

The Importance of Groundwater in Sustaining Streamflow in the Upper Colorado River Basin

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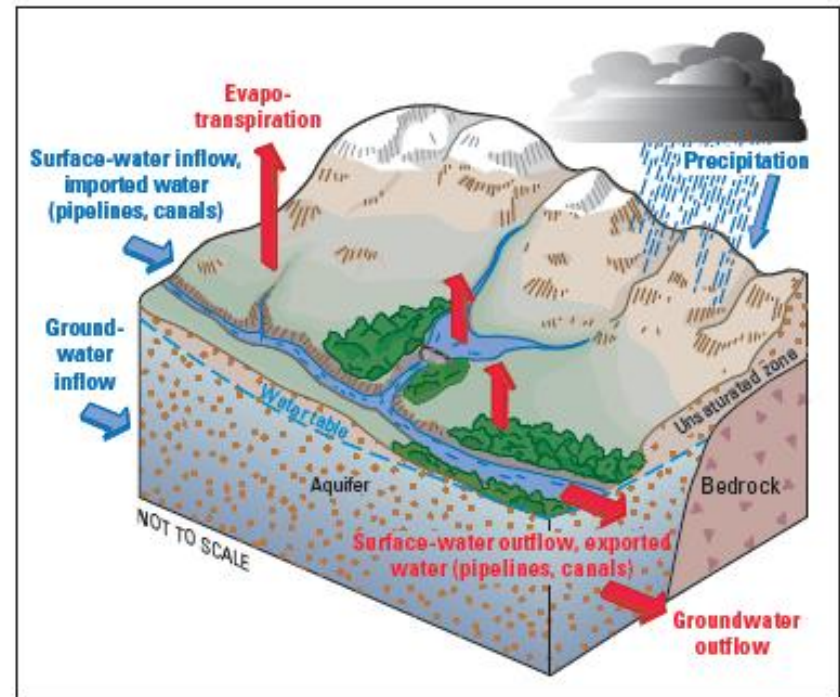
U.S. Geological Survey, Utah and Nevada Water Science Centers



