GROUNDWATER-SURFACE WATER INTERACTIONS OF THE GRAND CANYON

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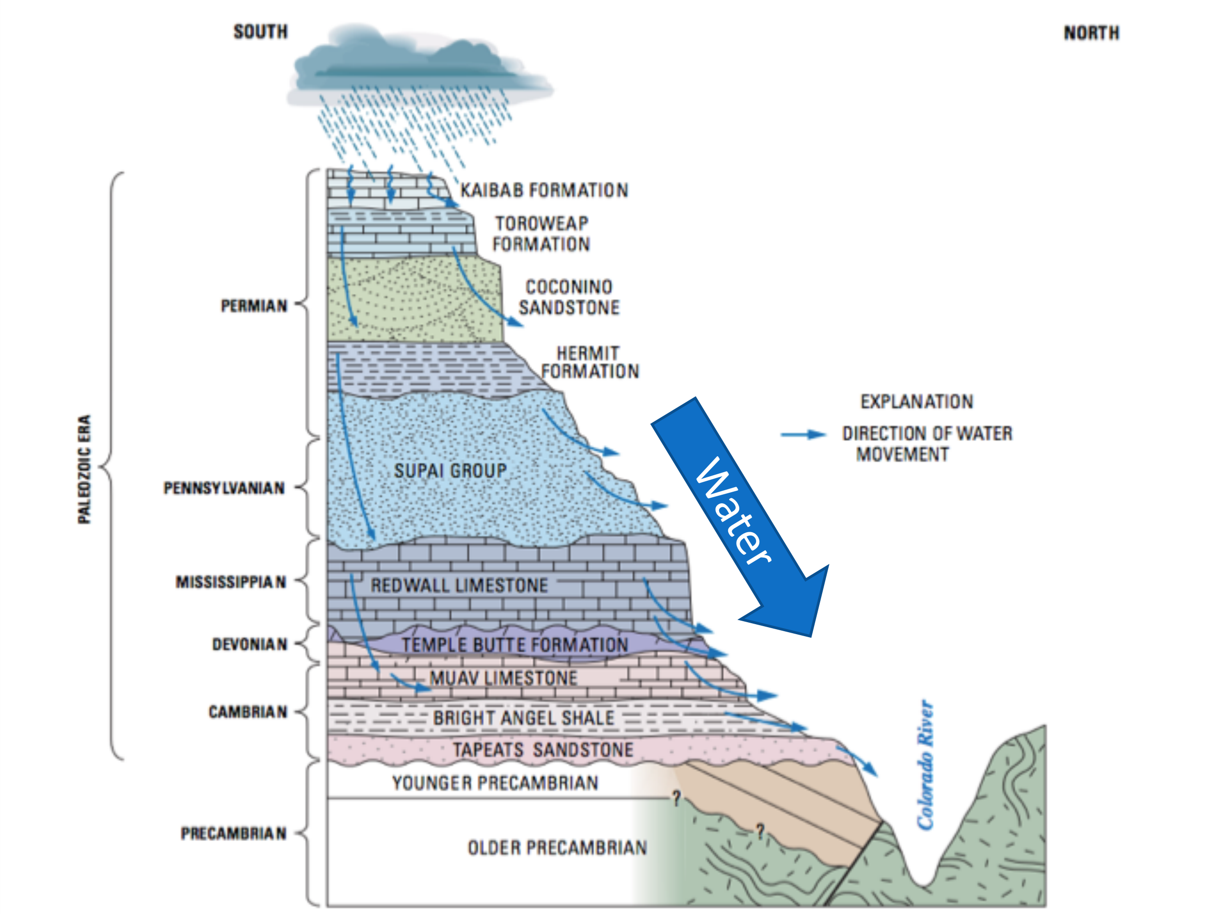
INTRODUCTION

The Colorado River Basin:

