



An Evaluation of Watershed Ecosystem Services and Market Mechanisms in Douglas County, NV

1 MOTIVATION

Climate Change & Water Supply Vulnerability

Located in a rain shadow at the base of the Eastern Sierra mountain range, Douglas County receives an average of ~5 inches of rain annually. As a result, water supply is driven primarily by Sierra Nevada snowpack. Climate change may alter the timing and volume of snowmelt, resulting in increased frequency of flooding events as well as longer dry periods.



Population Growth & Land Development

Douglas County experienced a greater than 70% increase in population between 1990 and the early 2000s. Urbanization in the surrounding floodplain is an increasing concern. The combination of population growth, urban development, and changing runoff timing is anticipated to stress urban, agricultural, and municipal water users into the future.



2 OBJECTIVES



Perform Watershed Analysis



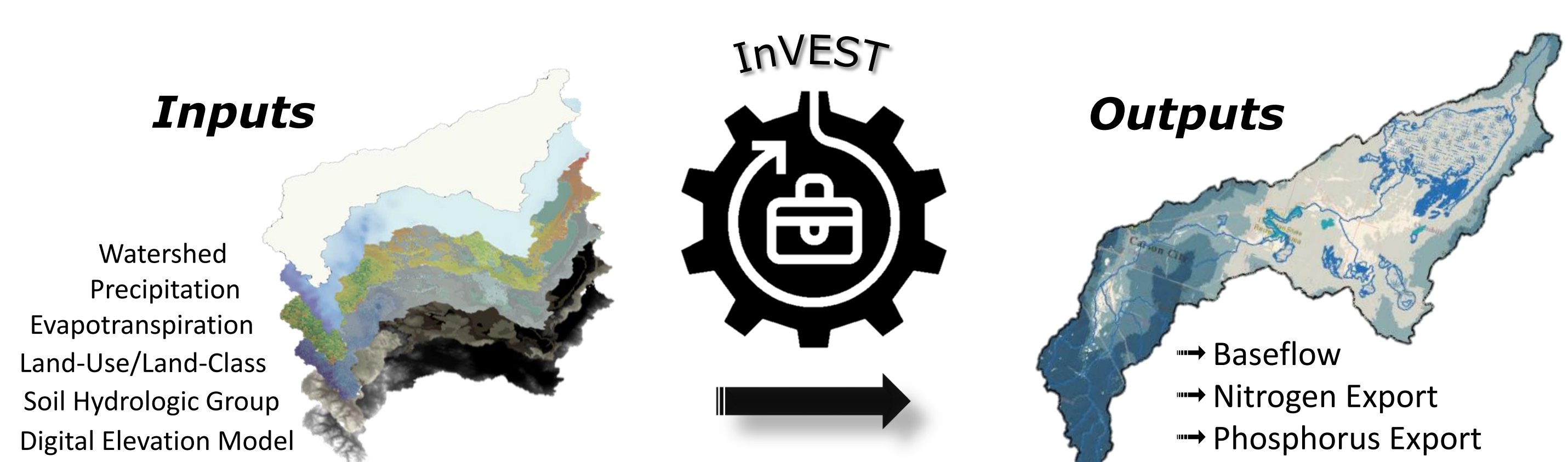
Evaluate Ecosystem Services in Respect to Climate Change



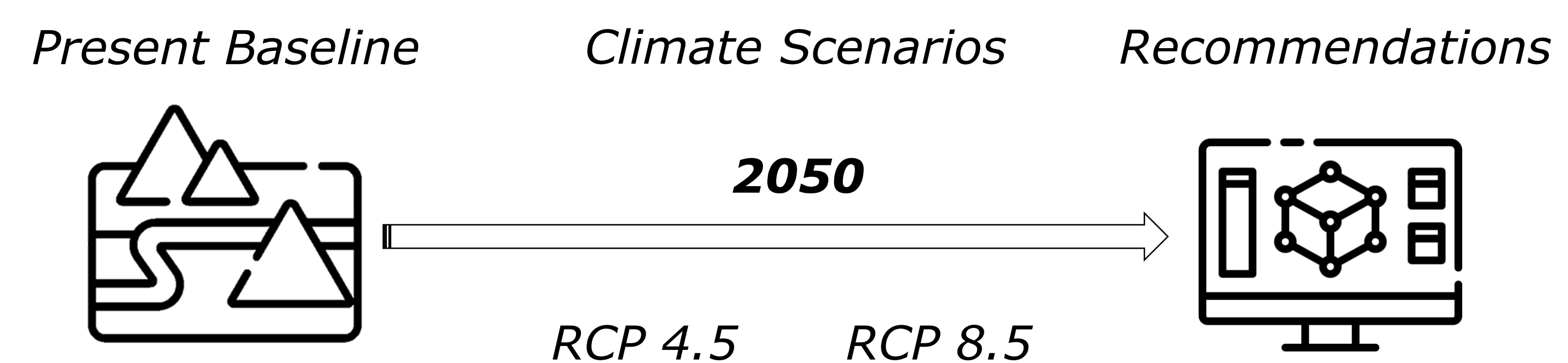
Identify Feasible Market Mechanisms

Main Research Question: Where should water managers be targeting their conservation efforts and which market strategies are the most applicable to help them accomplish these goals?