USGS National Water Census: Colorado River Basin Focus Area Study



1. Evapotranspiration
2. Snowpack Hydrodynamics
3. Water Use Information
4. *Groundwater Discharge to Streams*



Stream Geomorphology and Hydrographs and Groundwater

Gibbon River, Yellowstone

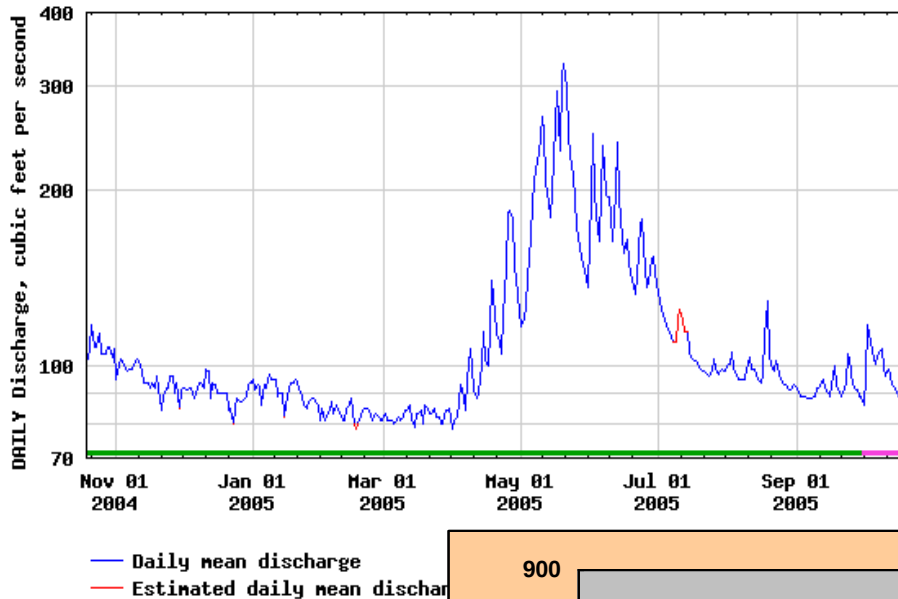


Soda Butte Creek, NE Yellowstone



Gibbon River

USGS 06037100 Gibbon River at Madison Jct, YNP

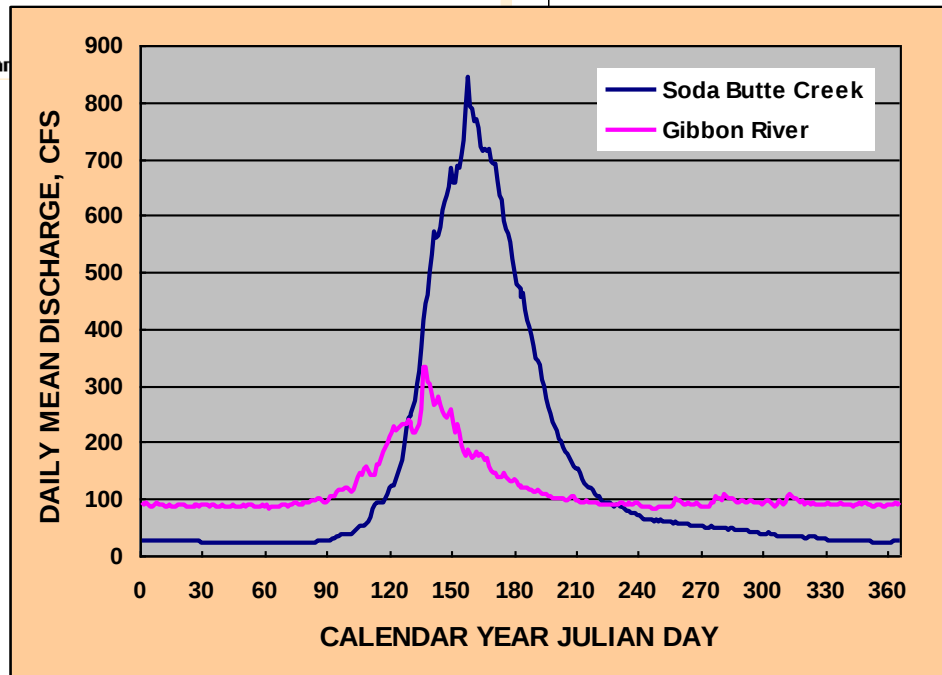
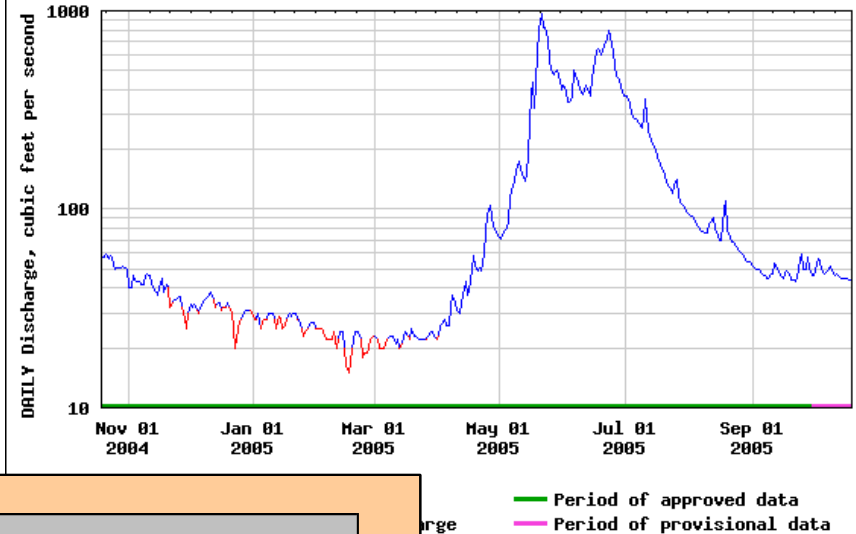


Gibbon River
Drainage Area
-- 126 mi²
Gage elevation
-- 6800 ft
Period of Record
2001-2007
Mean annual Q
90-160 cfs

Soda Butte Ck



USGS 06187950 Soda Butte Cr nr Lamar Ranger Station YNP



Soda Butte Ck
Drainage Area
-- 99 mi²
Gage elevation
-- 6630 ft
Period of record
1988-2007
Mean annual Q
100-200 cfs