- Supplies water to more than 50 million people
- Irrigates 4 million acres of cropland in the U.S. and Mexico
- Source for hydropower plants generating more than 10 billion kilowatt-hours annually

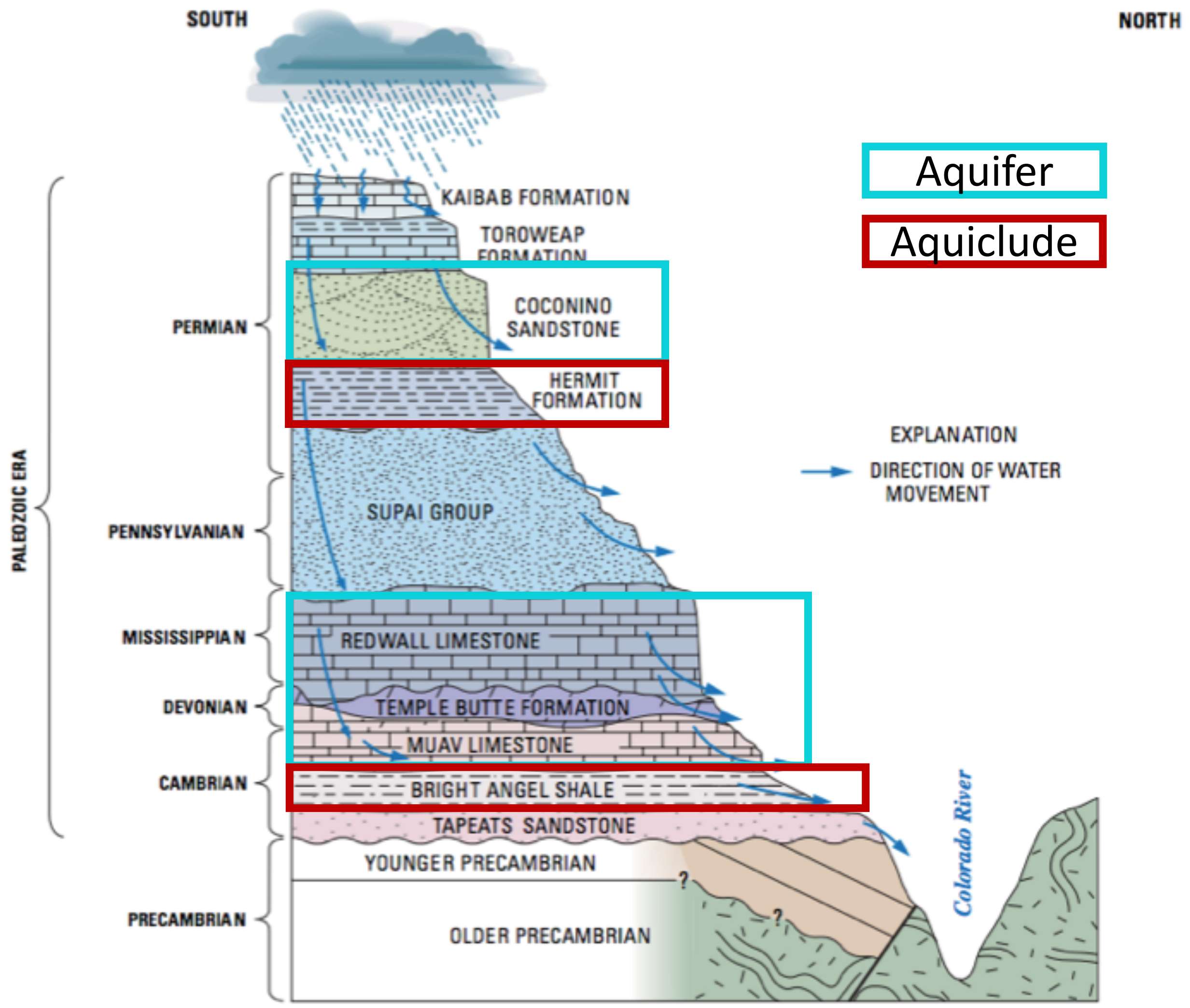
INTRODUCTION

- 56% of the Colorado River's flow originates as groundwater



