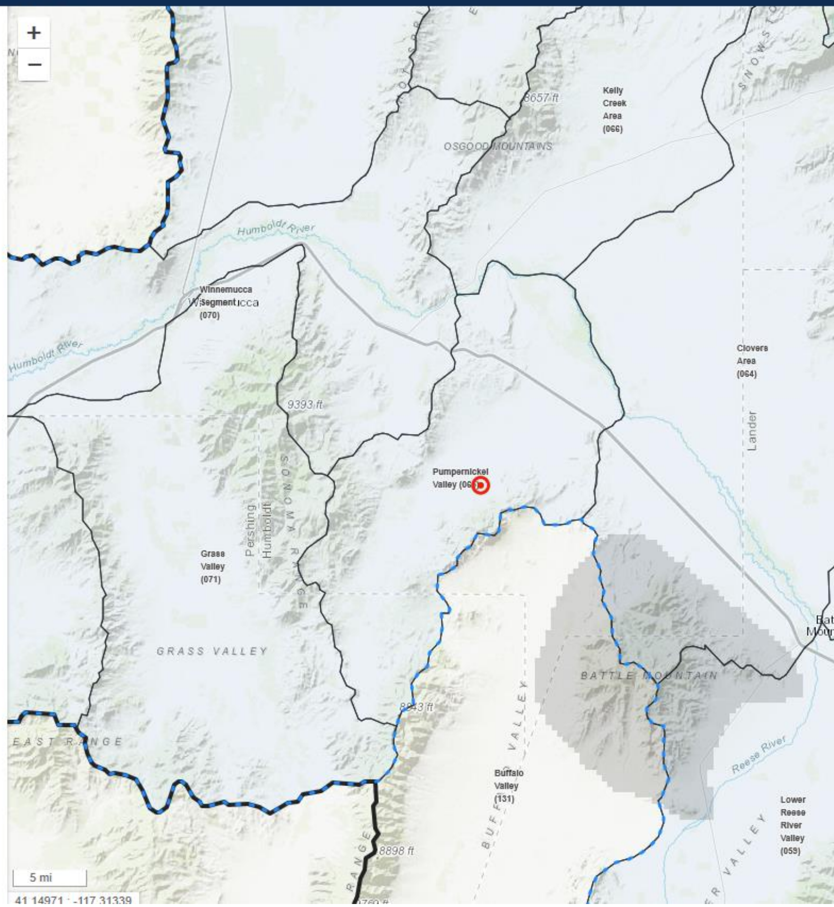
example: 500

Step 3: Select Years

Number of years pumping (1-100):

5 years

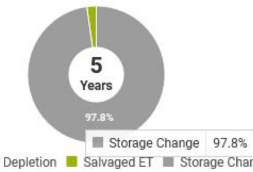
Results

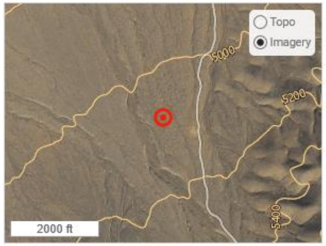


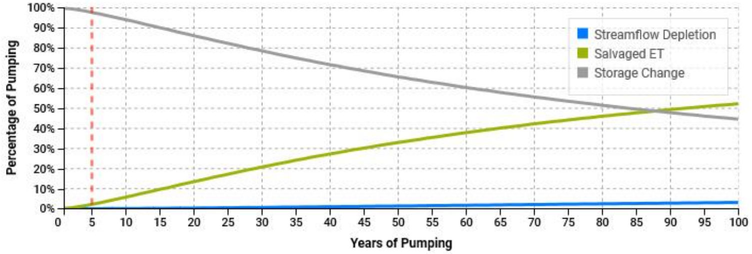
Humboldt Capture Query Tool Results

Print

After **5 years** of pumping at location **40.784181, -117.357131**, at a depth of **5 feet** below land surface, groundwater is derived from the following sources:



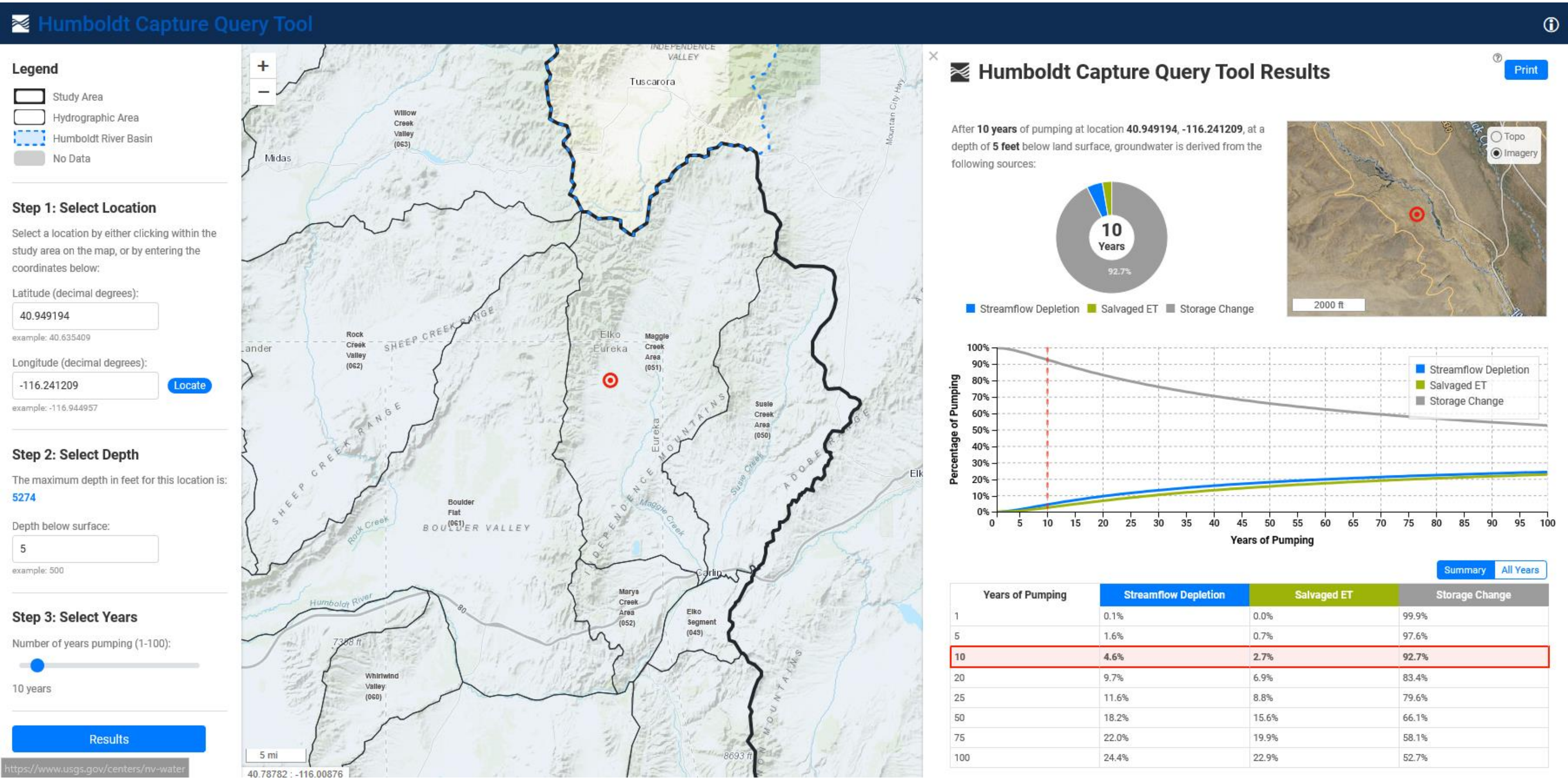




Summary | All Years

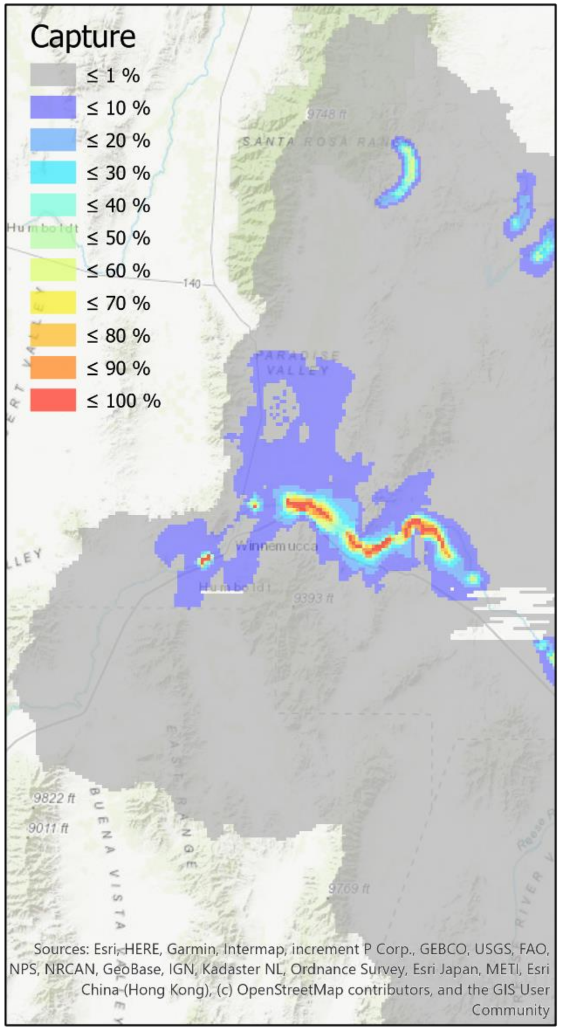
Years of Pumping	Streamflow Depletion	Salvaged ET	Storage Change
1	0.0%	0.2%	99.8%
5	0.0%	2.2%	97.7%
10	0.1%	5.8%	94.1%
20	0.3%	13.5%	86.1%
25	0.5%	17.2%	82.3%
50	1.4%	33.0%	65.6%
75	2.3%	44.2%	53.5%
100	3.1%	52.3%	44.6%

Capture: storage depletion dominated

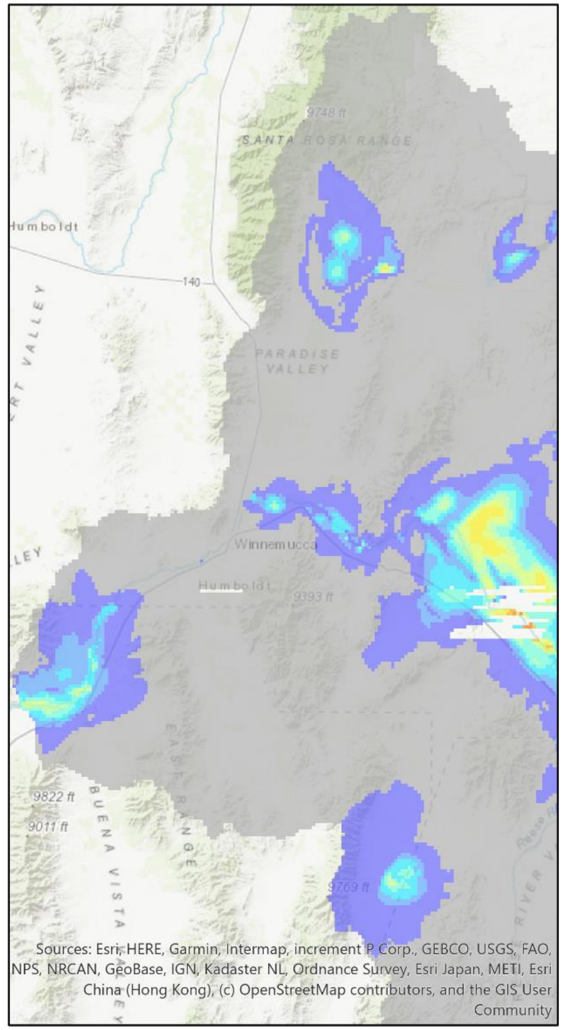


Years of Pumping	Streamflow Depletion	Salvaged ET	Storage Change
1	0.1%	0.0%	99.9%
5	1.6%	0.7%	97.6%
10	4.6%	2.7%	92.7%
20	9.7%	6.9%	83.4%
25	11.6%	8.8%	79.6%
50	18.2%	15.6%	66.1%
75	22.0%	19.9%	58.1%
100	24.4%	22.9%	52.7%