3 APPROACH



After an initial watershed analysis for both the Carson and Walker River basins and ecosystem service evaluation was conducted. Ecosystem services were evaluated and mapped using the Natural Capital Project's InVEST (Integrated Valuation of Ecosystem Services and Tradeoffs) modeling software. Using the baseflow results from the Water Yield Model, as well as the nitrogen and phosphorus export loading outputs from the Nutrient Delivery Ratio Model, our research team identified priority areas for TNC's conservation efforts.



In order to determine the impacts of climate change on the Carson and Walker basins, ecosystem services were mapped under a current baseline scenario as well as two future climate scenarios into 2050: 1) RCP4.5, the climate scenario under which the Paris Climate Accord is met and there is average global warming of 2.4°C, and 2) RCP8.5, the climate scenario under which business continues as usual and there is average global warming of 4.9°C. Modeled outputs from the RCP 8.5 conditions were overlaid to determine areas of priority.

4 ECOSYSTEM SERVICES AND CLIMATE CHANGE ANALYSIS RESULTS

Watershed Ecosystem Service Conditions

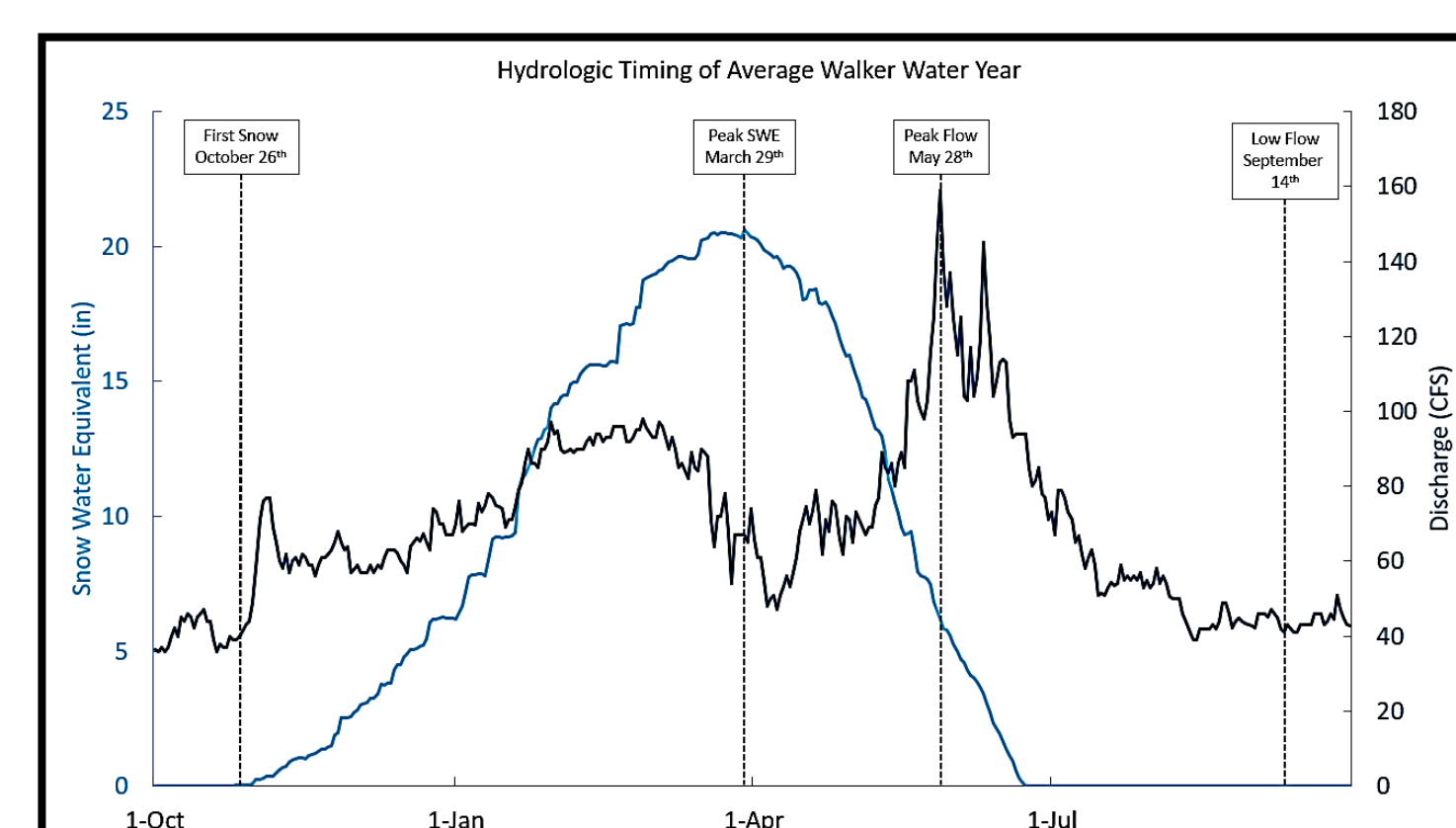


Figure 1. Walker Basin Average Water Year Hydrograph

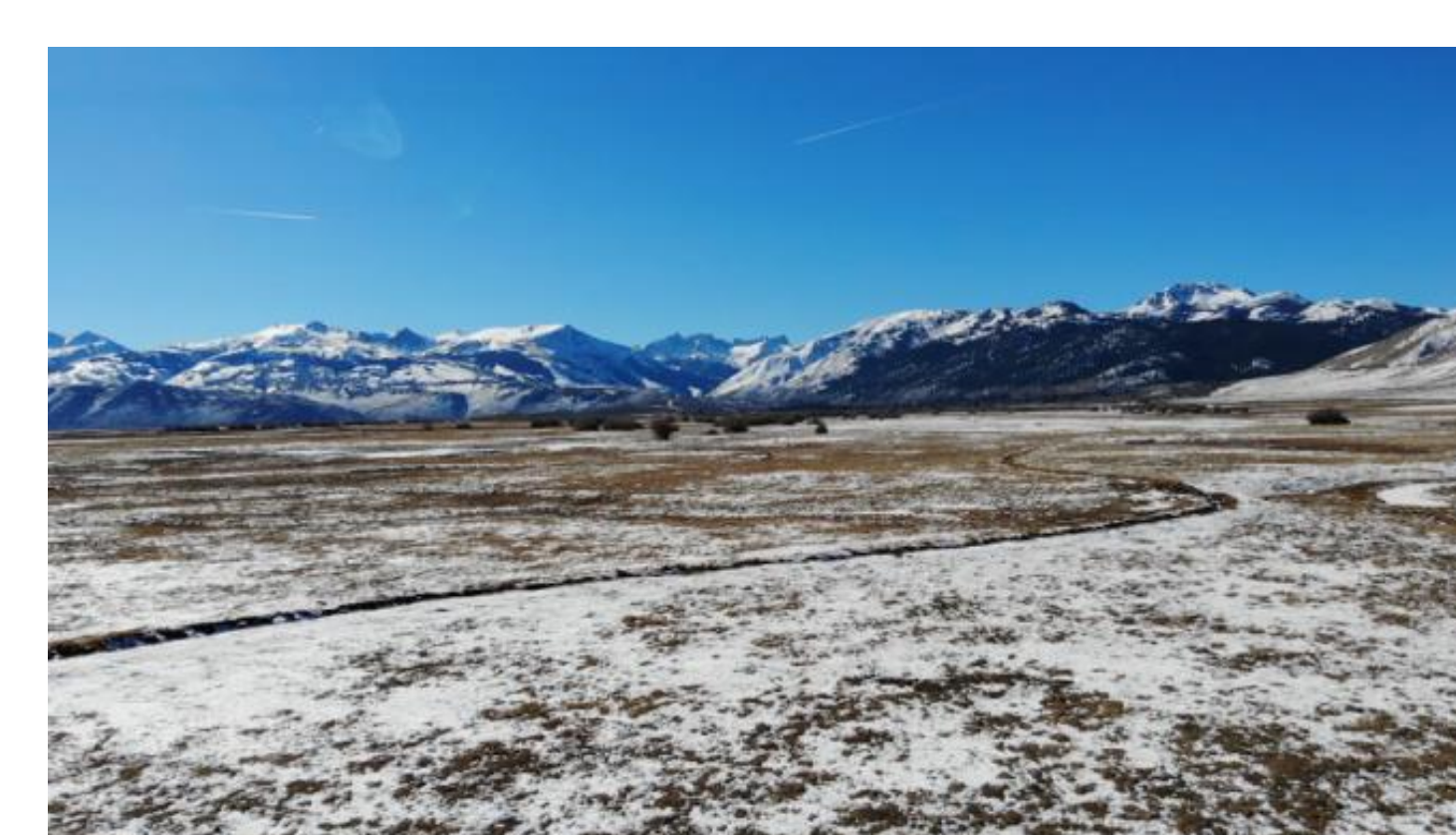


Figure 2. Walker Basin Watershed

Current baseline conditions in the Carson and Walker basins were assessed to determine land use area contribution to baseflow and nutrient mobilization. Records from snow pillow stations and stream gages were also analyzed, identifying an average water year with a substantial springtime release of snowmelt. Between April and June, nearly two thirds of the river's annual water budget are released as snowmelt from a snowpack that took six months to build. The average snow water equivalency is 21 in/yr. Major water quality concerns include nitrogen, phosphorus, and turbidity.