UCRB Focus Area Study Objectives

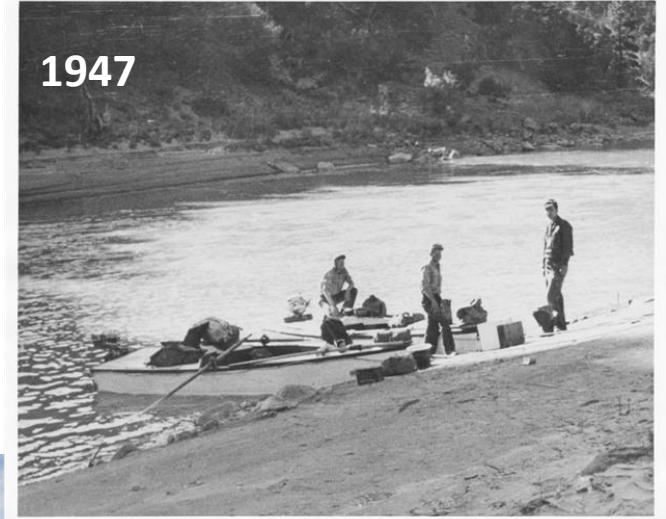
1. Determine the spatial distribution of groundwater discharge to streams (*where*)
2. Quantify the fraction of total streamflow that is supported by groundwater discharge (*how much*)
3. Quantify the age of groundwater in the UCRB (*vulnerability*)



USGS Long Term Records

- Long-term discharge and specific conductance data collected by USGS were used for chemical hydrograph separation
- Data from 1984-2012 used for present study

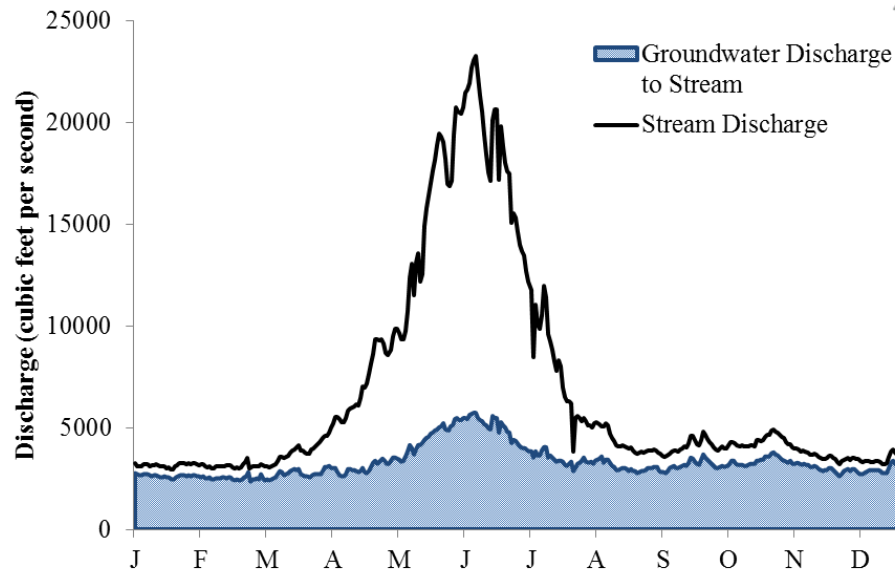
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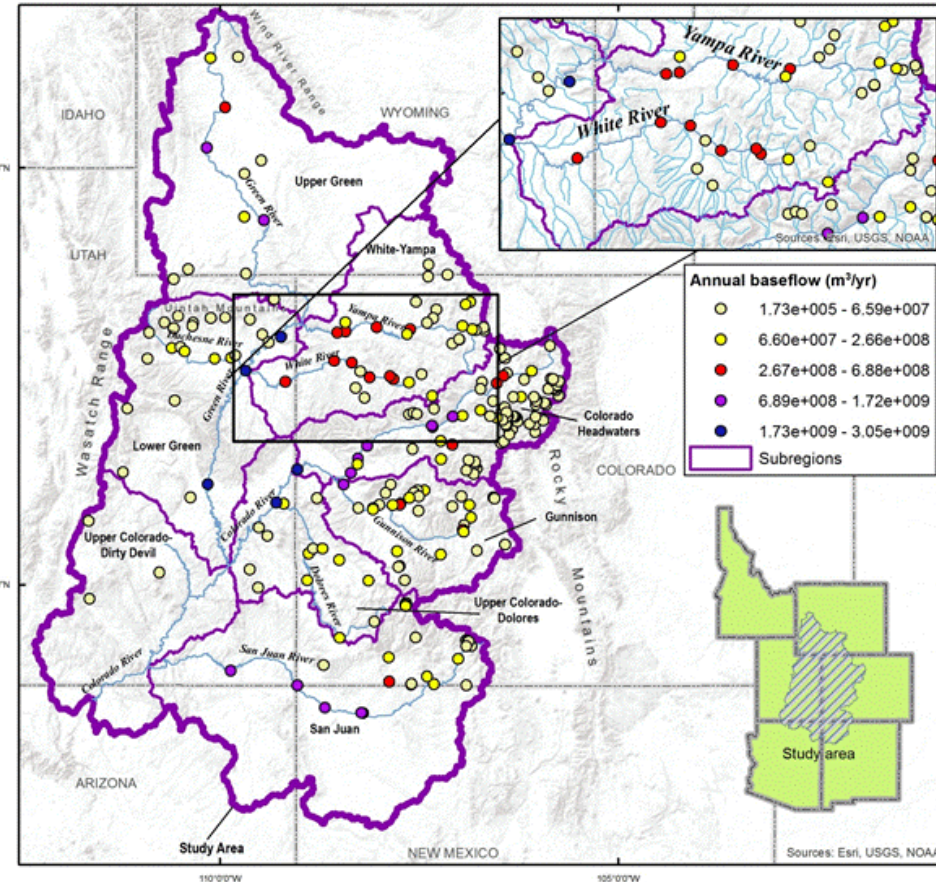
2010