Modified from Monroe et al. 2005

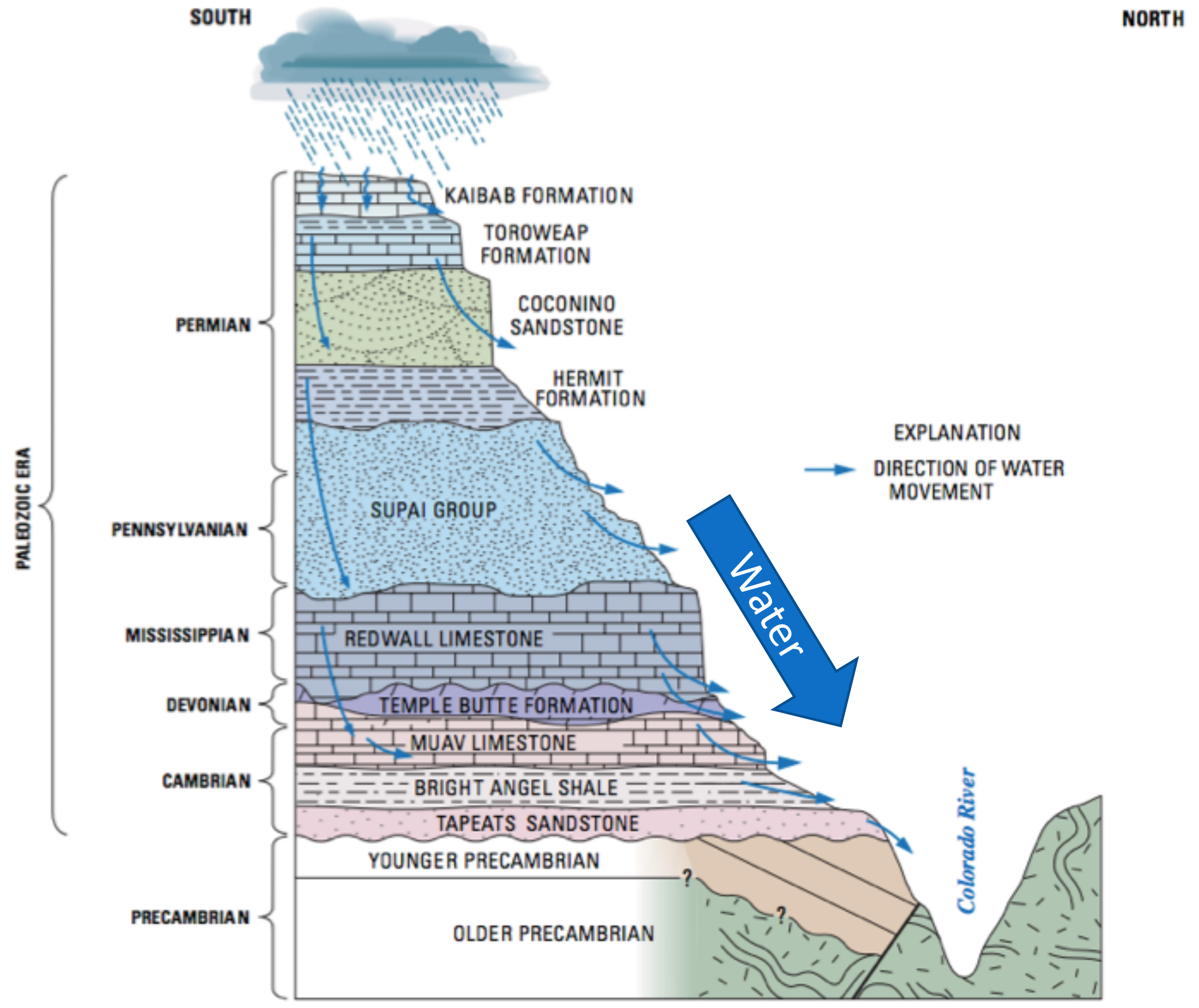
HYDROLOGIC SETTING



Modified from Monroe et al. 2005

- The Paleozoic Redwall and Muav formations are the main water-bearing units of the Grand Canyon
- At 900 m below the canyon rim, interconnected karstified limestone allow transport of water