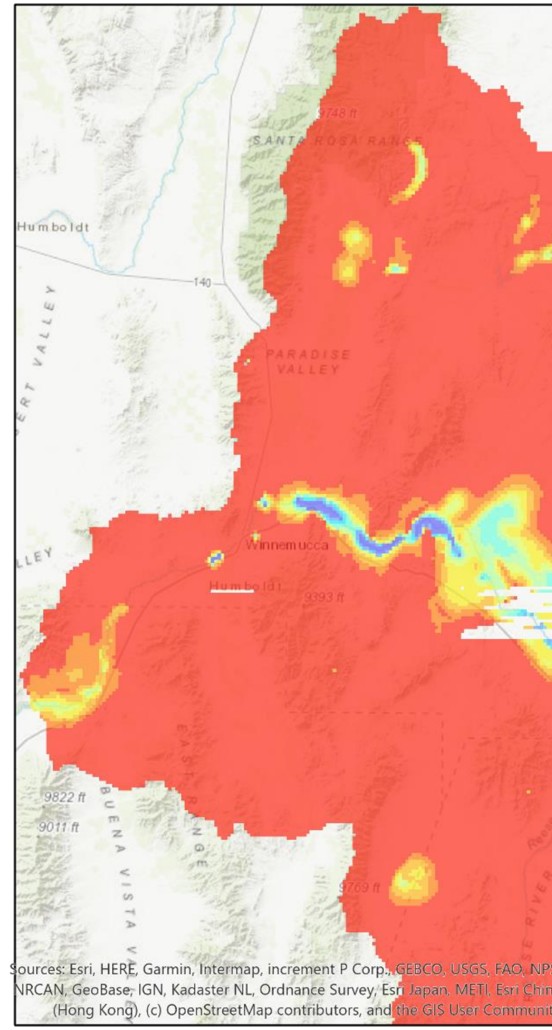
Stream Depletion



Salvaged ET

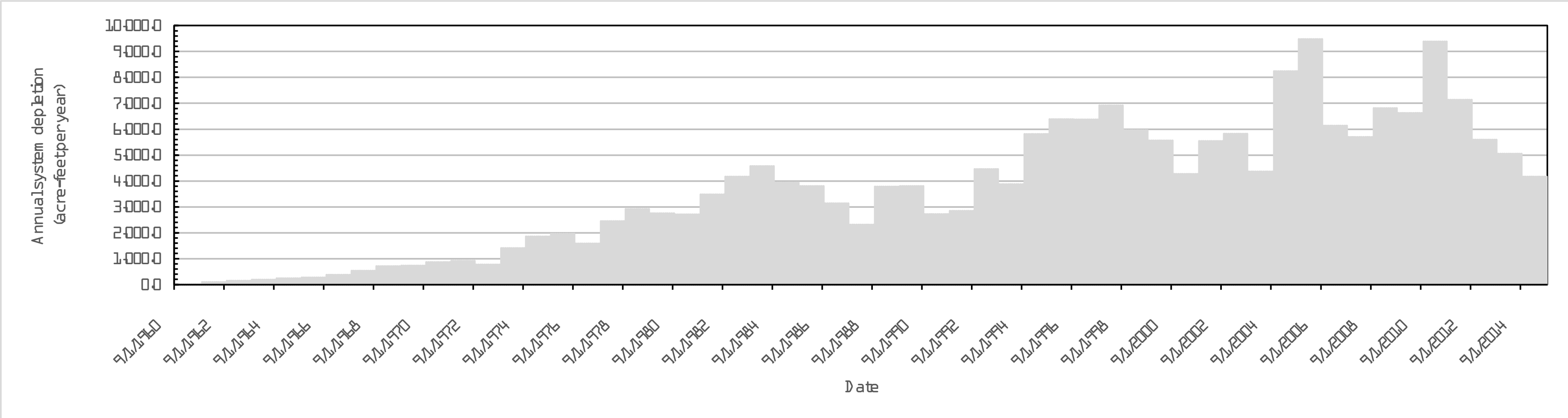


Storage Change

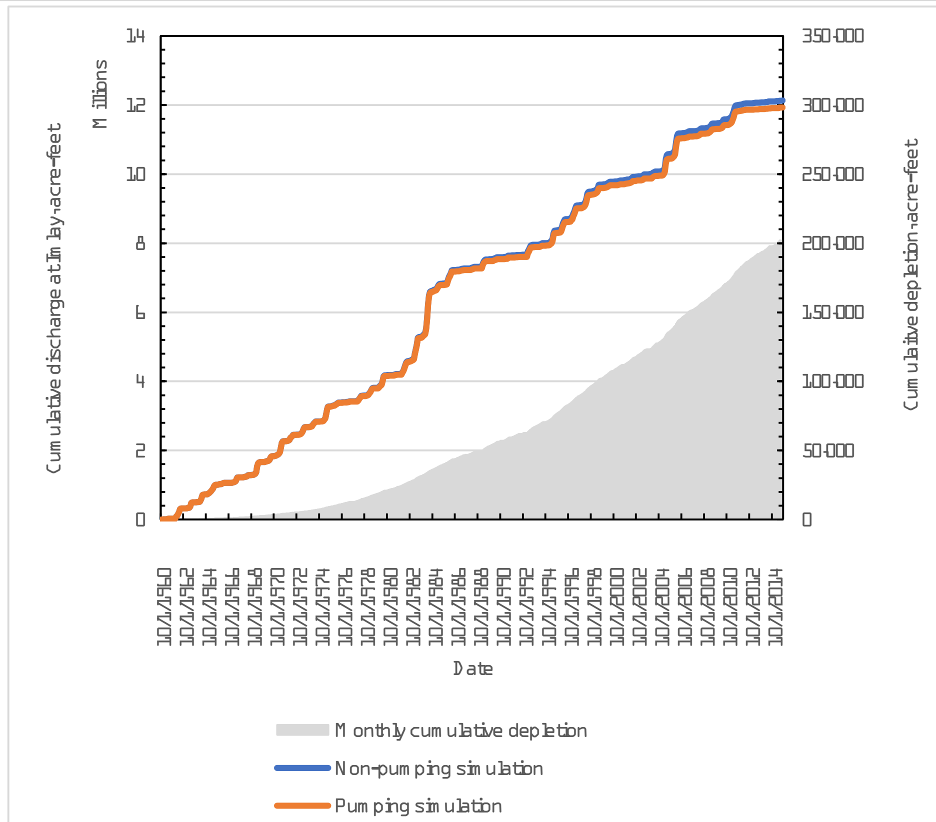


Year 10

System depletion with variable stresses calculated based on streamflow at Imlay

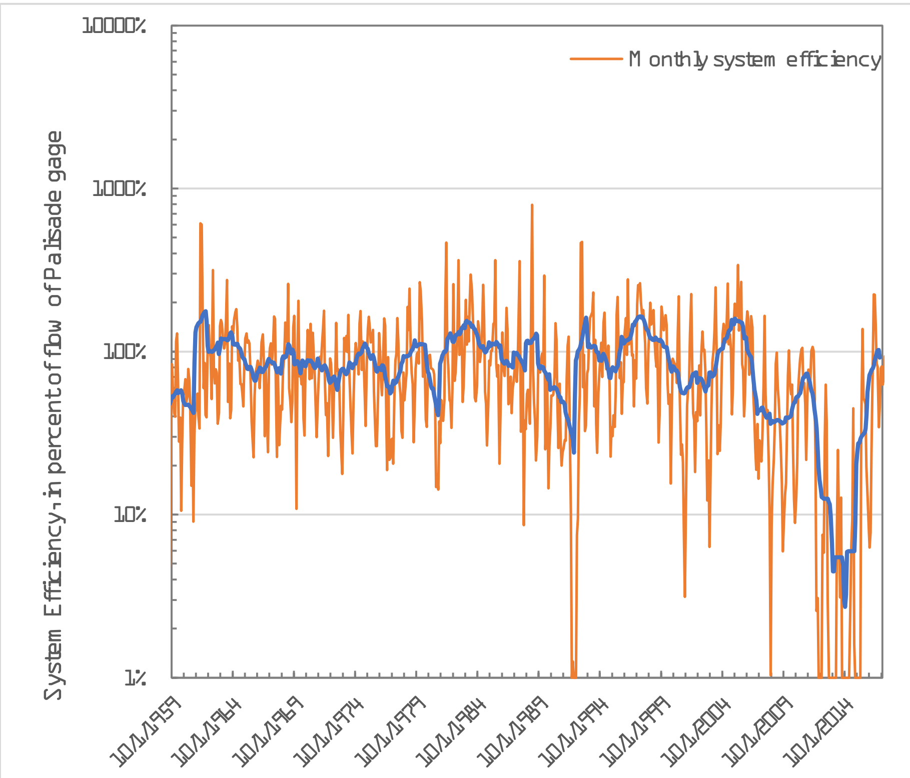


Cumulative system depletion with variable stresses calculated based on streamflow at Imlay

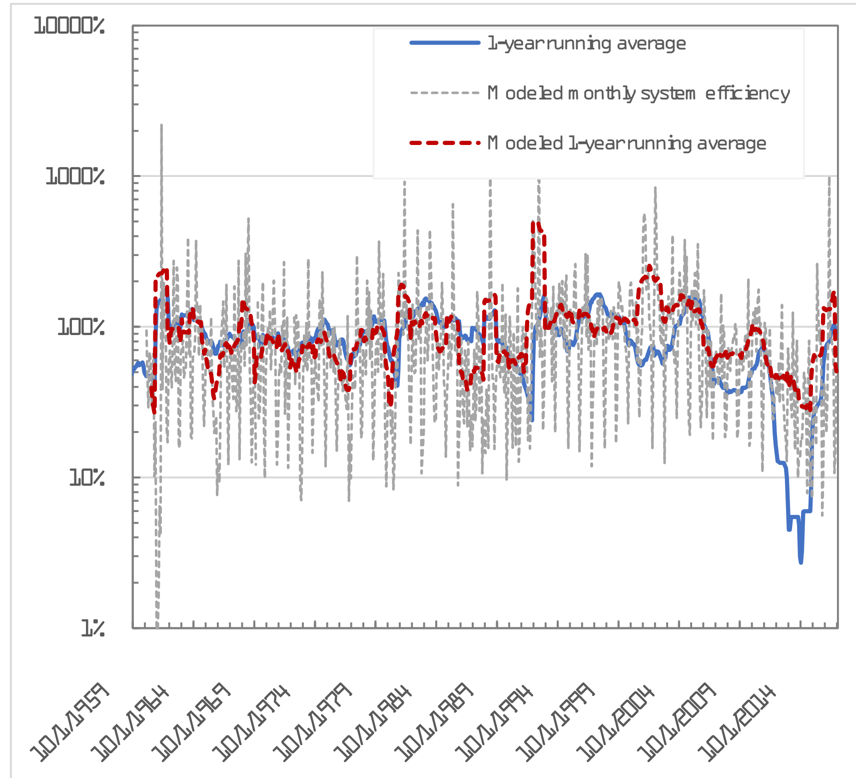


(B)

System efficiency (Imlay/Palisade flow; variable stress) (A) observed and (B) simulated



(A)



(B)

Information Products – Completed to date.

Damar, N.A., 2018, Geospatial Data for the Northern Nevada Rift: U.S. Geological Survey data release, https://doi.org/10.5066/F7SN0869.

Hess, G.W., Plume, R.W., and Arthur, J.M., 2018, River Channel Cross-Sections, Middle Humboldt River, North-Central Nevada: U.S. Geological Survey data release, https://doi.org/10.5066/F73X85WM.

Nadler, C., Allander, K.K., Pohll, G., Morway, E., Naranjo, R., 2017, Evaluation of bias associated with capture maps derived from nonlinear groundwater flow models: Groundwater, vol. 56, no. 3, p 458-469. https://doi.org/10.1111/gwat.12597.