Groundwater Discharge to Streams

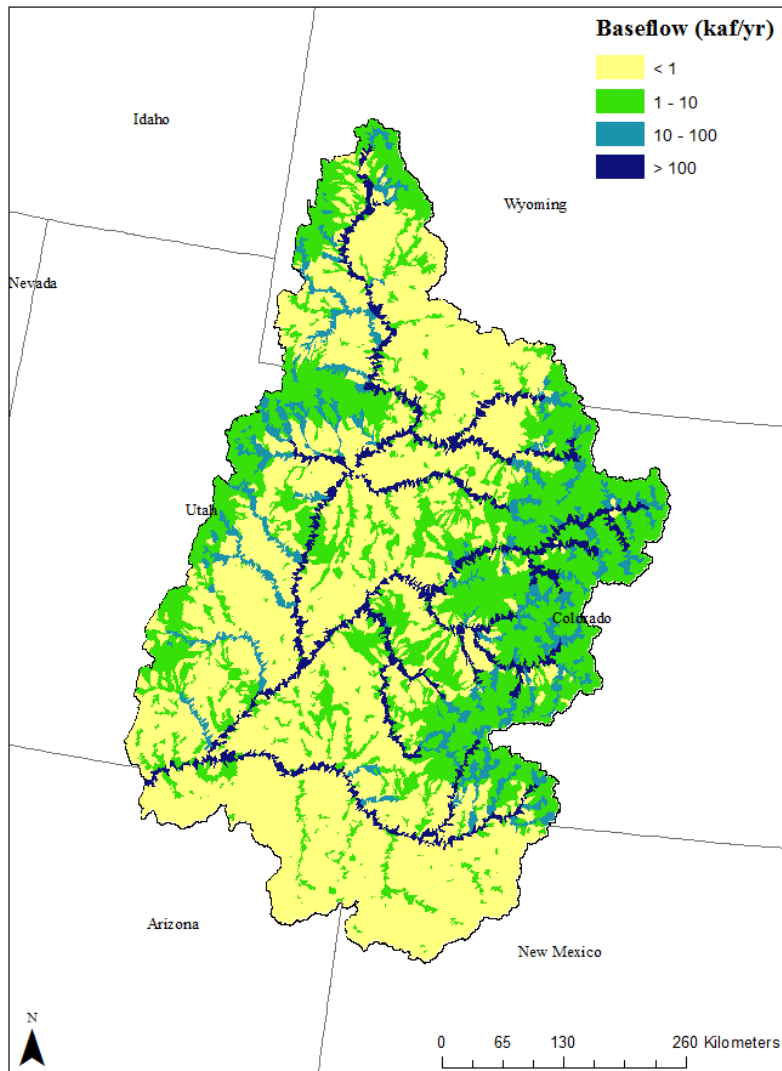


Hydrograph separation results for Colorado River at Cisco, UT



