Defining Evapotranspiration Units Across the State of Nevada

Estimating 'Pre-Development' Groundwater Discharge

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Background

Groundwater evapotranspiration (ETg) is the principal groundwater discharge component of water budgets in the majority of the Great Basin and the arid west. Accurate estimates of ETg are fundamental to understanding basin water balance and implementing effective groundwater management. As part of the Nevada Water Initiative (NWI), in collaboration with Nevada Division of Water Resources and the U.S. Geological Survey, hydrographic area (HA) estimates for ETg rates and volumes are being updated statewide.

Objectives

- Statewide groundwater discharge boundary database
- ET units defined within each HA
- Apply replacement rates to accurately estimate natural ETg
- Provide ETg estimates per ET unit

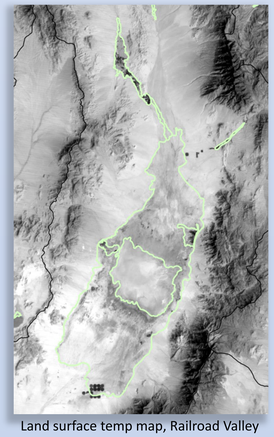
Greasewood taproot

Methods

Delineating Potential Areas of Groundwater Discharge

Discharge boundaries were created or refined at high resolution.

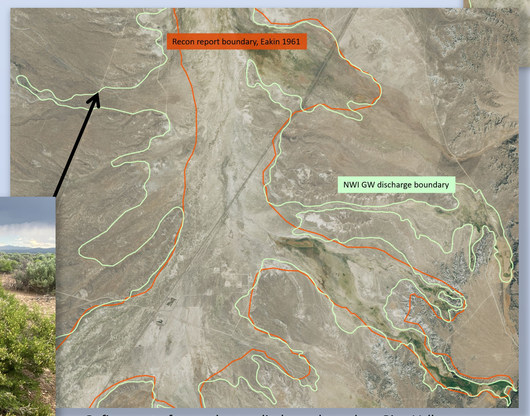
- Satellite imagery
- Groundwater levels
- Landsat land surface temperature maps
- SSURGO soil boundaries
- Historical aerial photos
- Topographic contours
- Field visits



Land surface temp map, Railroad Valley

Phreatophyte mapping

Greasewood and sage, Pine Valley



Refinement of groundwater discharge boundary, Pine Valley

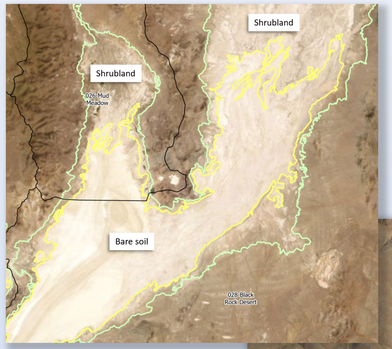
Methods continued…

Defining Evapotranspiration Units

To parse out the groundwater consumption of varying vegetation communities, they have been characterized into ET units:

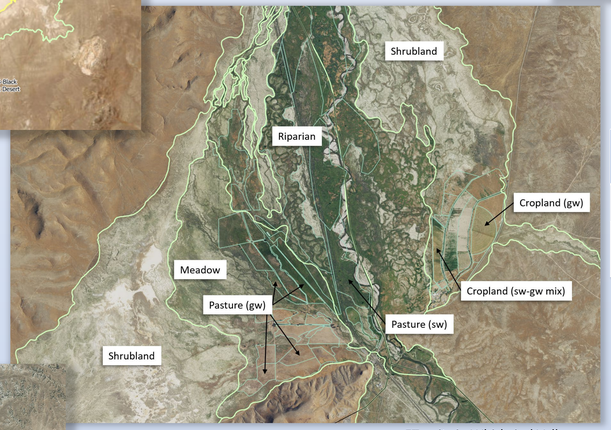
- Phreatophyte shrubland - shrub communities that tap into groundwater
- Riparian – vegetation growing directly alongside surface water
- Meadow – dense grassland or wetland areas
- Pasture – partially irrigated meadowlands
- Cropland – irrigated agricultural field
- Bare Soil – playa or large area without vegetation
- Open Water – standing water for majority of water year

ET units are delineated within potential areas of groundwater discharge, and consumption of groundwater can be estimated for each unit individually.