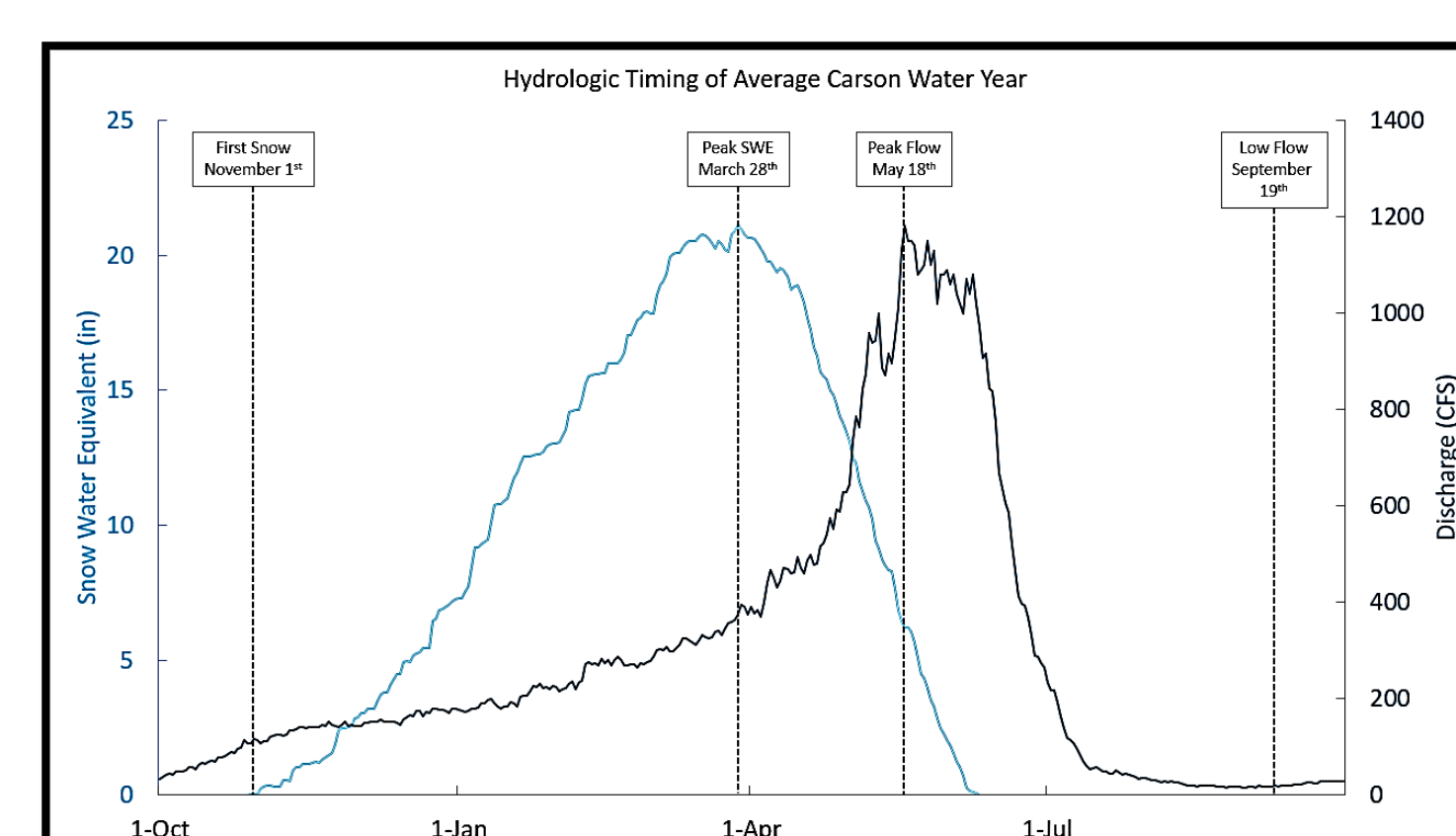


Figure 3. Carson Basin Average Water Year Hydrograph

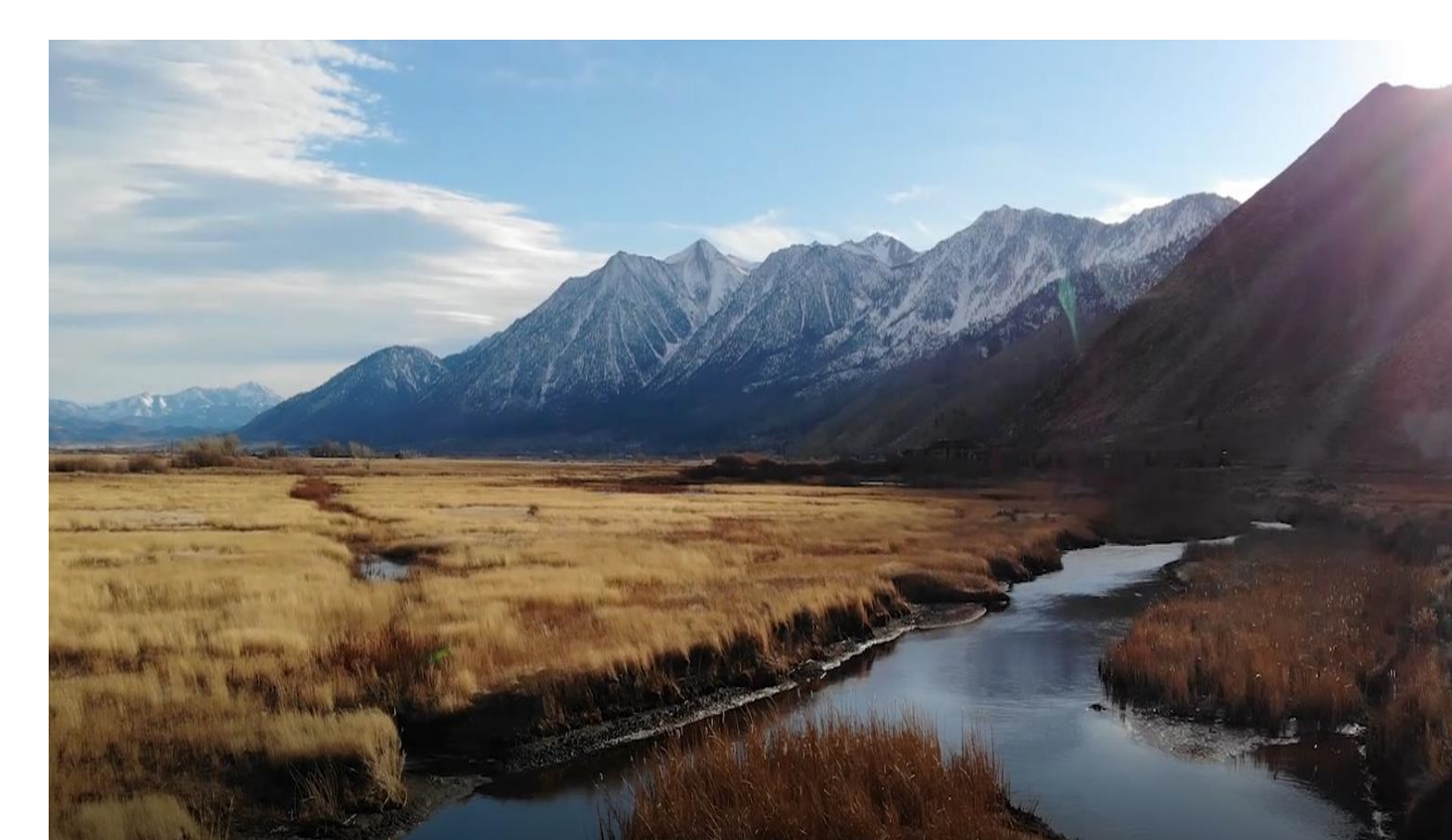


Figure 4. Carson Basin Watershed; River Fork Ranch

Modeled Climate Change Priority Areas

For three parameters, the watershed-wide change in ecosystem services were split into quintiles. Areas within the top 20th percentile for pollutant load and reduction of base flow were selected. The intersection of these areas were determined to be of the highest priority for The Nature Conservancy conservation efforts. The distribution of areas experiencing the greatest deterioration in water quality were mapped as priority areas. InVEST results indicate that land in the headwaters contributes most to reductions in baseflow and increases in pollutant loading. All modeled results in InVEST indicate a reduction in baseflow out to 2050 with increased pollutant loading around select agricultural areas. Forest and meadowland areas, known for water storage services, are observed to border these areas of modeled baseflow reduction (RCP 8.5) and may further be affected by these changes in the future.