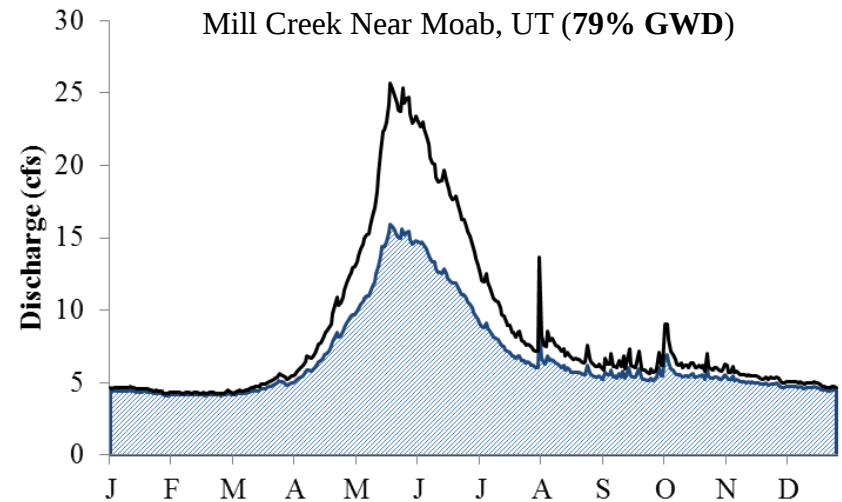
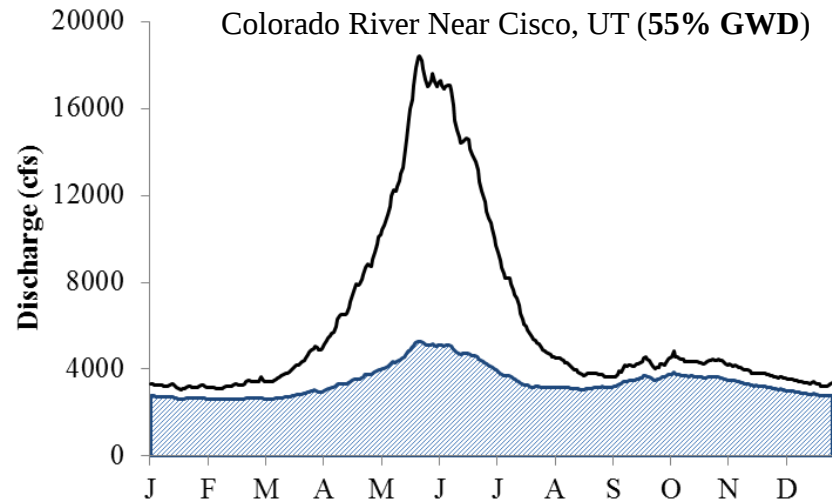
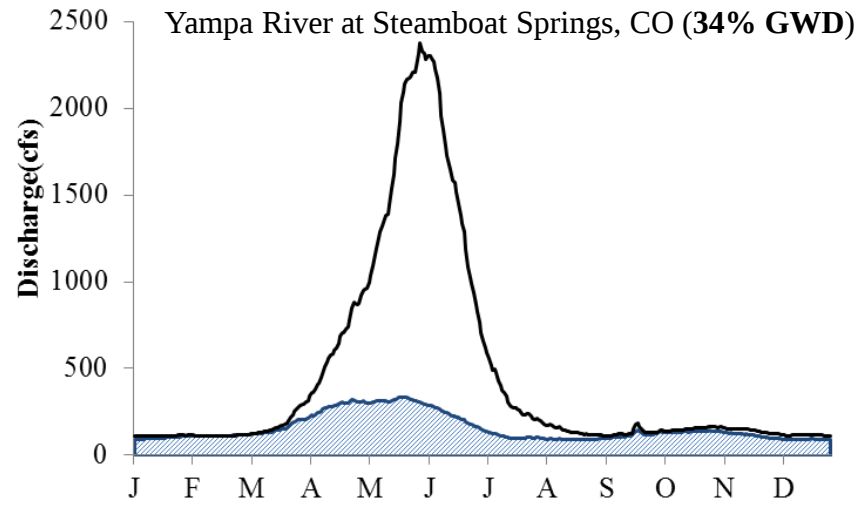
Groundwater discharge to streams estimated at 229 sites