Plume, R.W., and Medina, R.L., 2019, Data for the report Hydrogeologic framework and ground-water levels, 1982 and 1996, middle Humboldt River basin, north-central Nevada (U.S. Geological Survey Water-Resources Investigations Report 98-4209): U.S. Geological Survey data release, https://doi.org/10.5066/P9NPZTOT. (WRIR 98-4209)

Ponce, D.A., and Damar, N.A., 2017, Depth to pre-Cenozoic bedrock in northern Nevada: U.S. Geological Survey data release, https://doi.org/10.5066/F75B01DD . (Bulletin 2218 2-km pre-cenozoic basement)

Prudic, D.E., Herman, M.E., and Medina, R.L., 2020, Data for the report Ground-water flow and simulated effects of development in Paradise Valley, a basin tributary to the Humboldt River in Humboldt County, Nevada (U.S. Geological Survey Professional Paper 1409-F): U.S. Geological Survey data release, https://doi.org/10.5066/P9ZJBQF2.

Smith, J.L., Warmath, Eric, and Medina, R.L., 2017, Groundwater discharge areas for the 14 hydrographic areas in the middle Humboldt River Basin, north-central Nevada: U.S. Geological Survey data release, https://doi.org/10.5066/F72805TT . (WRIR 2000-4168: Groundwater discharge areas.)

Smith, J.L., Welborn, T.L., and Medina, R.L., 2017, Evapotranspiration units and potential areas of groundwater discharge delineated July 20–24, 2009 in the upper Humboldt River Basin, northeastern Nevada: U.S. Geological Survey data release, https://doi.org/10.5066/F7668BN7 . (SIR 2013-5077).

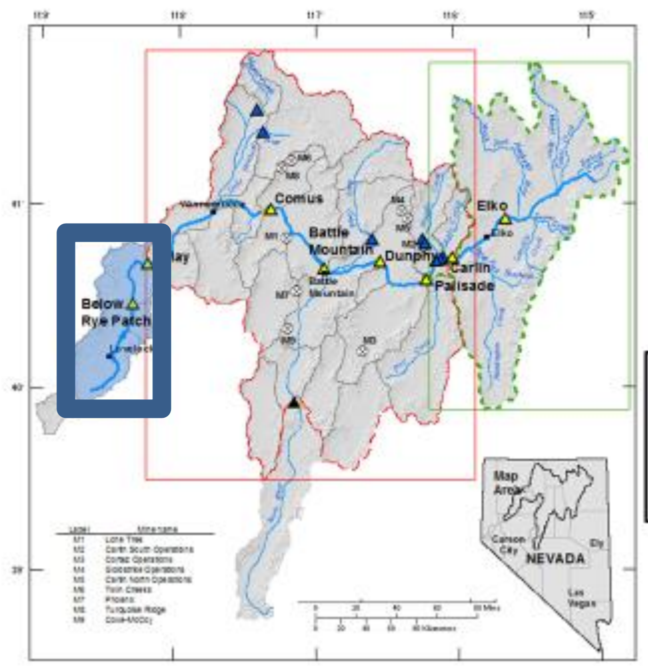
Welborn, T.L., and Medina, R.L., 2017, Depth-to-water area polygons, isopleths showing mean annual runoff, 1912-1963, and water-level altitude contours for the Humboldt River Basin, Nevada: U.S. Geological Survey data release, https://dx.doi.org/10.5066/F7XW4GXC . (Bulletin 32 datasets: water levels, water level altitude, isopleths of mean annual runoff.)

Final model report, in progress, USGS Professional Paper report series, planned publication: February 2021.

Plans for next year

- Finalize calibration
- Finalize capture maps and capture analyses
- Final report

Lower Humboldt River Basin Model

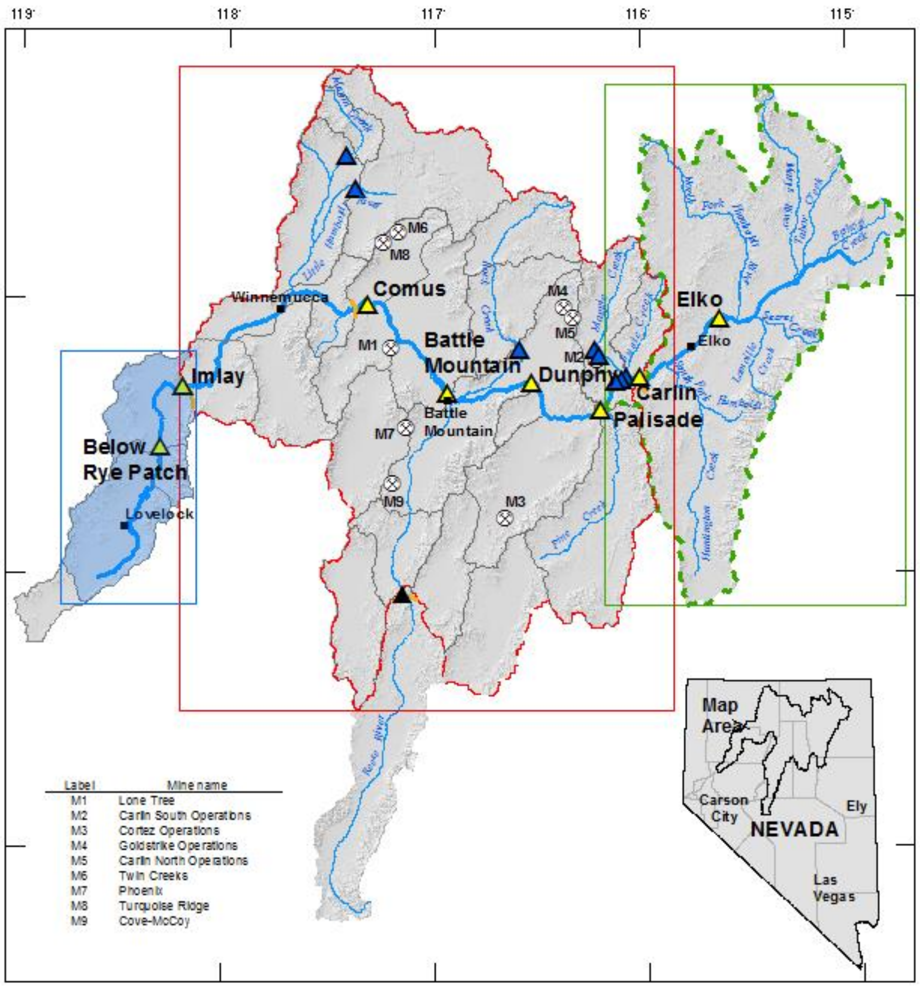


- Upper basin model – DRI
- Middle basin model – USGS
- Lower basin Model – USGS/DRI

DRI/USGS

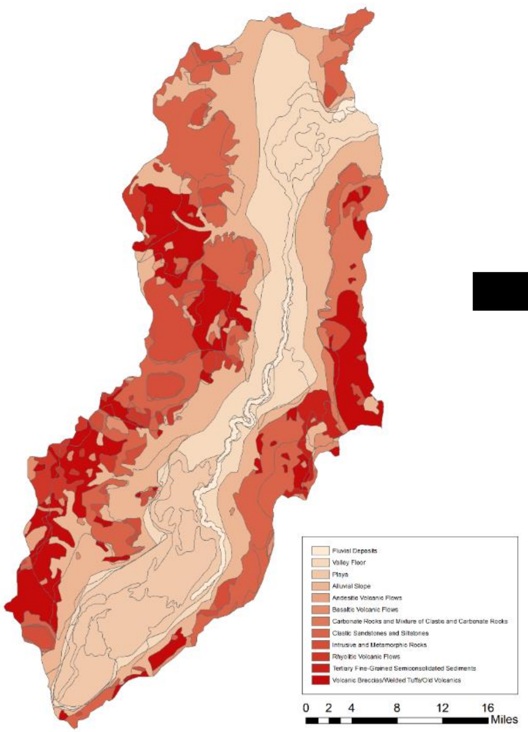
Lower Humboldt River Basin Model

Susie Rybarski - DRI

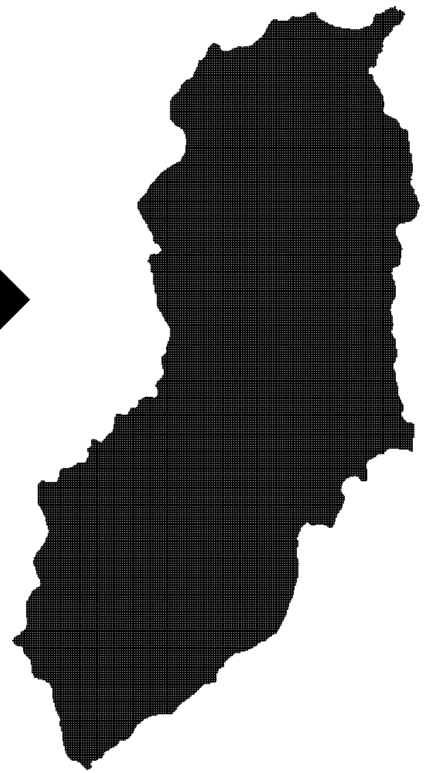


- Upper basin model - DRI
- Middle basin model - USGS
- Lower basin Model – USGS/DRI

Model Domain



Modified from Maurer and others (2004)



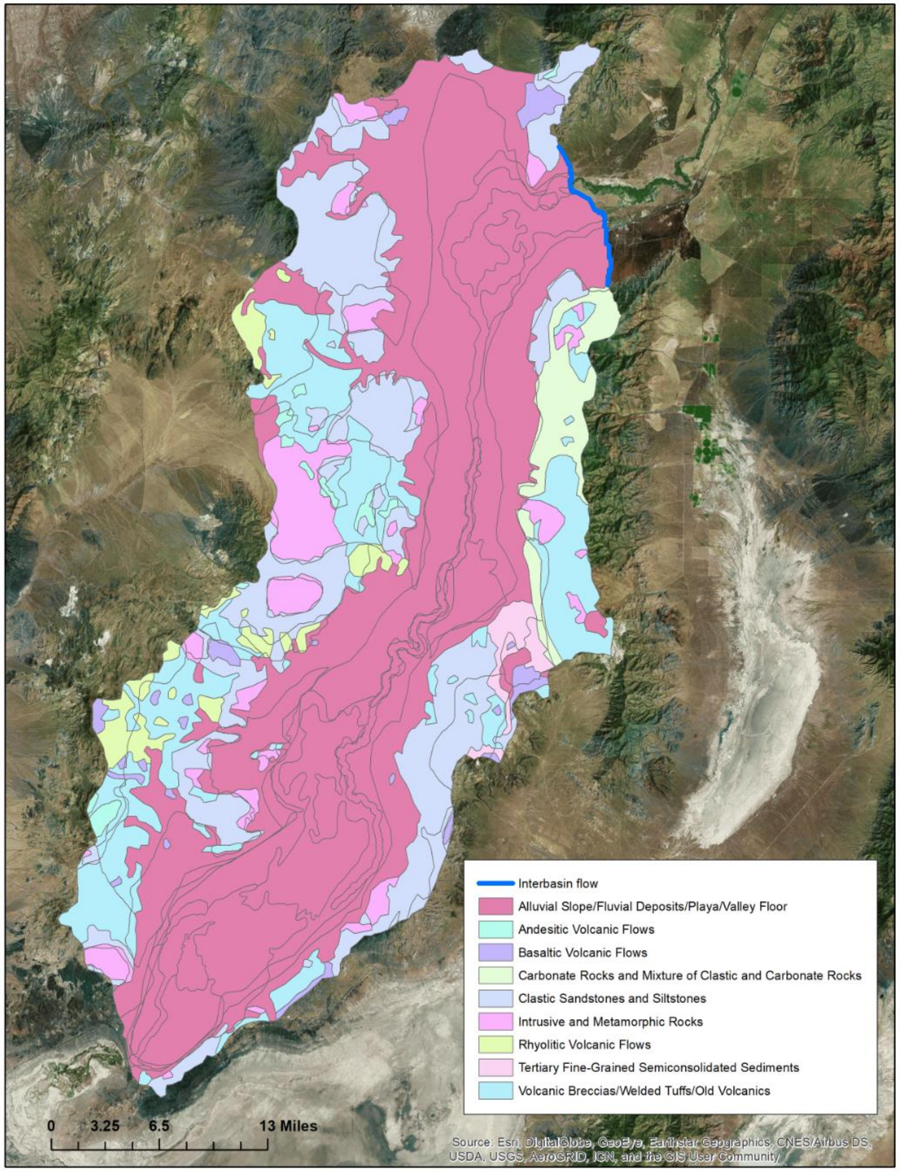
- 500 ft grid cell resolution
- Includes mountain block/bedrock
- 3 layers, generally representing clay (layer 1), alluvium/valley fill (layer 2), bedrock (layer 3)
- Thickness of clay layer set to 50 feet
- Depth to basement defined by Justin Mayers (USGS), and used to define elevation of top of layer 3, with a minimum depth of 20 feet bls.