Black Rock Desert playa defined

Designation of ET units allow estimates to be parsed by dominant vegetation type and will determine if and how replacement rates are applied to best represent long-term natural conditions



ET units in Whirlwind Valley

…and continued

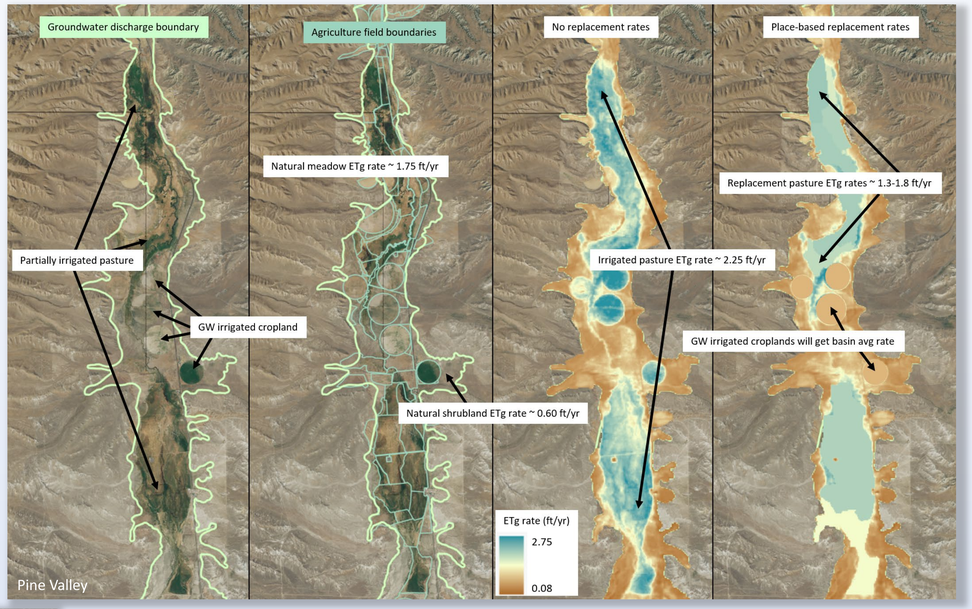
Applying Replacement Rates

To best estimate pre-development conditions, steps are taken to scale down ETg estimates for irrigated lands. Irrigation source is based on Place of Use and decree data from NDWR.

- GW irrigated areas replaced by basin average ETg rate
- SW or mixed irrigation pasture is scaled by 0.5
- SW or mixed irrigation cropland scaled by 0.33
- Place-based replacement rates can be applied instead of scaling factors or basin avg replacements

Scaling factors based on Harrill and Moore 1970

Results



Agriculture fields in natural shrubland areas can be replaced with a basin wide average rate to represent pre-development conditions, as seen in previous studies (i.e. Welch et al 2007). Croplands or irrigated pastures in areas where the natural ETg is significantly higher than the basin average, such as in a wetland or meadow area, can be scaled based on irrigation source or place-based replacement rates can be assigned to individual fields to more accurately represent pre-development conditions in these areas.

Pine Valley ETg estimates

Groundwater discharge	No Place-Based replacements	With Place-Based replacements
Volume (ac-ft/yr)	26,800	27,700
Average Rate (ft/yr)	0.59	0.61

Pine Valley estimates go up after place-based replacement rates are applied because irrigated pastures were initially getting assigned basin average rates.

Whirlwind Valley ETg estimates

Groundwater discharge	No Place-Based replacements	With Place-Based replacements
Volume (ac-ft/yr)	7,700	7,500
Average Rate (ft/yr)	0.65	0.63

Whirlwind Valley estimates go down after place-based replacement rates are applied because pasture lands without an associated irrigation source were initially not being scaled

ET unit	Area (acres)	ETg rate (ft/yr)	ETg volume (ac-ft/yr)
Phreatophyte shrubland	6680	0.37	2500
Meadow	2055	0.87	1800
Riparian	2430	1.16	2800
Irrigated Cropland	610	0.63	400

Whirlwind Valley groundwater discharge estimates per ET unit.

Statewide database will include table of ETg estimates for each ET unit (as seen in Huntington et al 2022) allowing for relative comparisons and better understanding of ecological influences and sensitivities of different vegetation communities.

Acknowledgements and References

The collaborative NWI research is building upon fundamental hydrologic research across the state of Nevada too numerous to list. Updates to basin water budgets, conceptual understandings, and overall water resource management all stand on the foundational research laid out before us. This work would not be possible without the USGS Reconnaissance Reports and Water Resource Bulletins and all ensuing studies that advanced understanding of hydrologic relationships and water resources.

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