Spatial Distribution of Groundwater Discharge

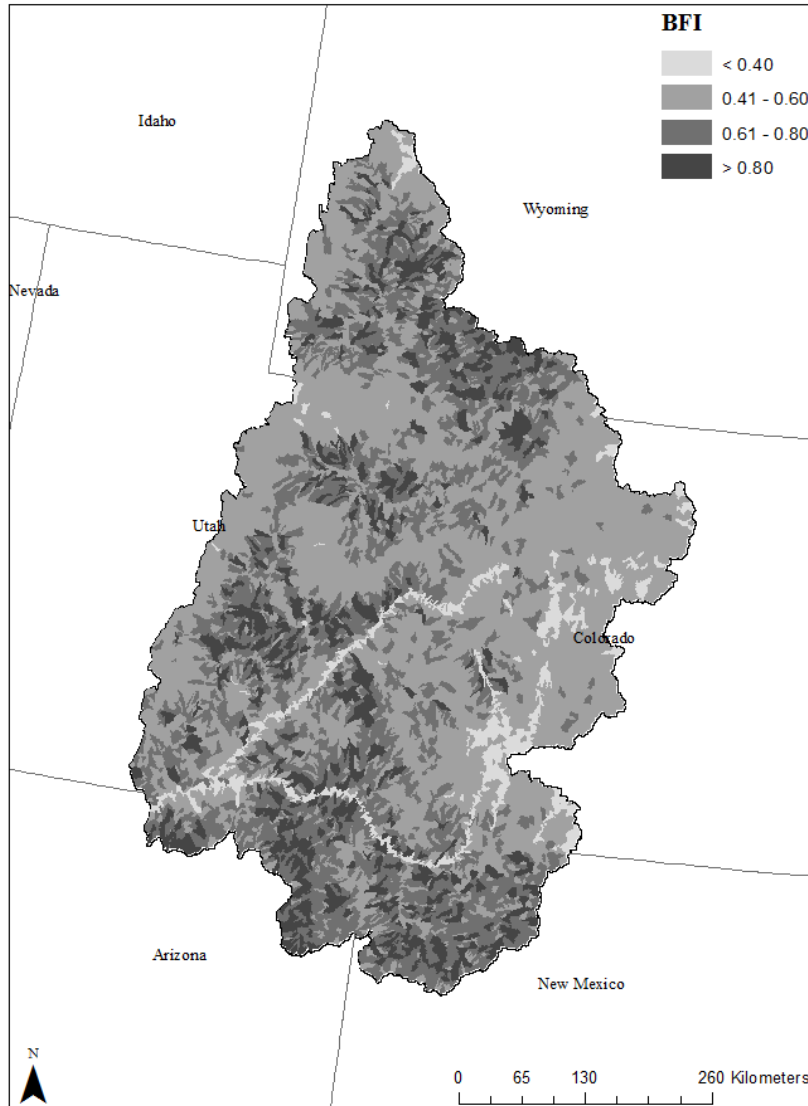


- *Most groundwater discharge to streams occurs in upper elevation catchments*
- *Climate change in high elevation systems will affect the groundwater resource, and therefore the amount of surface water in streams*
- *14.5 maf/yr = Groundwater discharge to streams in Upper Basin*
- *2.7maf/yr = Water delivered to the Lower Basin that originated as groundwater*
- *Water lost during in-stream transport due largely to irrigation withdrawals, stream losses and evapotranspiration*