Lakes and River

- Humboldt River simulated using River package (RIV), in two segments to prevent overlap with Rye Patch Reservoir.
- Rye Patch Reservoir simulated as a constant head boundary (CHD), using mean stage for SS model.
- Pitt-Taylor Reservoirs, Toulon Lake, and Humboldt Lake not simulated as they are frequently dry and heads are unknown.
- Mean annual stages applied to transient model.
- River conductance calibrated to estimated steady-state river loss of 9,900 AFA
- 6,000-14,000 AF mean annual reservoir loss to bank storage; loss to aquifer unknown (Eakin, 1962; Fereday and Nash, 2017). Simulated loss of 900 AFA determined by model given calibration to ET in Imlay area and local heads.

Interbasin Flow

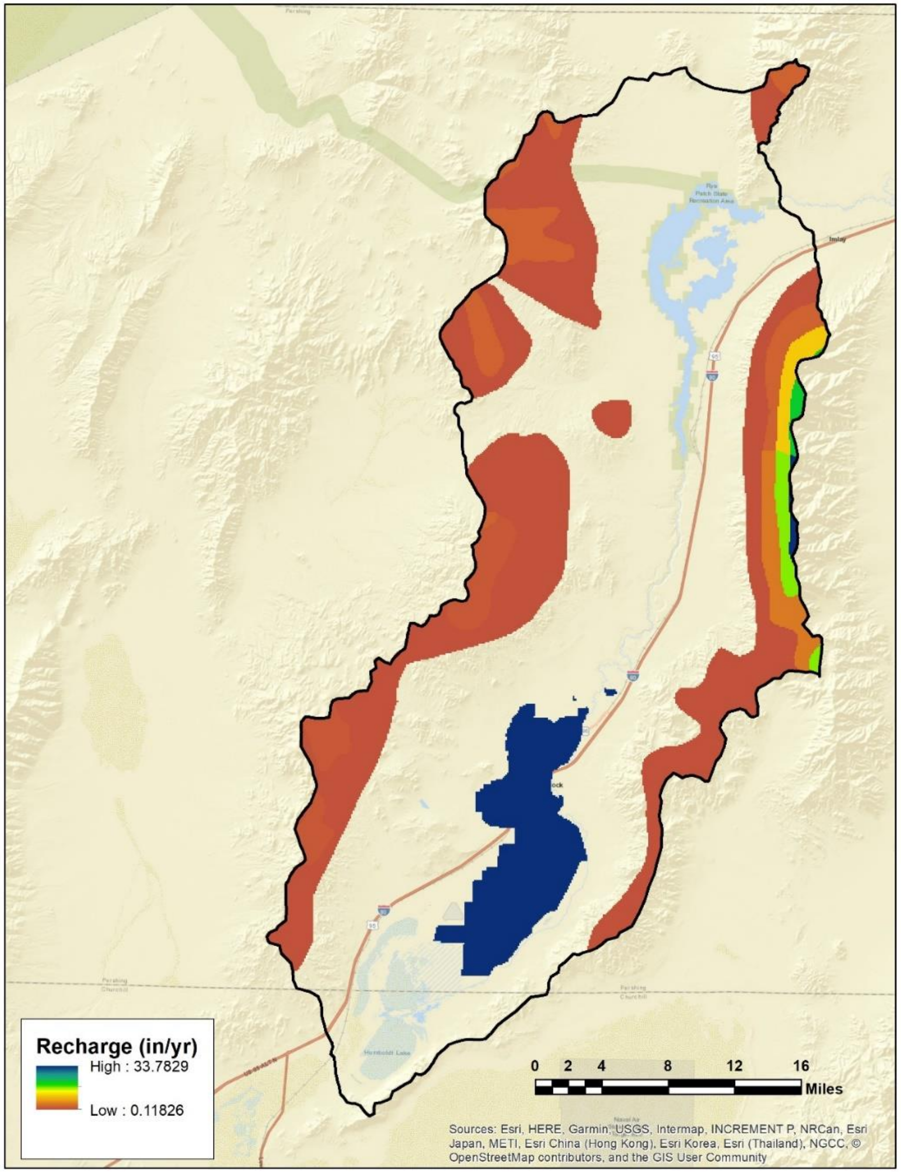
- Specified flux boundary applied along shared boundary with Middle Humboldt model
- Limited to extent of alluvial slope/fluvial deposits/playa/valley floor
- SS flux of 771 AFA based on current outflow from Middle Humboldt model



Steady State Recharge

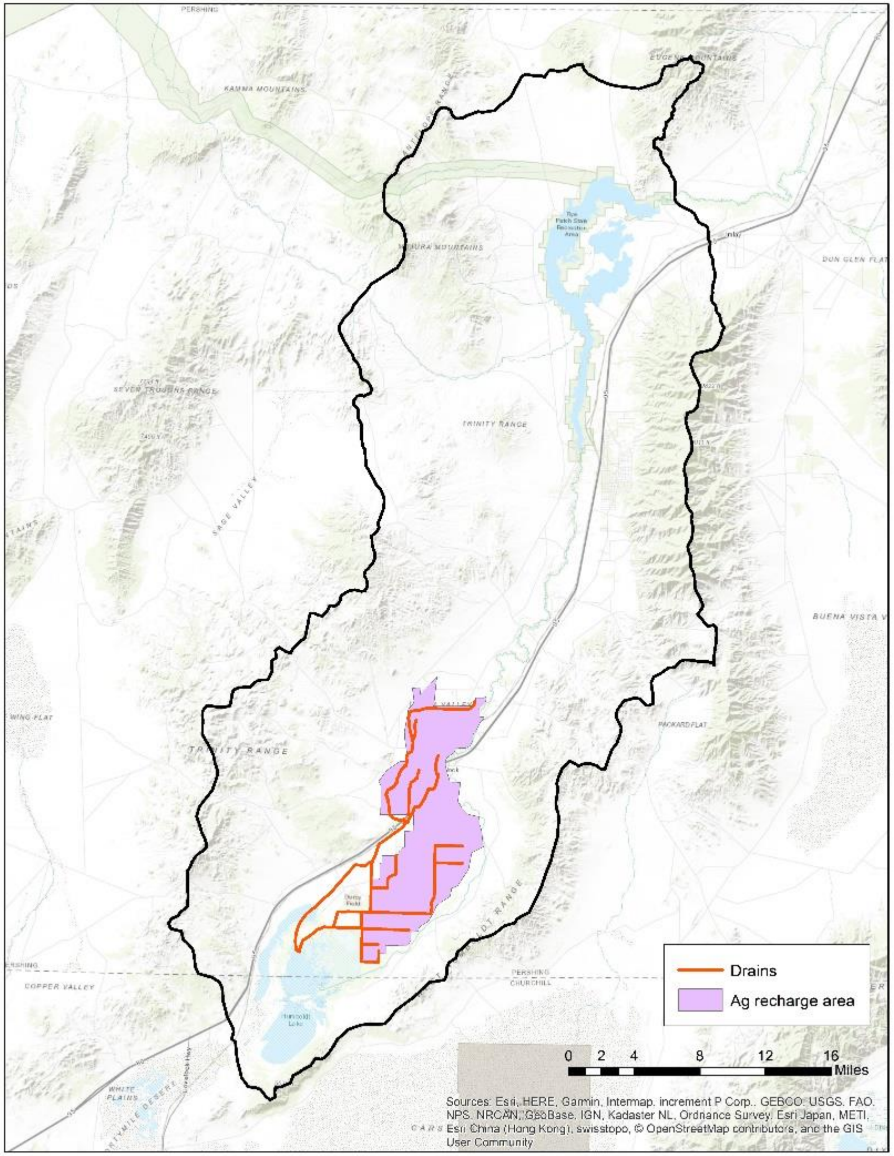
	Mountain Block Recharge (afy)				
Reference	Lovelock	Oreana	Imlay	Model Domain	Methodology
Everett and Rush, 1965	1,200	2,000	--	--	Maxey-Eakin, 1949
Eakin, 1962	--	--	4,000	--	Maxey-Eakin, 1949

- Mountain block recharge estimates from Recon Reports distributed proportionally over Hardman map intervals
- Ag recharge rate applied as median of 1960-1990 regression (127,800 AFA)
- Mountain block recharge = 5,700 AFA



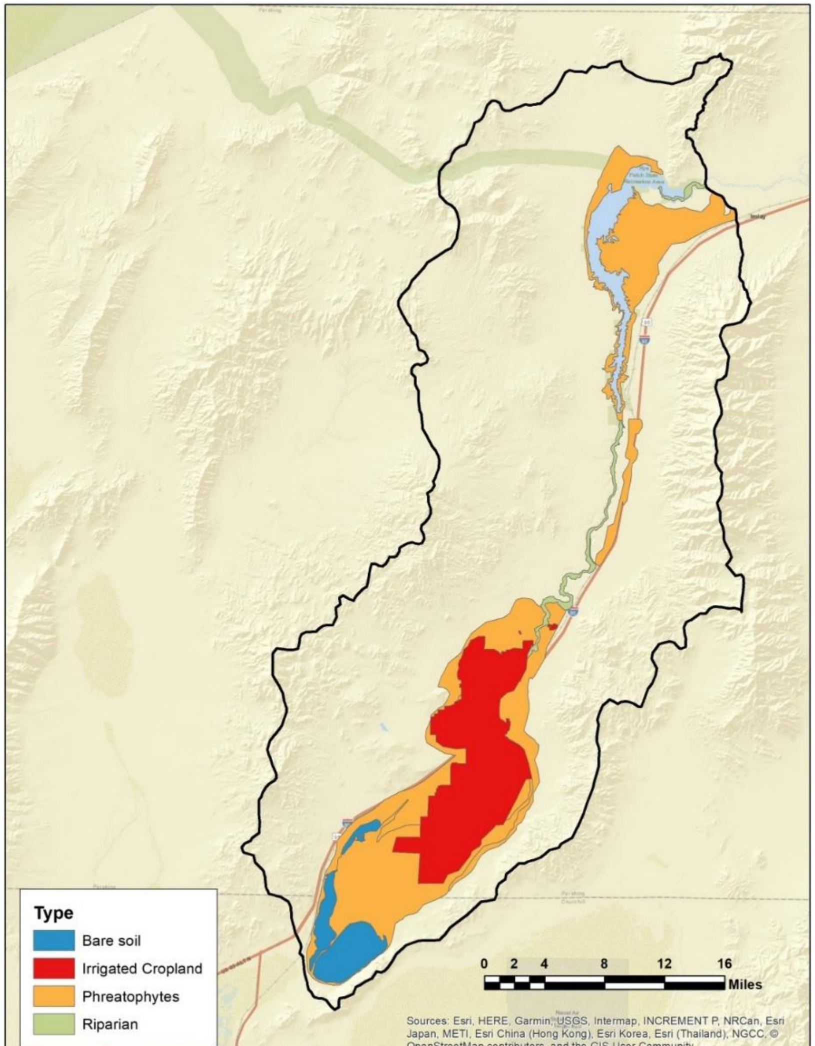
Drains

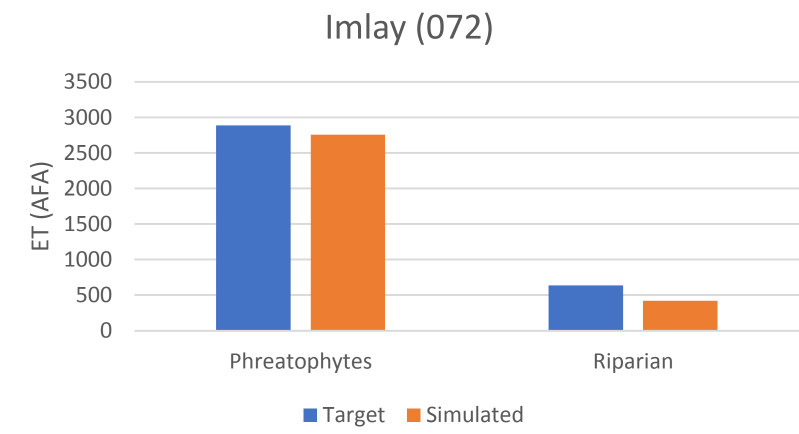
- Represents ag runoff/recharge lost to sink; simulated using Drain (DRN) package
- Drain bottoms set to 9 ft bls
- Drain outflow estimated to be ~18,000 AFA