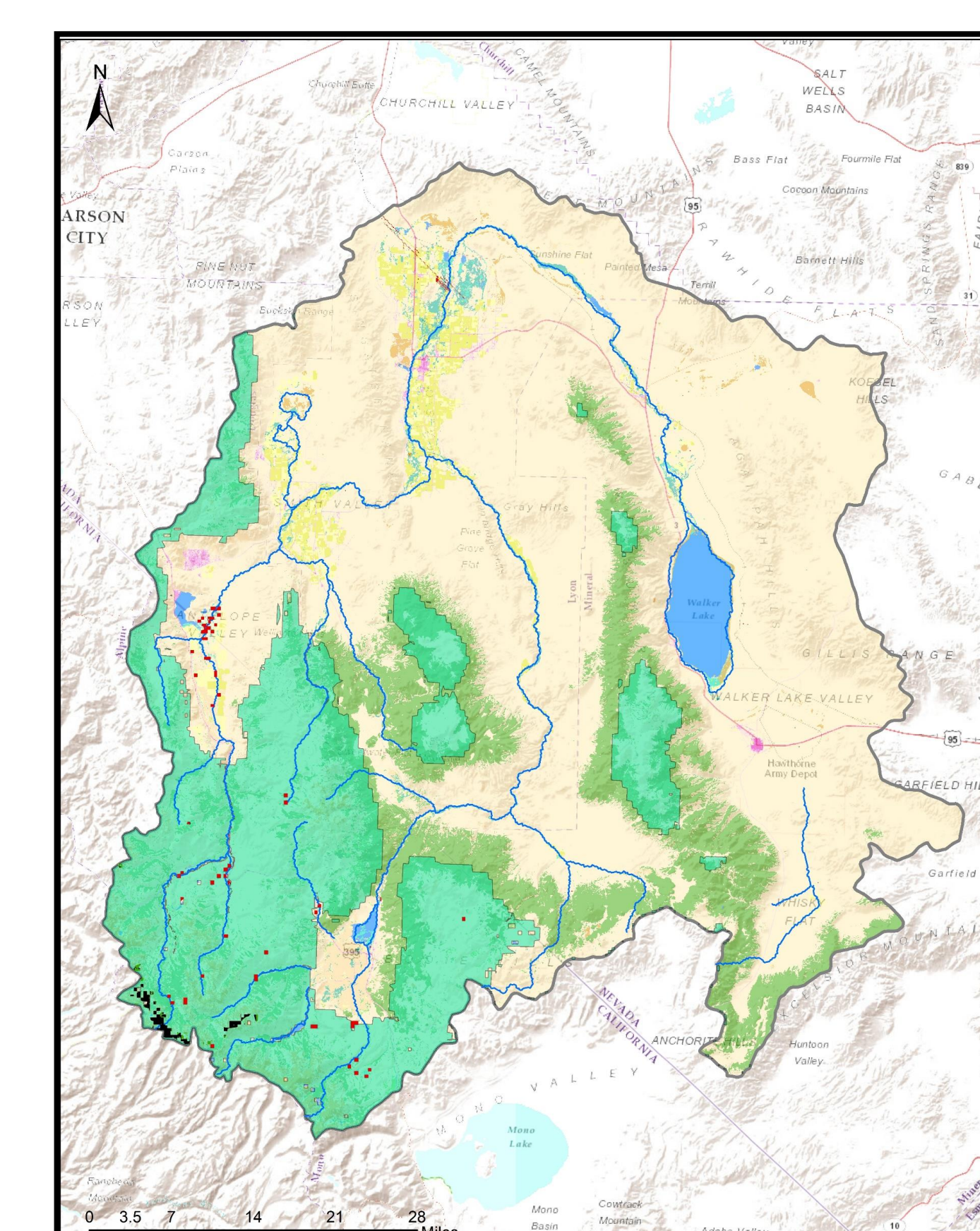


Figure 5. Walker Basin Modeled Priority Areas

Legend

- Pollutant Increase (N+P)
- Priority Areas (All Models)
- Baseflow Decrease

Waterbodies

- Intermittent Wetlands
- Reservoirs
- Lakes and Ponds

Land Use Type

- Residential
- Commercial/Industrial
- Unusable Land
- Deciduous Forest
- Coniferous Forest
- Mixed Forest
- Rangeland
- Cropland/Pasture
- Forested Wetland