Groundwater and Surface Water – A Single Resource

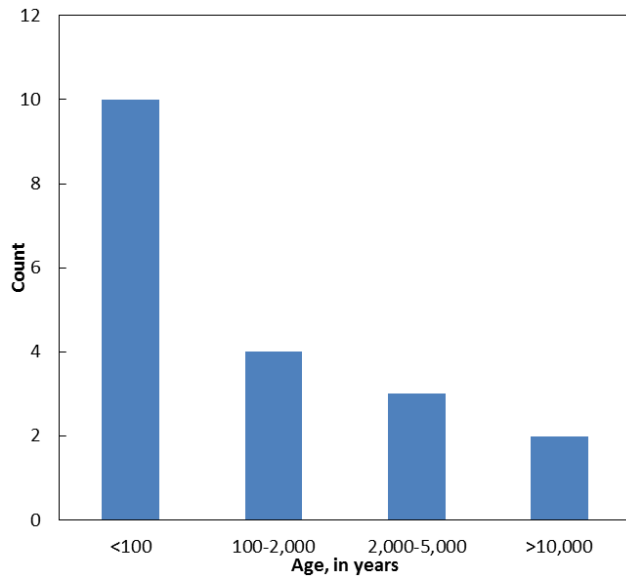


Streamflow Sustained by Groundwater



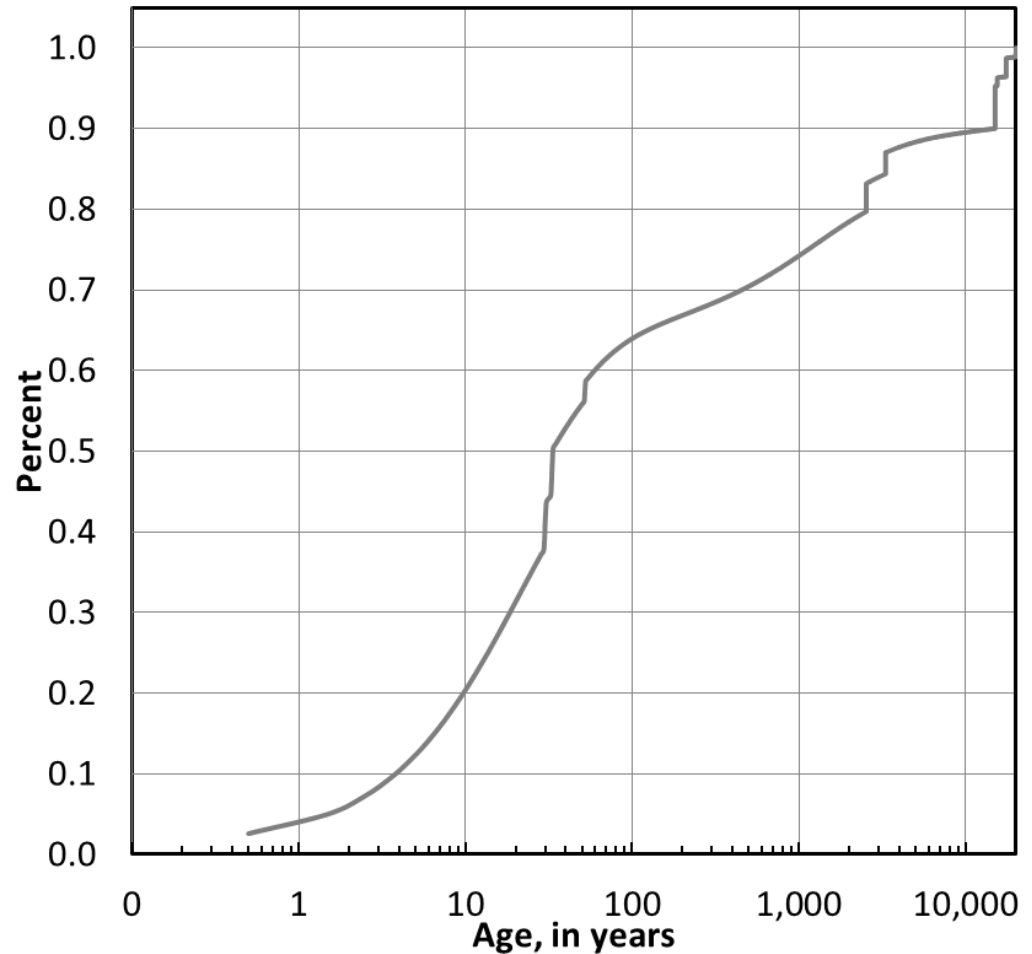
- *On average 56% of streamflow in the UCRB is estimated to be from groundwater discharge*
- *Streamflow in lower elevation catchments is more dependent on groundwater discharge than high elevation systems*
- *These streams support ecologically sensitive habitats (e.g. riparian zones)*