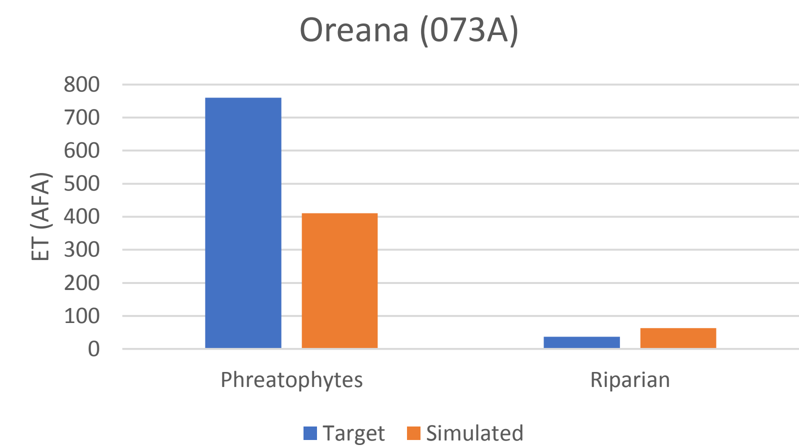


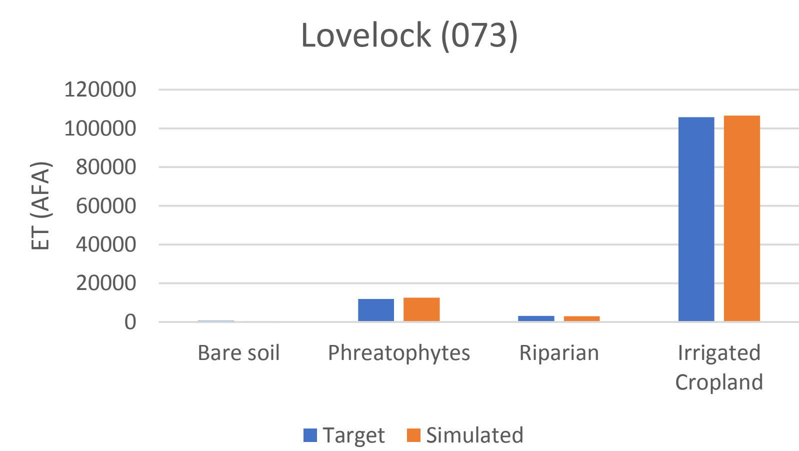
Evapotranspiration

- ET zones applied over DRI polygons, estimated at 126,000 AFA.

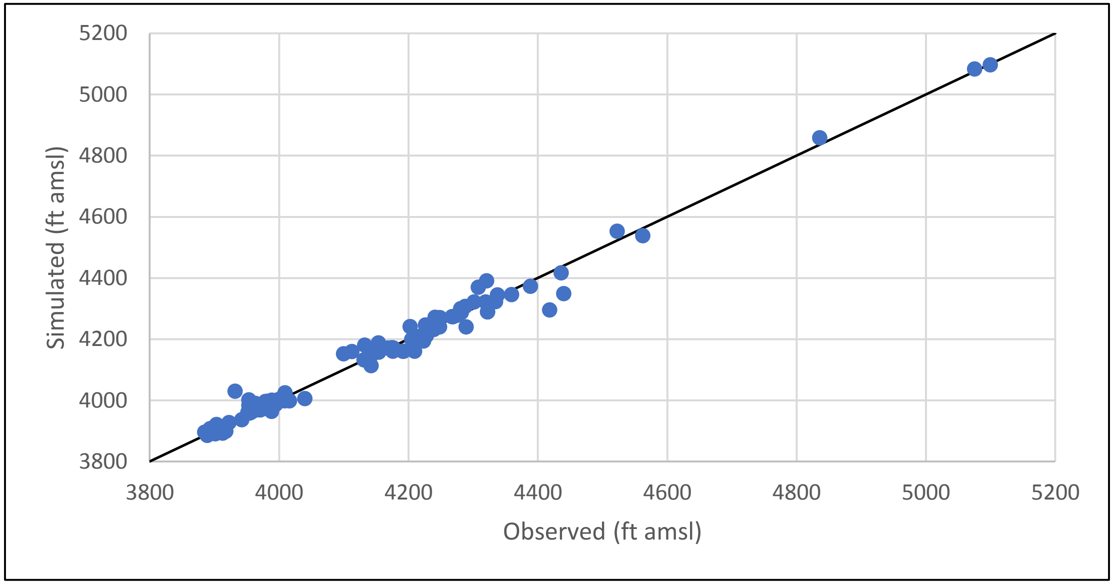








SS Model Calibration

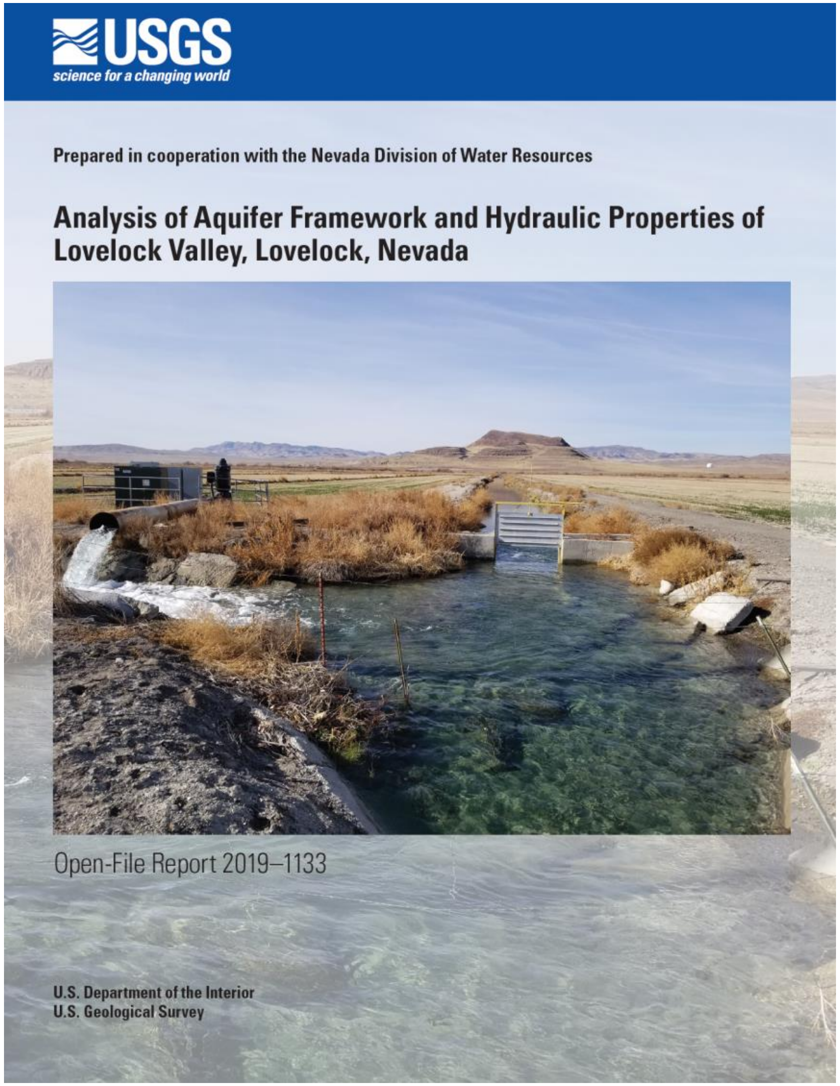


Mean Residual (Head) (ft)	-2.51
Mean Absolute Residual (Head) (ft)	17.84
Root Mean Squared Residual (Head) (ft)	27.24
Relative Error	1.4%

USGS Open File Report

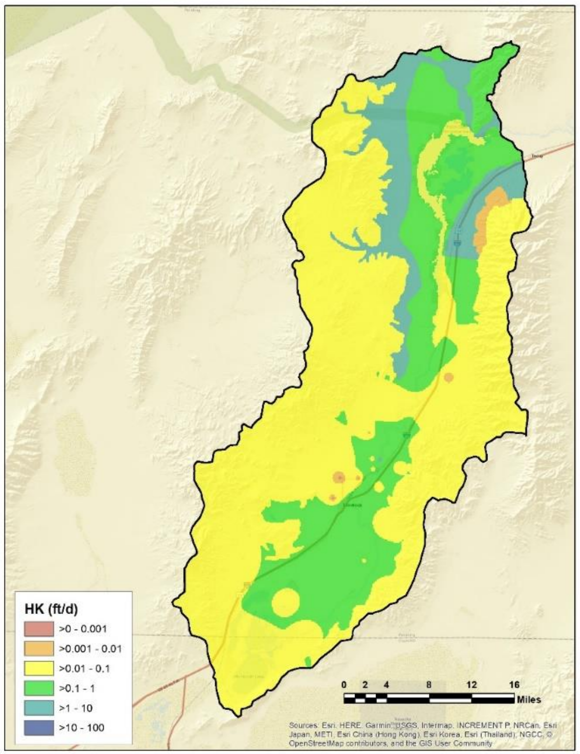
- Seven slug tests, one single-well pumping test, and two multi-well pumping tests conducted 2017-2018 to determine aquifer properties for capture models
- OFR published in 2020: https://doi.org/10.3133/ofr20191133

Test well numbers	Test type	Test dates	Aquifer tested	Transmissivity (ft^2/d)
6, 7, 12, 13, 15, 16	Injection slug tests	January 9, 2018–April 15, 2018	Lahontan clays and silts	2–1,500
14	Injection slug test	August 10, 2017	Coarser alluvium	400
3	Single-well pumping test	August 9, 2017	Coarser alluvium	130
4	Multi-well pumping test	March 8, 2017–March 12, 2017	Lahontan clays and silts, fluvial deposits, and coarser alluvium	0.0001–95,000
10	Multi-well pumping test	November 28, 2017–December 4, 2017	Lahontan clays and silts, fluvial deposits, and coarser alluvium	0.0001–95,000

