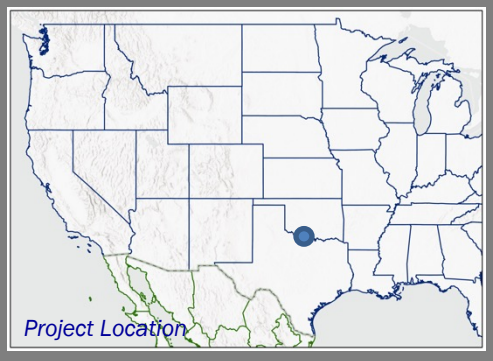
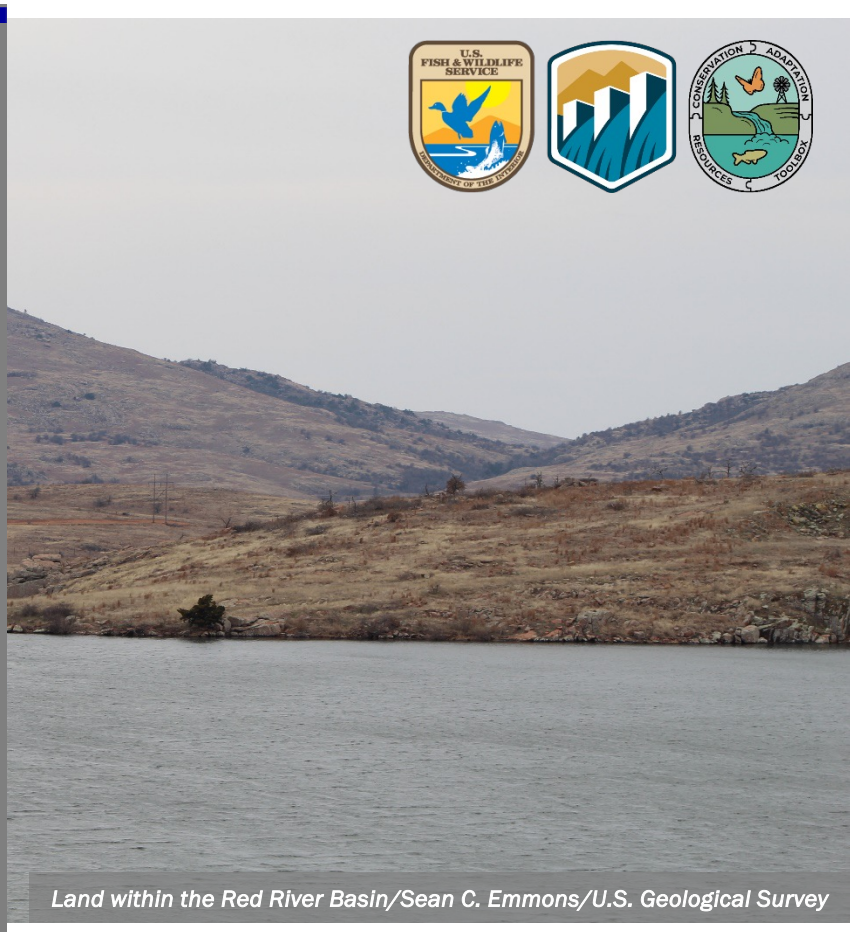
ACTIONABLE SCIENCE

Balancing Water Usage and Ecosystem Outcomes Under Drought and Climate Change Conditions

SOUTH CENTRAL
CLIMATE ADAPTATION SCIENCE CENTER

The Red River (RR) Basin is a transboundary river basin spanning five states in the South-Central United States. Its 38 reservoirs supply water for municipal, agricultural, and industrial use and are home to over 150 native fish species. Environmental flows are the appropriate quantity, quality, and timing of freshwater flows needed to sustain riparian ecosystems, which are valuable for supporting human cultures and economies (Arthington et al., 2018). To identify areas and maximize investment of conservation resources in support of environmental flows, researchers from the University of Oklahoma modeled optimal freshwater usage and future species distributions.





Land within the Red River Basin/Sean C. Emmons/U.S. Geological Survey

KEY ISSUES ADDRESSED

Climate change is impacting water availability in the basin. Severe drought and heavy precipitation events will become more frequent, and further warming will increase evapotranspiration rates. Scientists predict climate change will alter the distributions of basin fish species, but the extent of this change has not yet been quantified. Insufficient funds, a lack of coordination between water agencies, and managers' differing views on the value of environmental flows are barriers to implementing conservation actions. A lack of regulations permitting environmental flows and concerns that environmental flows may interfere with existing water use permits present additional challenges.

PROJECT GOALS

- Model water availability and usage in the RR Basin under several climate scenarios
- Quantify variation in fish species' distributions across future climate scenarios
- Evaluate water managers' attitudes towards environmental flows and analyze their communication patterns
- Identify prime conservation resource investment areas that maximize benefits for fish species

BEYOND THE BASIN

This approach to modeling future water availability and demand in the Red River Basin can be applied to drought-prone river basins in other parts of the world.

Irrigation Canals/Saleh Taghvaeian/University of Nebraska Lincoln

PROJECT HIGHLIGHTS

Decision-Support Tools: Researchers constructed a spatial planning model to optimize human and environmental water needs under changing climate conditions. They investigated tradeoffs between social equity, economic efficiency, and conservation outcomes of incentive-based water conservation.

Prioritizing Aquatic Species Conservation Areas: The researchers overlaid projected distributions of 31 basin fish species across climate scenarios to display species loss hotspots. Managers can use these maps alongside climate model predictions to assess the benefits of conservation actions at specific locations.

Stakeholder Connection: The team met with members of the Chickasaw and Choctaw Nations to understand their water conservation needs and concerns. Researchers surveyed resource managers in the basin to construct a communication network map for further analysis.

Framework for Water Conservation: Based on the spatial patterns of water scarcity among the nine climate scenarios, researchers designated the 38 major reservoirs as either "Rarely Water Scarce," "Sometimes Water Scarce," or "Often Water Scarce." Each designation has a corresponding recommendation for the level of investment in water conservation.

LESSONS LEARNED

The model demonstrated that small reductions in human water use can generate large environmental benefits. The researchers expect water demand to increase while streamflow decreases in the basin, but there is great variability in projected water demand between counties.

The research team found future distributions of individual species are highly uncertain across climate scenarios, but they were able to highlight areas where a group of 31 fish species are projected to be most negatively impacted. Practitioners can use this information to determine locations where conservation efforts may have the most favorable outcomes for native fish species.

The RR Basin is a complex socioeconomic system, so it was important for the researchers to capture the views of many groups, including federal and state agencies, Tribal Nations, and private entities. Water resources transcend man-made boundaries, so collaboration among water managers across political jurisdictions and economic sectors is essential for balancing water needs in drought-prone basins.

NEXT STEPS

- Integrate biophysical and social models to determine when and where to implement incentive-based water conservation
- Research collaboration decisions and willingness of conservation stakeholders and water users for incentive-based conservation and modeling
- Explore implementation methods of an incentive-based conservation program in the RR Basin

Collaborators

- University of Oklahoma Department of Geography and Environmental Sustainability
- South Central Climate Adaptation Science Center

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Stakeholder Meeting/Thomas Neeson/University of Oklahoma