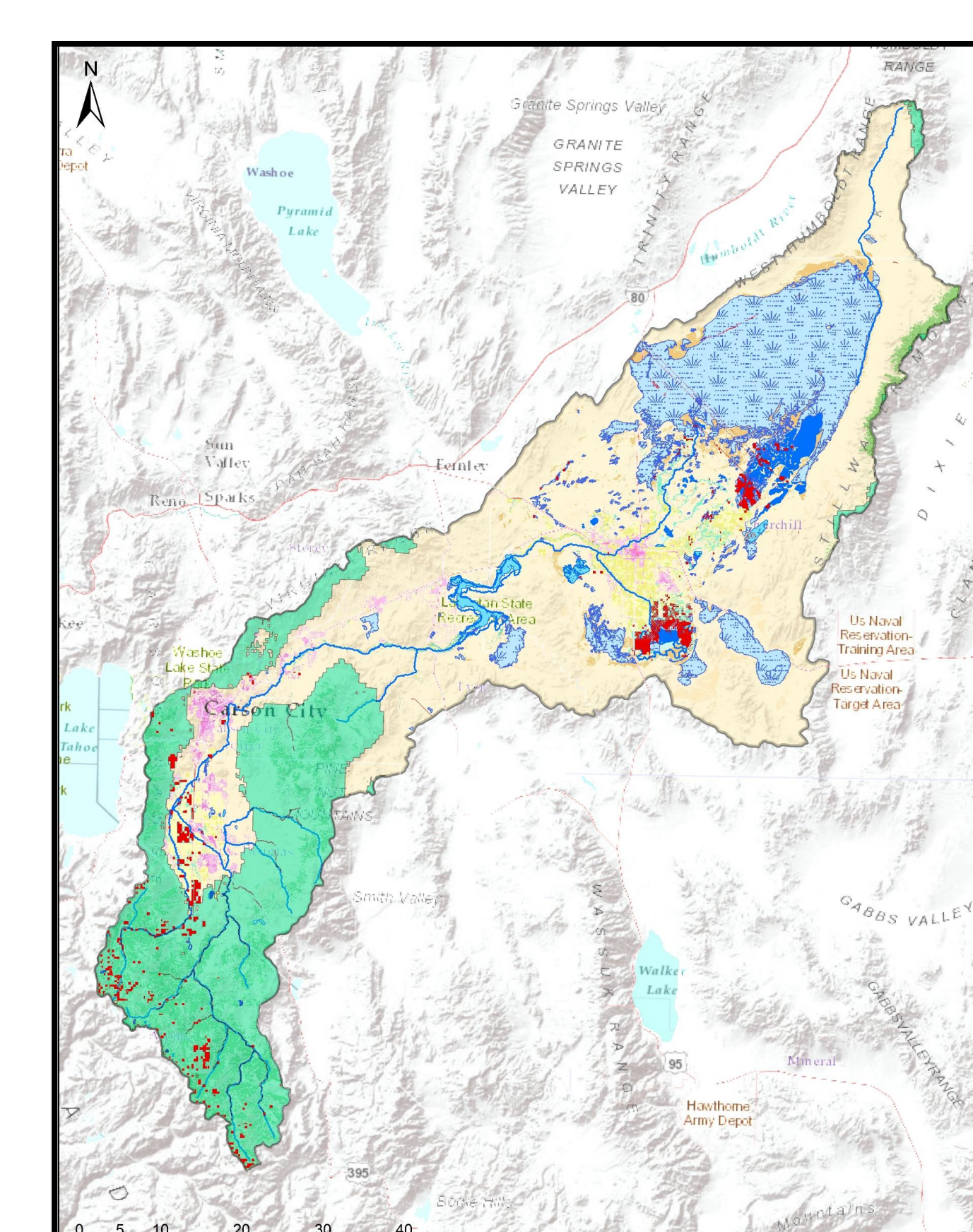


Figure 6. Carson Basin Modeled Priority Areas

5 APPLICABLE MARKET MECHANISMS AND INVESTMENT FEASIBILITY STUDY

Douglas County and TNC

Modeled priority areas include headwater lands of both the Carson and Walker Basins. Currently, TNC manages sizable conservation easements and restoration projects throughout both watersheds. With increasing populations (indicated by developed lands and residential areas) public water supplies experience stress with variations in water supply and quality. TNC and local water managers currently seek to target investment opportunities for adaptive management actions, as opposed to traditional infrastructure, e.g. dams.