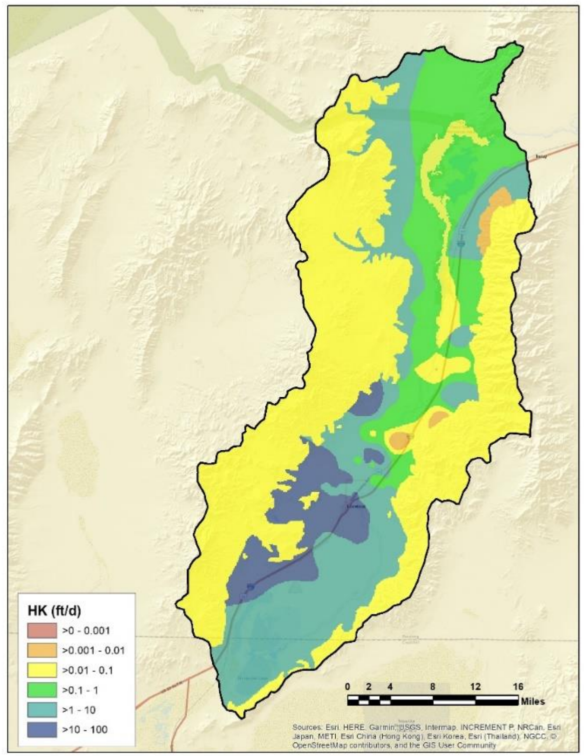


Hydraulic Conductivity

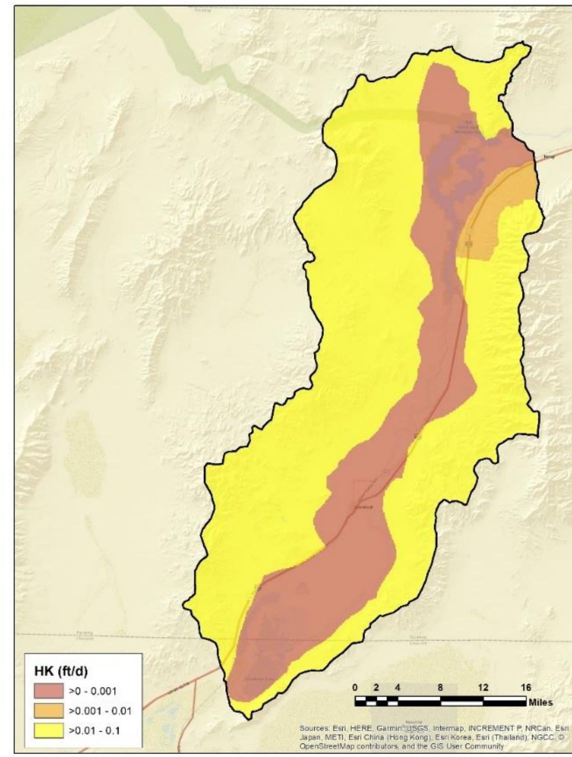
Layer 1



Layer 2



Layer 3



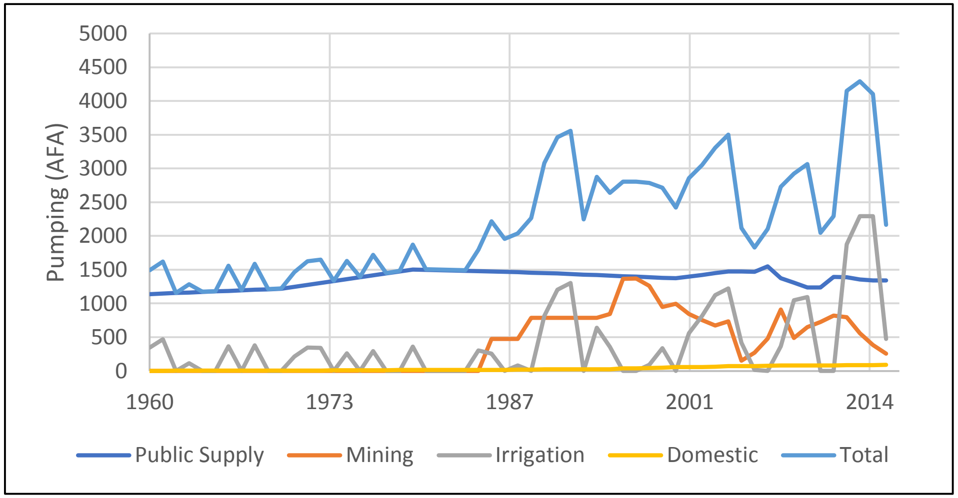
Flow Budget

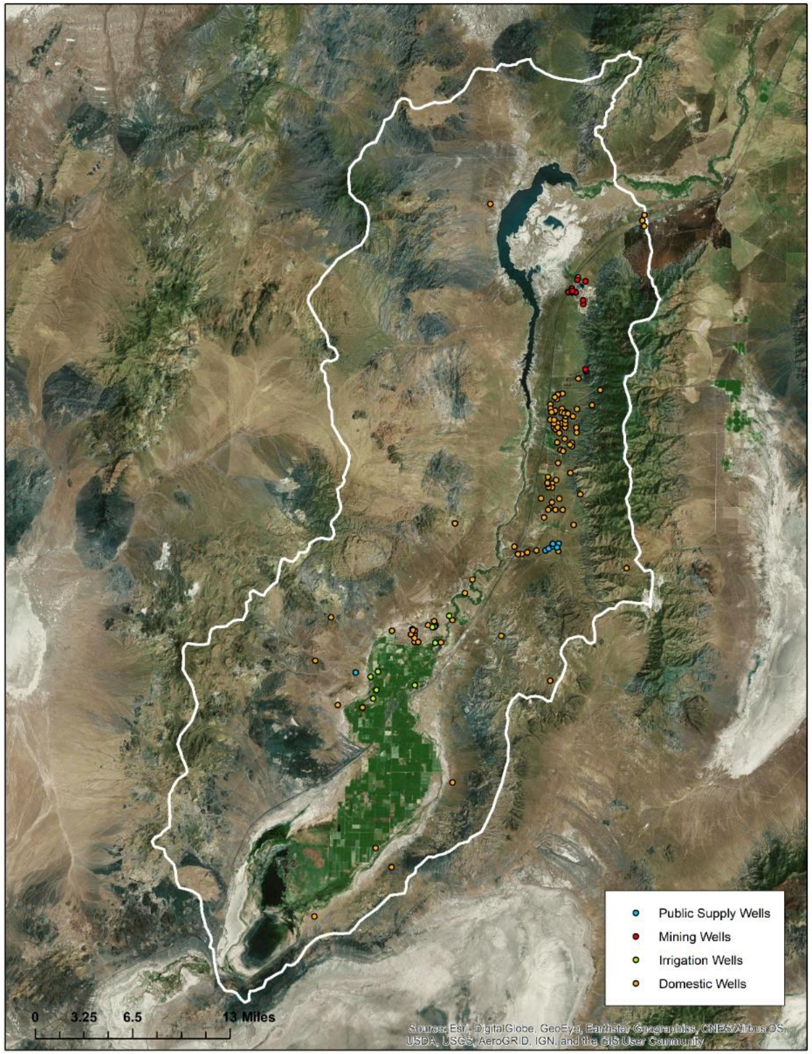
Inflows	**Target (AFA)**	**Simulated (AFA)**
Recharge (Mountain block + Total Ag)	133,500	133,500
Reservoir Loss	<14,000	100
River Loss	9,900	9,900
Interbasin Flow	800	800
Total	144,200 + reservoir loss	144,300

Outflows	**Target (AFA)**	**Simulated (AFA)**
Evapotranspiration	126,000	125,900
Drains	18,200 + reservoir loss	18,400
Total	144,200 + reservoir loss	144,300

Transient Pumping

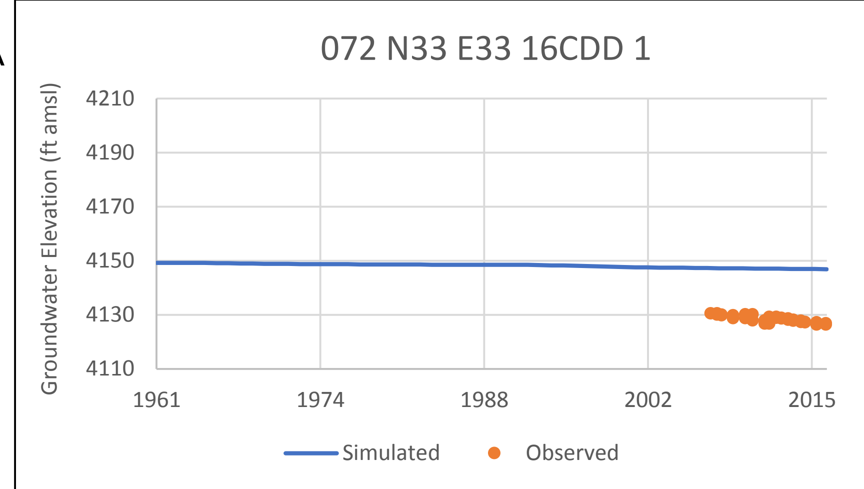
- Domestic wells pumping outside of Lovelock Meadows service area at 0.7 AFA.
- Public supply wells pumped at rates extrapolated backwards to 1960 based on population.
- Mining wells pumpage extrapolated earliest known rates backwards to 1986.
- Irrigation wells pumpage inversely proportional to the ratio of estimated ag recharge relative to the mean ag recharge 1960-1990.