Age of Groundwater in UCRB



20% of groundwater < 10 years old

65% < 100 years old



Relatively young age of groundwater suggests potential rapid response to changes in environmental conditions

Summary and Implications

1. Quantitative estimates of groundwater discharge to streams indicate that groundwater and surface water are a single resource
2. Any process that affects the groundwater resource will also affect the surface water resource
3. These results are being used to:
 - a. Develop a tool to assess climate impacts on the joint groundwater-surface water resources in the UCRB
 - b. Improve our understanding of salinity sources, transport, and temporal trends in the UCRB
 - c. Develop similar estimates of groundwater discharge to streams in other watersheds....beginning work in the Great Lakes watershed

Thank you

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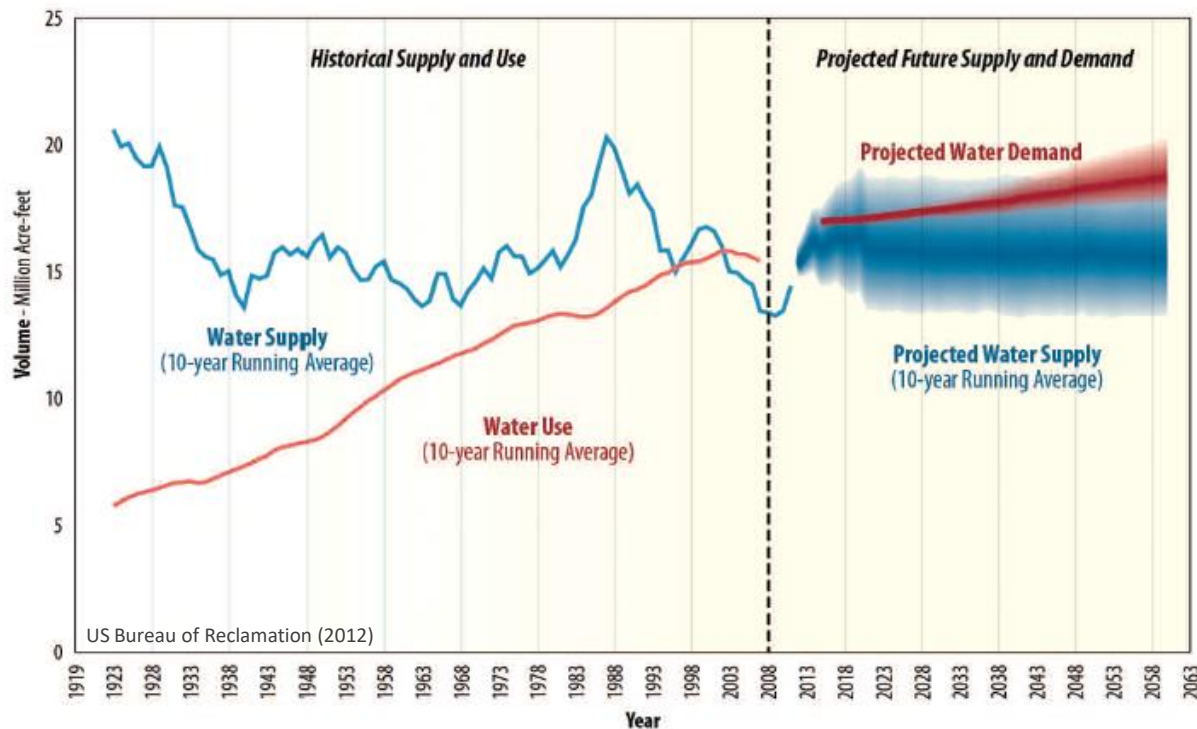


Project Development and Coordination

- Objectives developed from a USGS meeting with selected stakeholders including Reclamation
- Strategy focused on filling in information gaps
- Lack of groundwater information in UCRB
- Groundwater and surface water are an interconnected resource
- Leverage historic USGS data



BOR Colorado River Basin Supply and Demand Study



Overarching Objective
Provide quantitative information that adds new understanding of the joint groundwater-surface water resource in the UCRB

- Projected demand is greater than projected supply
- Median imbalance of ~ **3.2 million acre-feet** by 2060

