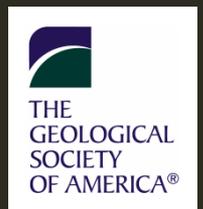


EARTHEN JARS: MONITORING THE TINAJAS OF SAGUARO NATIONAL PARK

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Geological Society of America · Mosaics in Science Program

National Park Service · Geoscientists-in-the-Parks Program



OVERVIEW

- Introduction
- Purpose and goals
- Methods
- Results and further research
- Acknowledgements
- Questions



INTRODUCTION

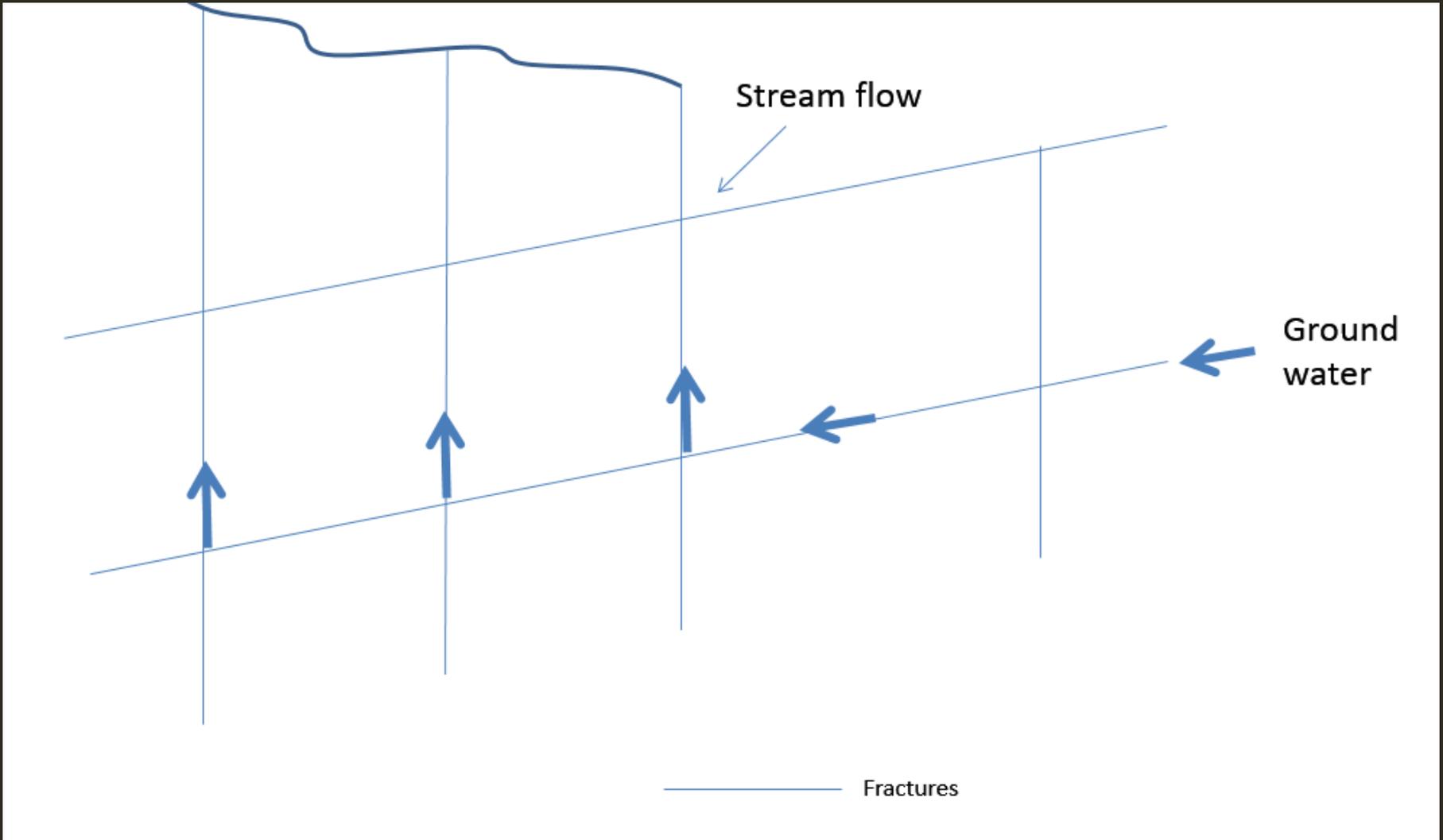
*Photo: Madrona Pools,
Saguaro NP*

WHAT IS A *TINAJA*?