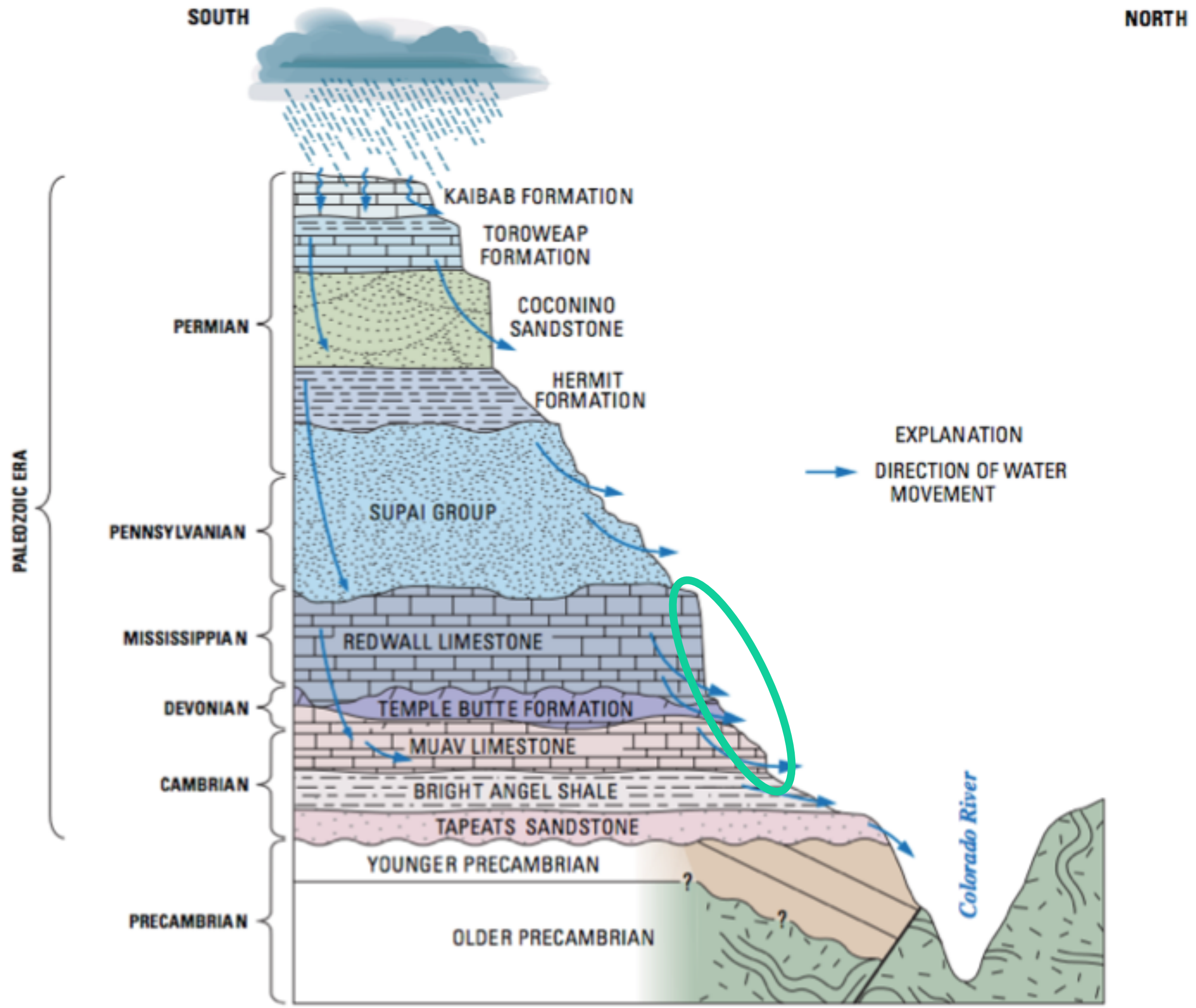
HYDROLOGIC SETTING



Modified from Monroe et al. 2005

- Unusual system because the entire surface water system is located beneath majority of the aquifer system
- Groundwater → Surface water and not the other way around

SPRINGS



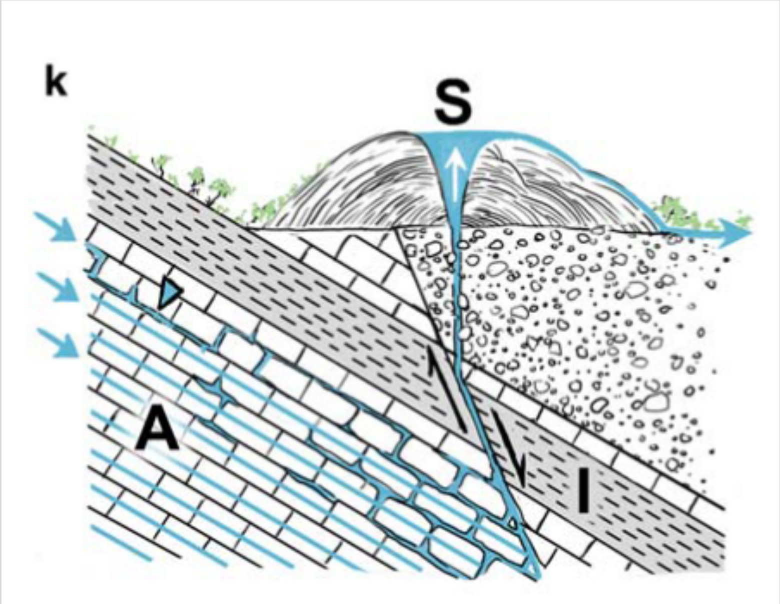
Modified from Monroe et al. 2005

- Snowmelt and rainwater from overlying land travels down through geologic formations