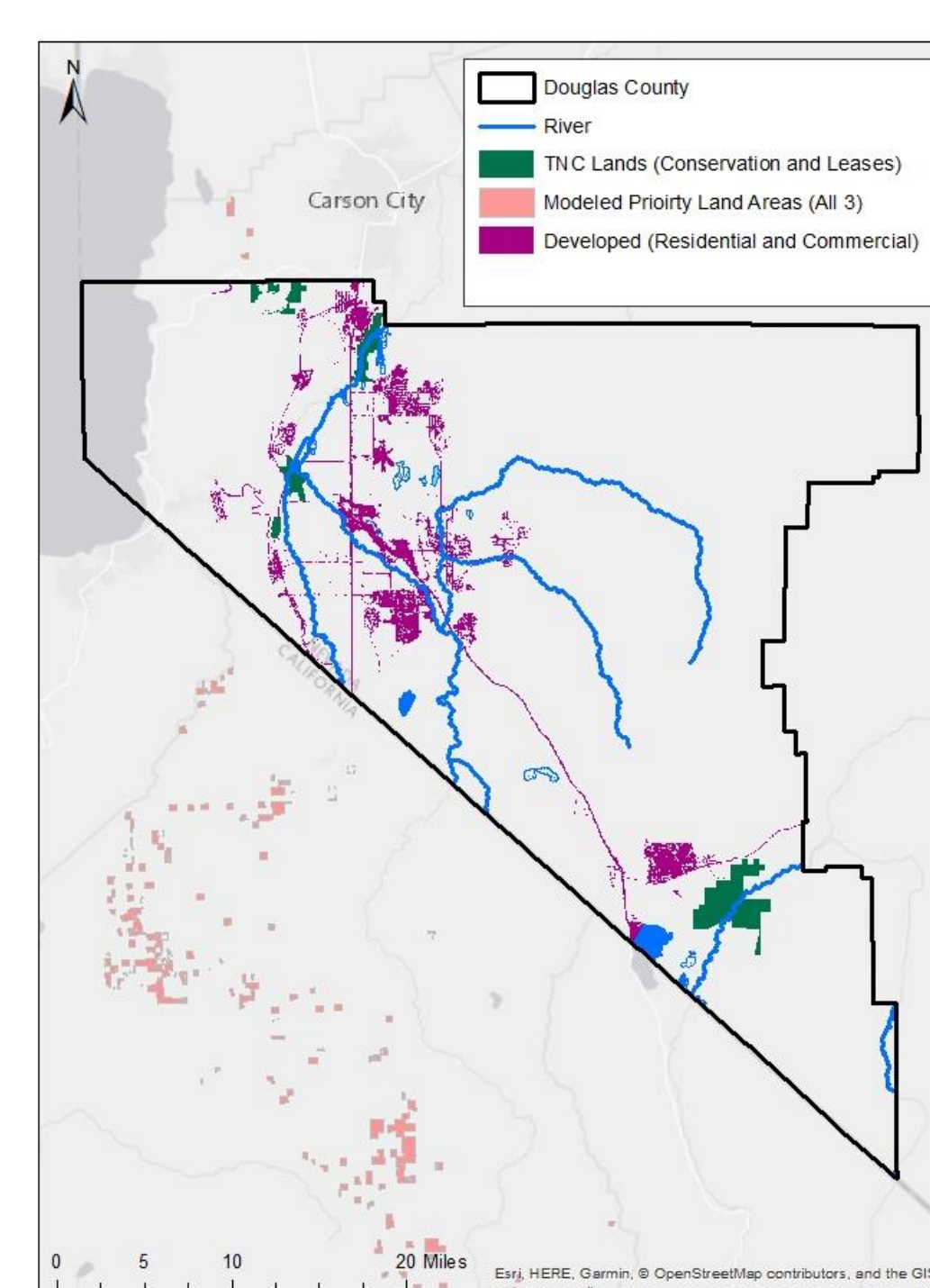


Figure 7. TNC Lands, Priority Areas, and Developed Lands (Downstream Users)

Relevant Market Mechanisms

Water Fund: Payments for watershed services where beneficiaries (usually downstream users) pay into a central fund that is managed for conservation projects throughout the area.

Water Trades and Transfers: The temporary or permanent exchange of a water right's point of diversion, nature of use, or point and place of use between a buyer and seller.

Payments for Ecosystem Services (PES): Voluntary transactions where defined ecosystem services (land uses and practices) are purchased (funded) by a service buyer under a form of conditional agreement.

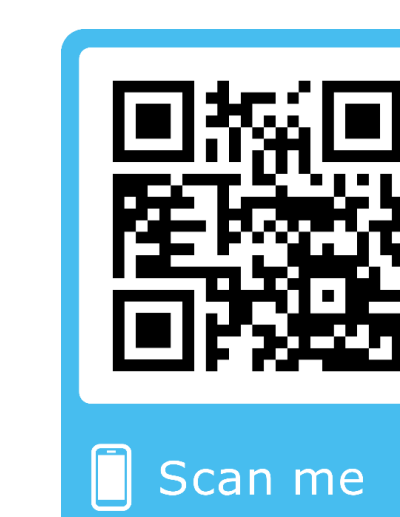
Feasibility Score

- 33%** With a population under 50,000 people, resources split between over 10 different water purveyors, and a central environmental "champion" present, a water fund does not appear feasible here.
- 50%** Statewide half of the recommended legal and political components are met to facilitate trades. Transfers programs are already active on the Truckee and Walker Rivers.
- 75%** Three of four recommended Payment for Ecosystem Services schemes are applicable with motivated stakeholders present in the area to carry-out these actions

6 RECOMMENDATIONS AND NEXT STEPS

- 1) Implement water supply and water quality management actions through a **stakeholder outreach process** (organizing working groups and ongoing discussions) as well as creating a centralized platform to integrate different projects and provide funding opportunities.
- 2) Management actions should be implemented in the **identified priority areas for future water supply and water quality** conservation efforts –considered and placed in conjunction with existing conservation easement projects to maximize beneficial outcomes.
- 3) Rather than a water fund, it is recommended that a **variety of funding options and mechanisms** be utilized including water transfer and payments for ecosystem for their applicability to the local context and future water management needs of the basins.

For more information please visit our website for the full graduate thesis report, accompanying maps and models, as well as video content for these watersheds.



7 ACKNOWLEDGMENTS

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