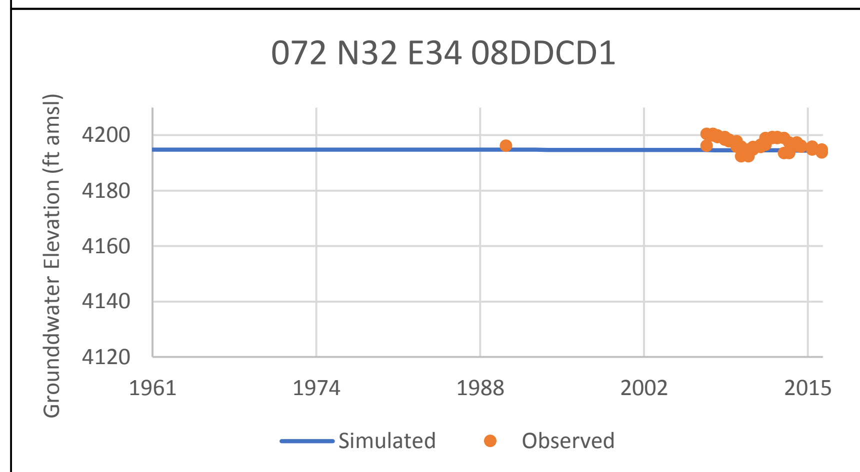


Transient Results

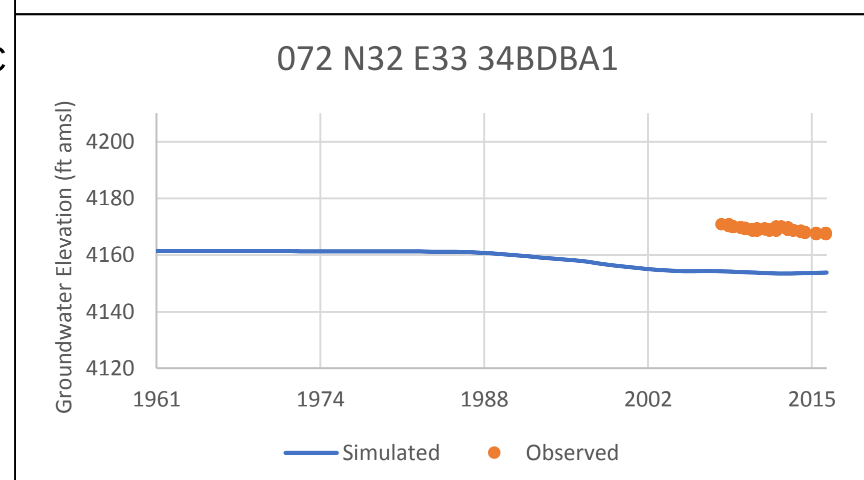
A



B

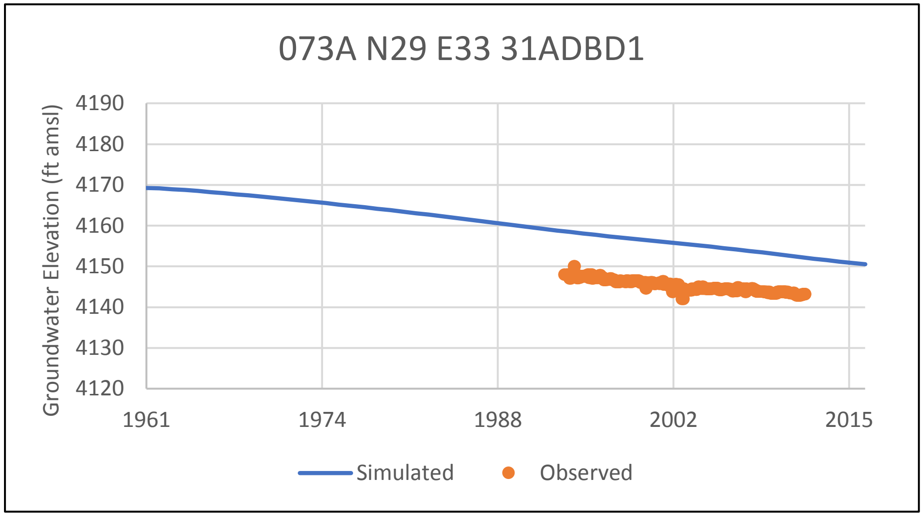


C

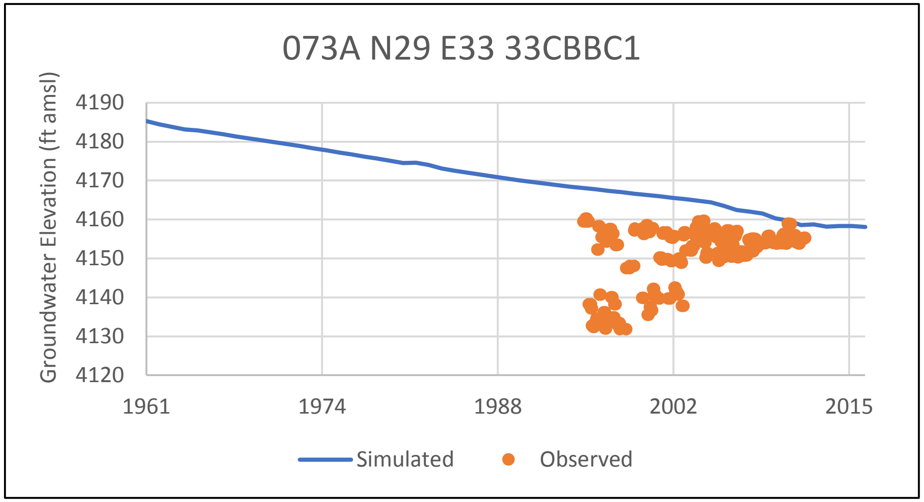


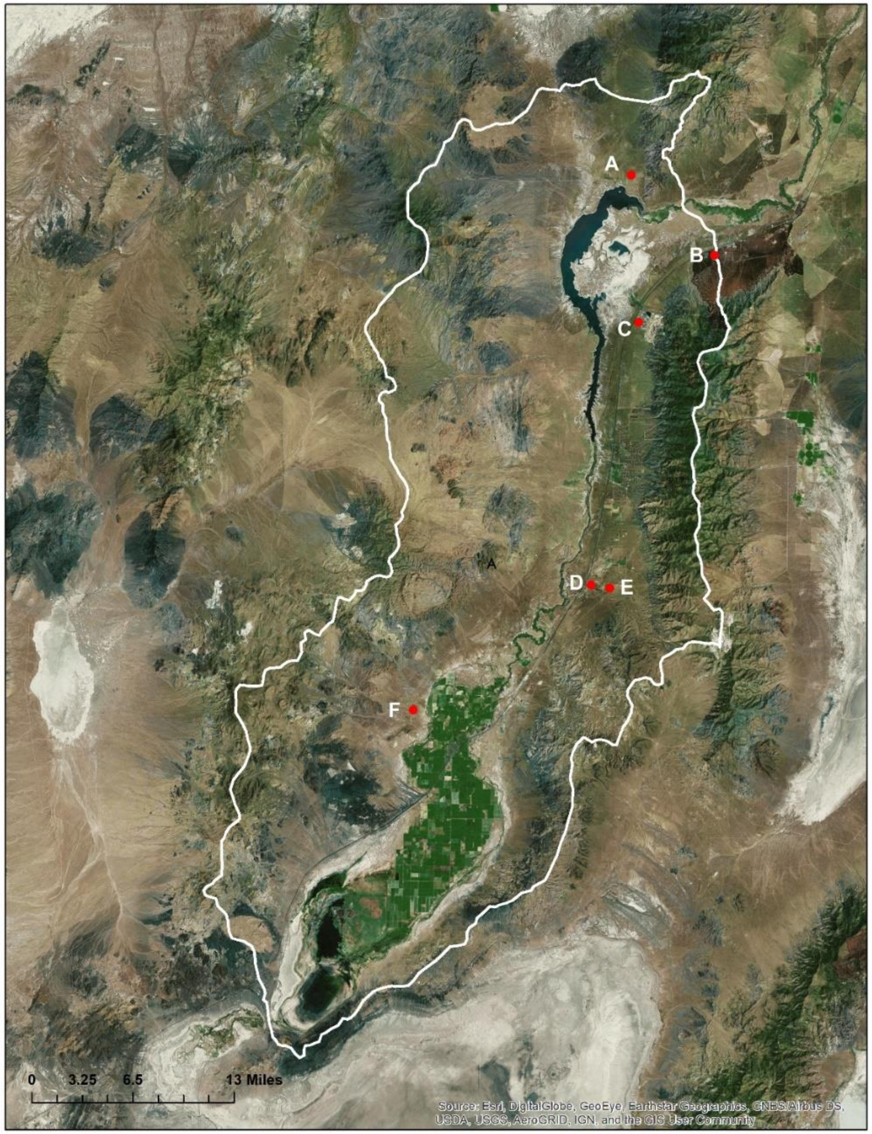
Transient Results

D



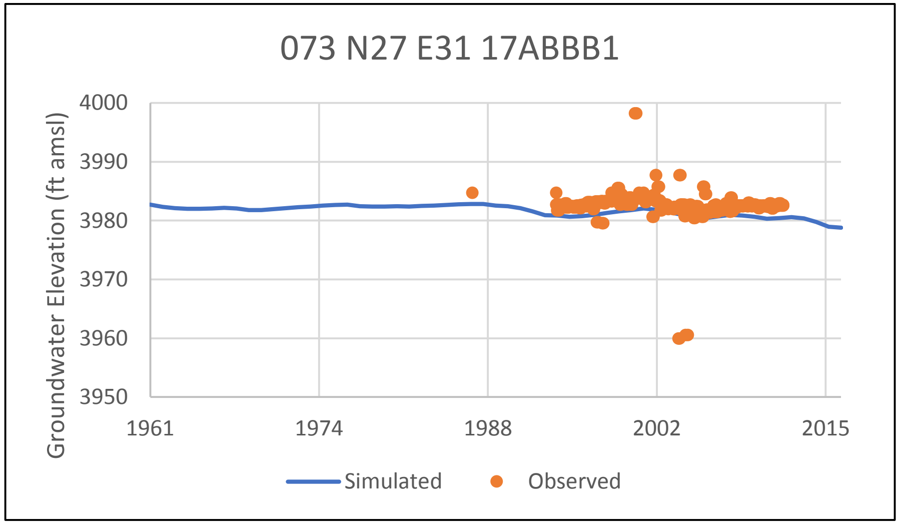
E

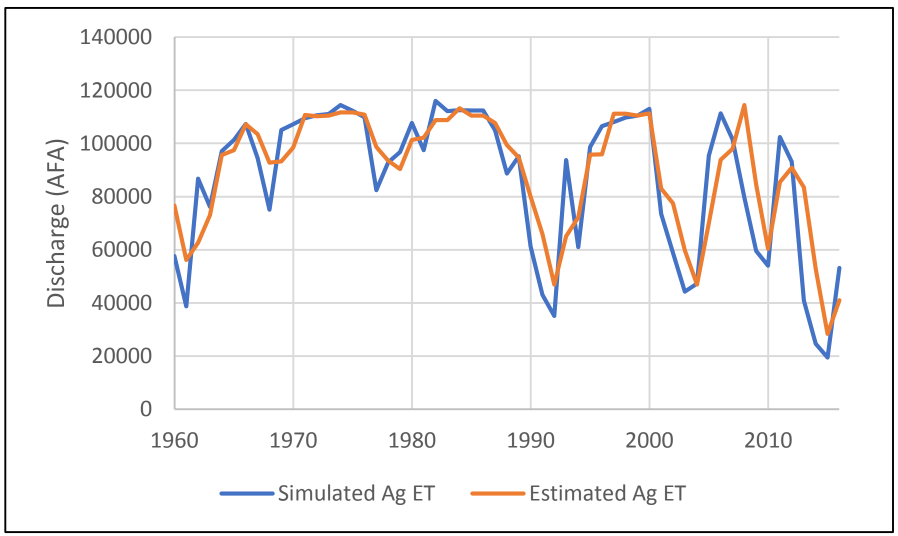




Transient Results

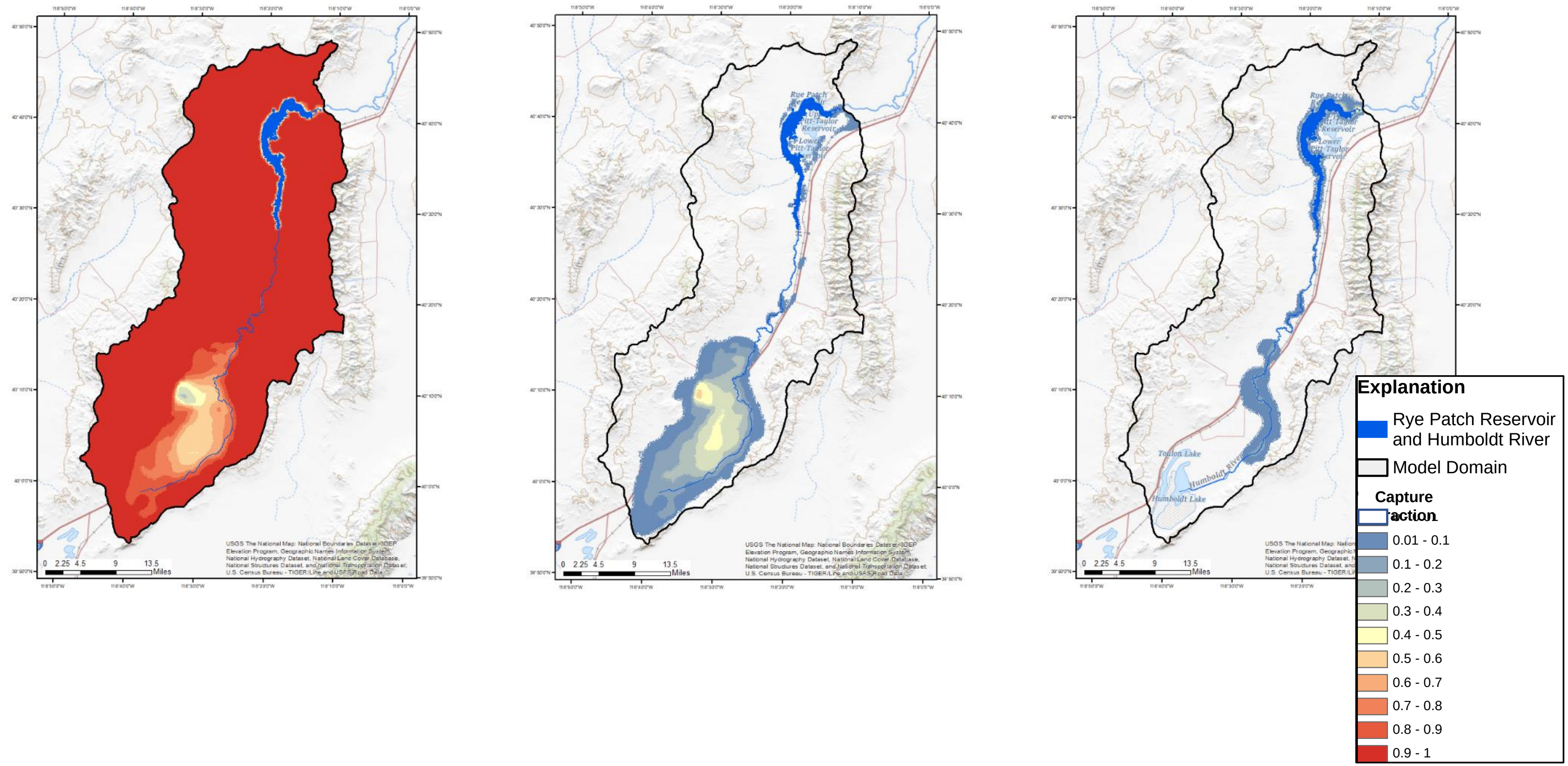
F





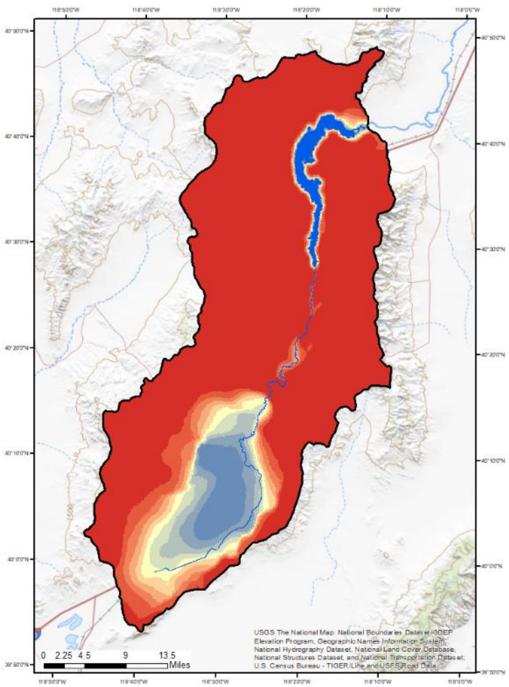
Capture – 1 Year

Storage Change | Salvaged ETg | Streamflow Depletion

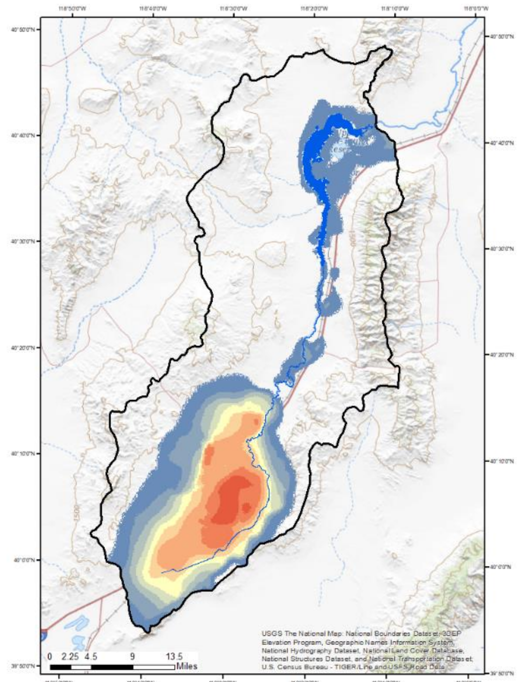


Capture – 5 Years

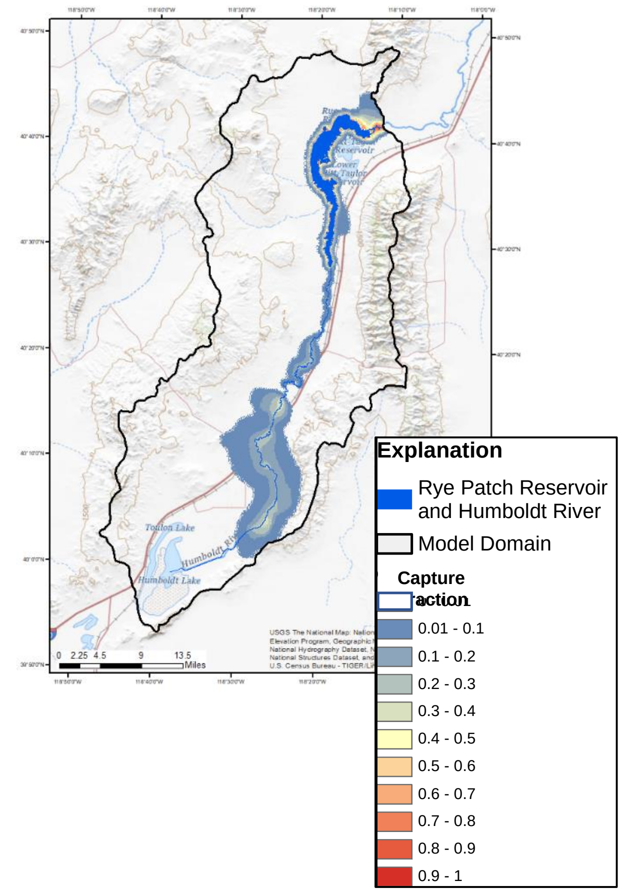
Storage Change



Salvaged ETg

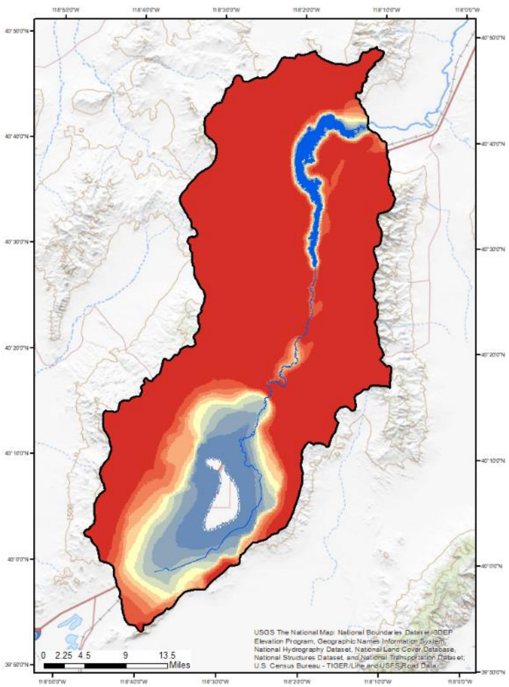


Streamflow Depletion