- This water exits the hydrogeologic units through springs
- Spring: an ecosystem created when groundwater meets the ground surface

SPRINGS

- 10 of the 12 spring types can be found in the Grand Canyon

Carbonate mound-form



Springer and Stevens 2008

SPRINGS

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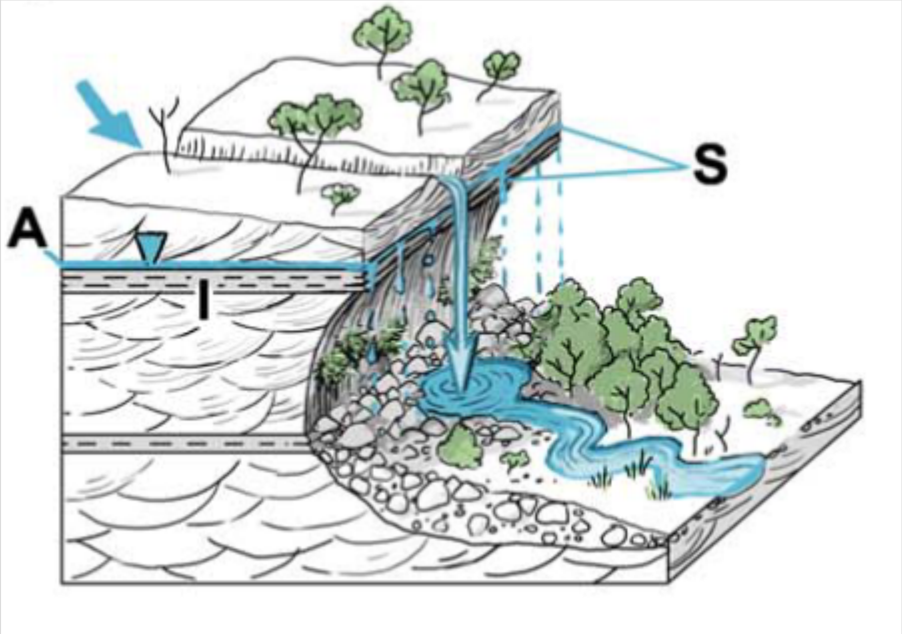
Hanging garden