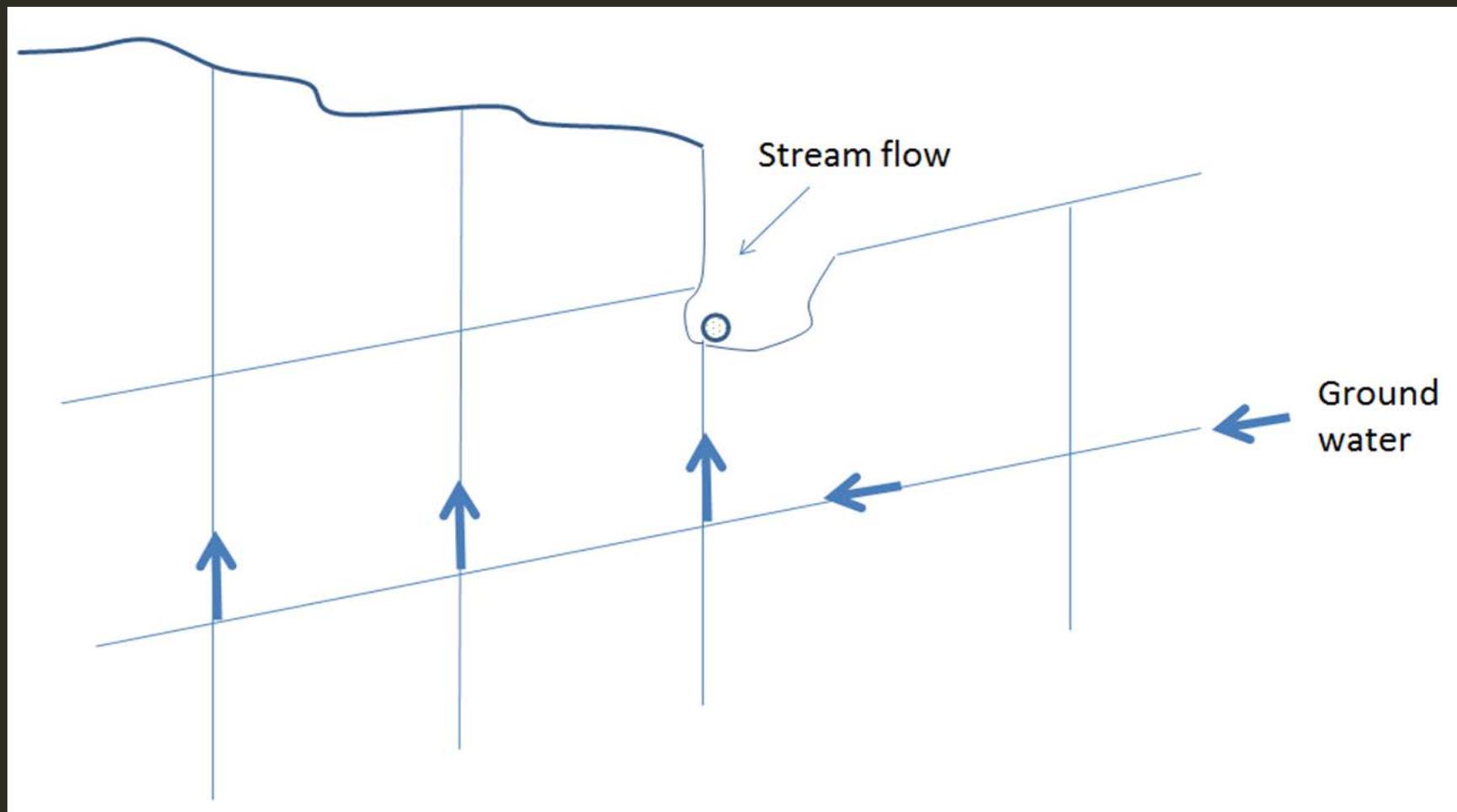
The word *tinaja* is a regional, Spanish term for “small earthen jar” that describes perennial and semi-perennial bedrock pools (and rheocrene springs) in the Sonoran Desert.