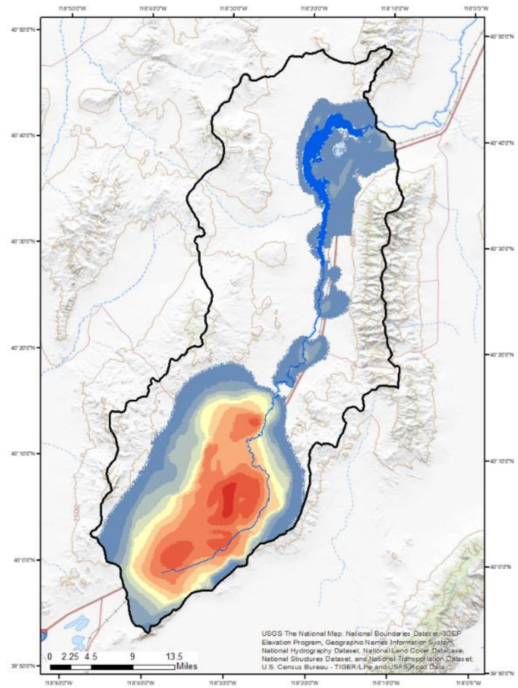


Capture – 10 Years

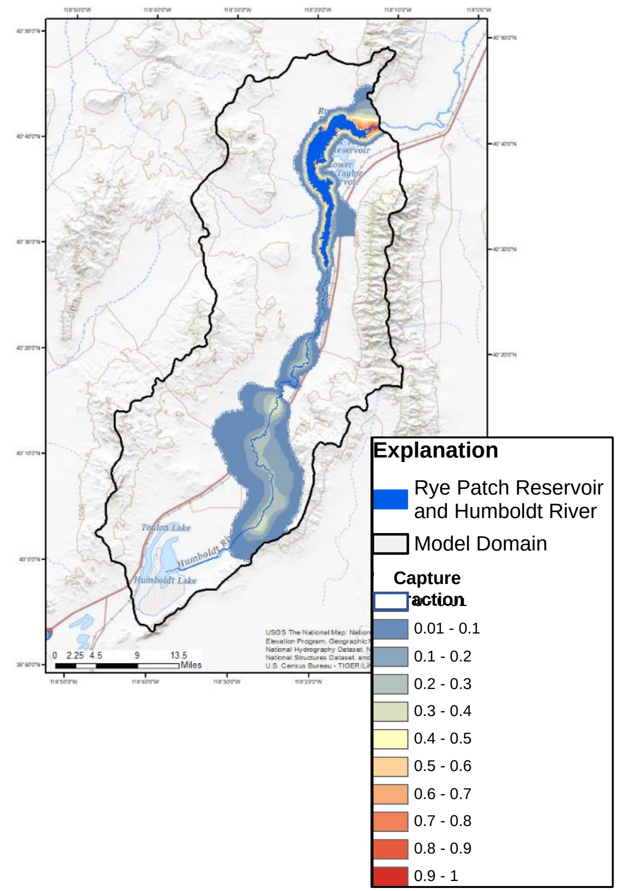
Storage Change

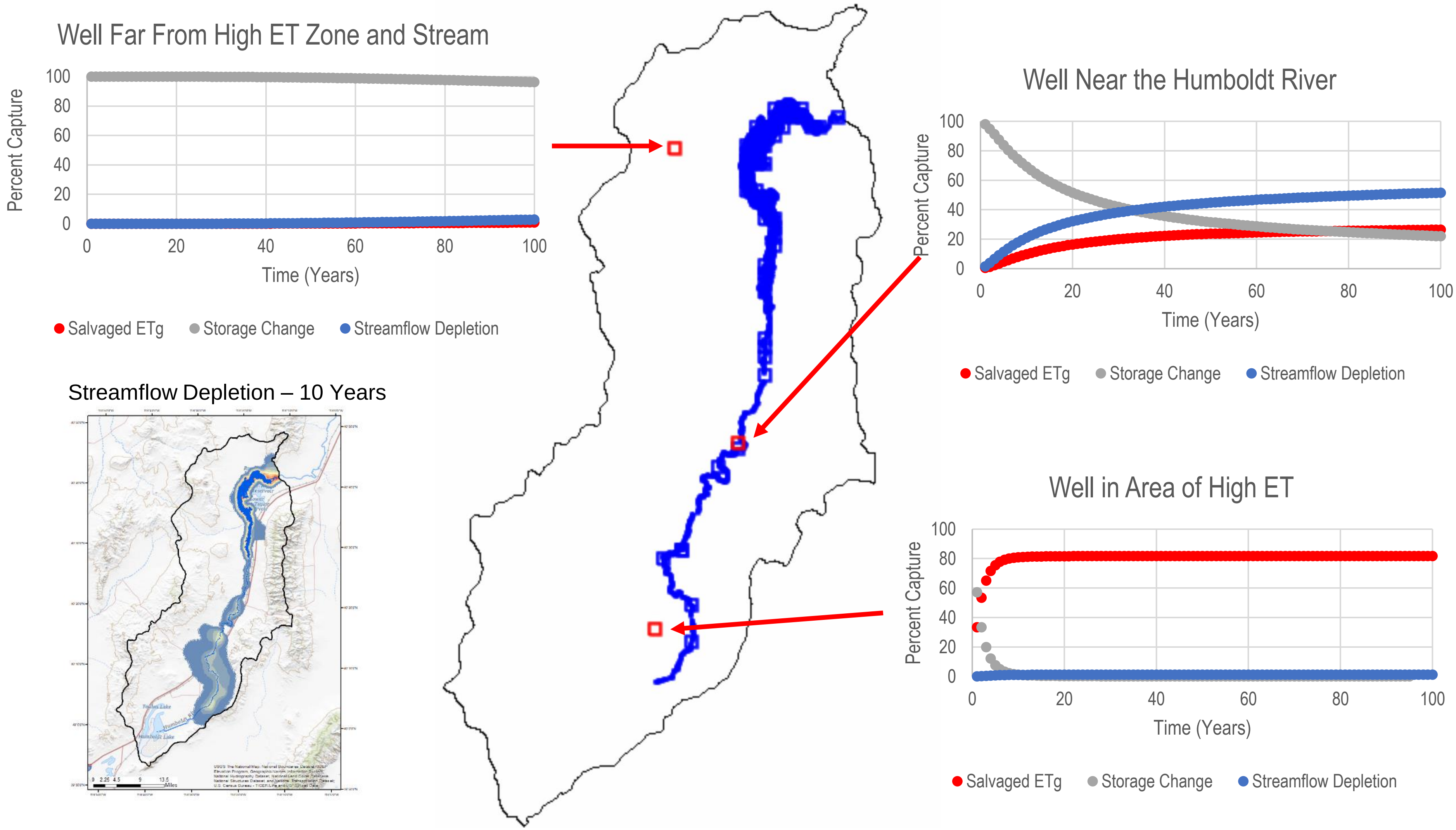


Salvaged ETg



Streamflow Depletion





Well Far From High ET Zone and Stream
Percent Capture
100
80
60
40
20
0
0
20
40
60
80
100
Time (Years)
Salvaged ETg
Storage Change
Streamflow Depletion
Streamflow Depletion – 10 Years
Well Near the Humboldt River
Percent Capture
100
80
60
40
20
0
0
20
40
60
80
100
Time (Years)
Salvaged ETg
Storage Change
Streamflow Depletion
Well in Area of High ET
Percent Capture
100
80
60
40
20
0
0
20
40
60
80
100
Time (Years)
Salvaged ETg
Storage Change
Streamflow Depletion

End of Technical Presentations


Questions