Dave Chenault Photo



Springer and Stevens 2008

SPRINGS

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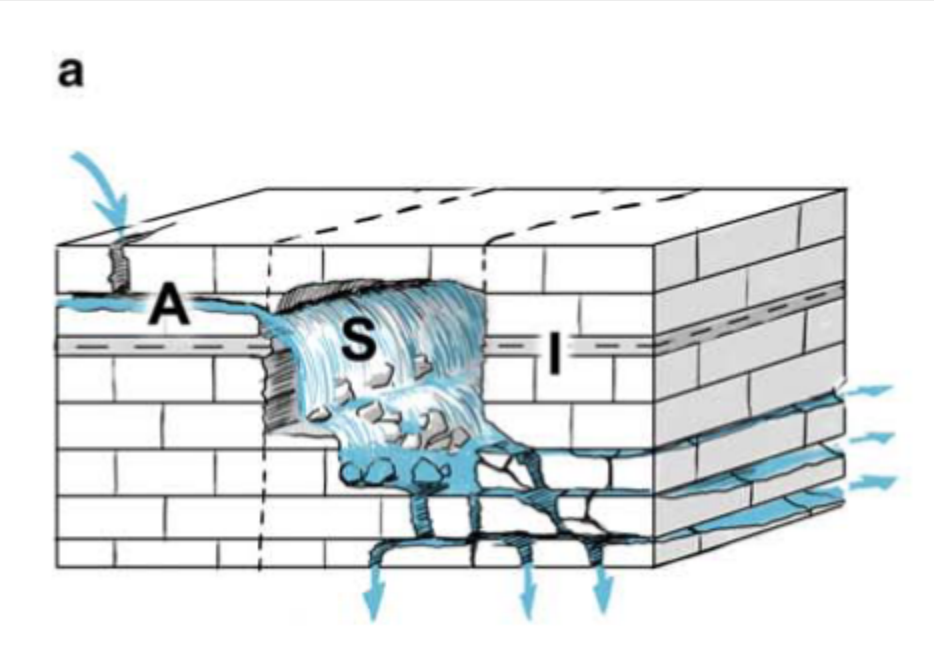
Cave

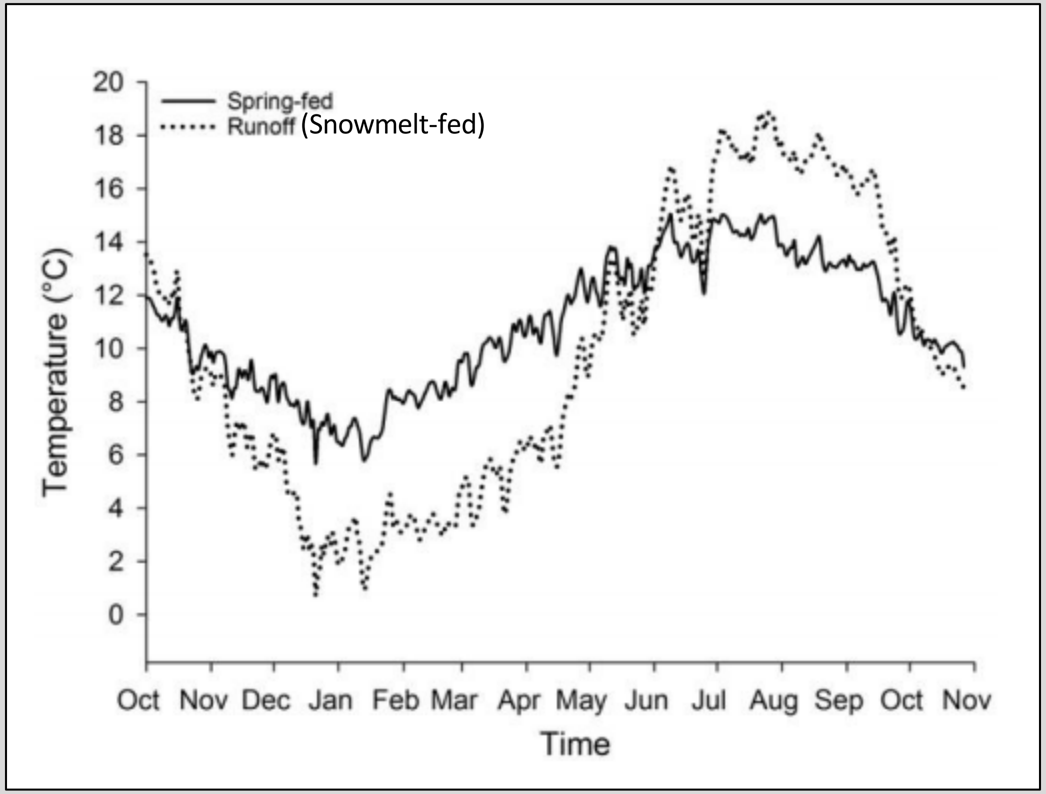


Springer and Stevens 2008

SPRINGS

- Spring-fed streams have a longer residence time than snowmelt-fed streams

- Creates less variability in temperature



Lusardi et al. 2016

SPRINGS

- Spring environments support 100 to 500x the species diversity than their surroundings
- Springs comprise only 0.01% of Grand Canyon's land mass and host 36% of the flora and fauna
- During low flow season, groundwater is the sole source of flow in spring-fed tributaries

Grand Canyon Wetsalts Tiger Beetle

SPRINGS

- **Roaring Springs**, located on the North Rim at 5200 ft, provides drinking water for the North Rim, South Rim and the inner Canyon
- The **12.5 mile Transcanyon Pipeline** delivers water to Grand Canyon Village
- Water is first transported to Indian Creek (3800 ft) by gravity
- Water is pumped to Grand Canyon village at 7043 ft elevation
- Roaring Springs provides 21 cfs of consistent flow

Roaring Springs

GROUNDWATER SCARCITY

- Aquifer systems have had significant storage reductions due to growth of surrounding communities such as Flagstaff, AZ

- Trends of decreasing discharge has been observed in Springs throughout the Park

- Trends of decreasing discharge, increased pumping and effects of climate change could damage spring-fed ecosystems over relatively short timescales (Kobor 2004)

Havasu Spring

WATER MANAGEMENT

- 100% of the Park's water supply is from the unreliable Transcanyon Pipeline

- Grand Canyon National Park's water demand is expected to double by 2050 (reaching 1,255 acft/year)

WATER MANAGEMENT

- Bureau of Reclamation conducted a water appraisal study in 2002 to plan for future water needs
  - Potential strategies include
    - Drilling a well into the aquifer that supplies Roaring Springs
    - Increasing durability of the Transcanyon Pipeline
    - Construction of pumping plant on Bright Angel Creek
- Proposed Tusayan Development and Grand Canyon Escalade projects have fallen through

Nps.gov

WATER MANAGEMENT

- Arizona relies on groundwater for 40% of their water supply
- After severely over-extracting their aquifer systems during the 20th century, Arizona began managing their groundwater in 1980
  - Passed a Groundwater Management Code that aims to ensure sustainable groundwater pumping practices by 2025

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QUESTIONS?