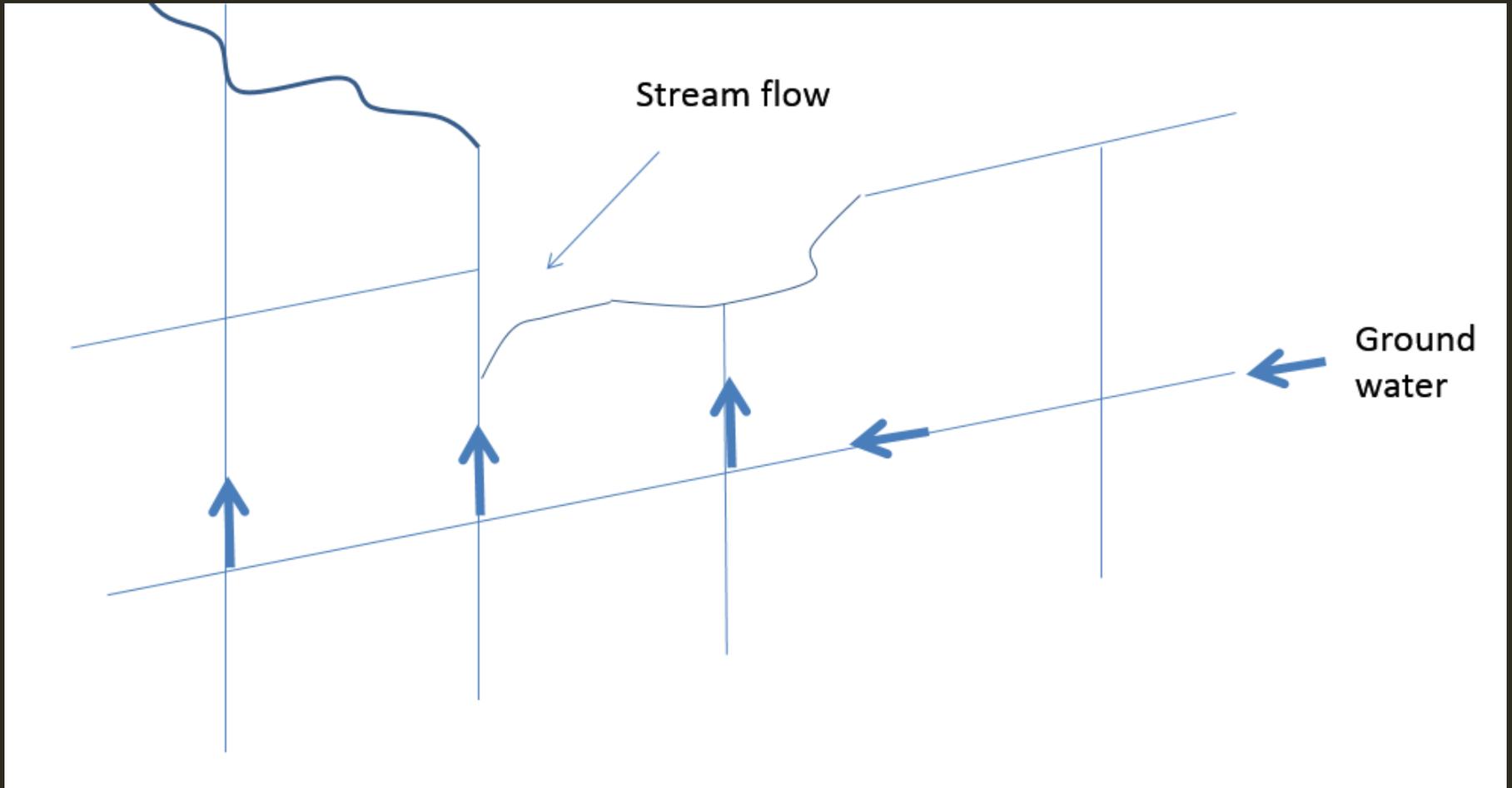
Tinajas are important water sources for terrestrial wildlife and vital habitat for rare, aquatic species of plants and animals.

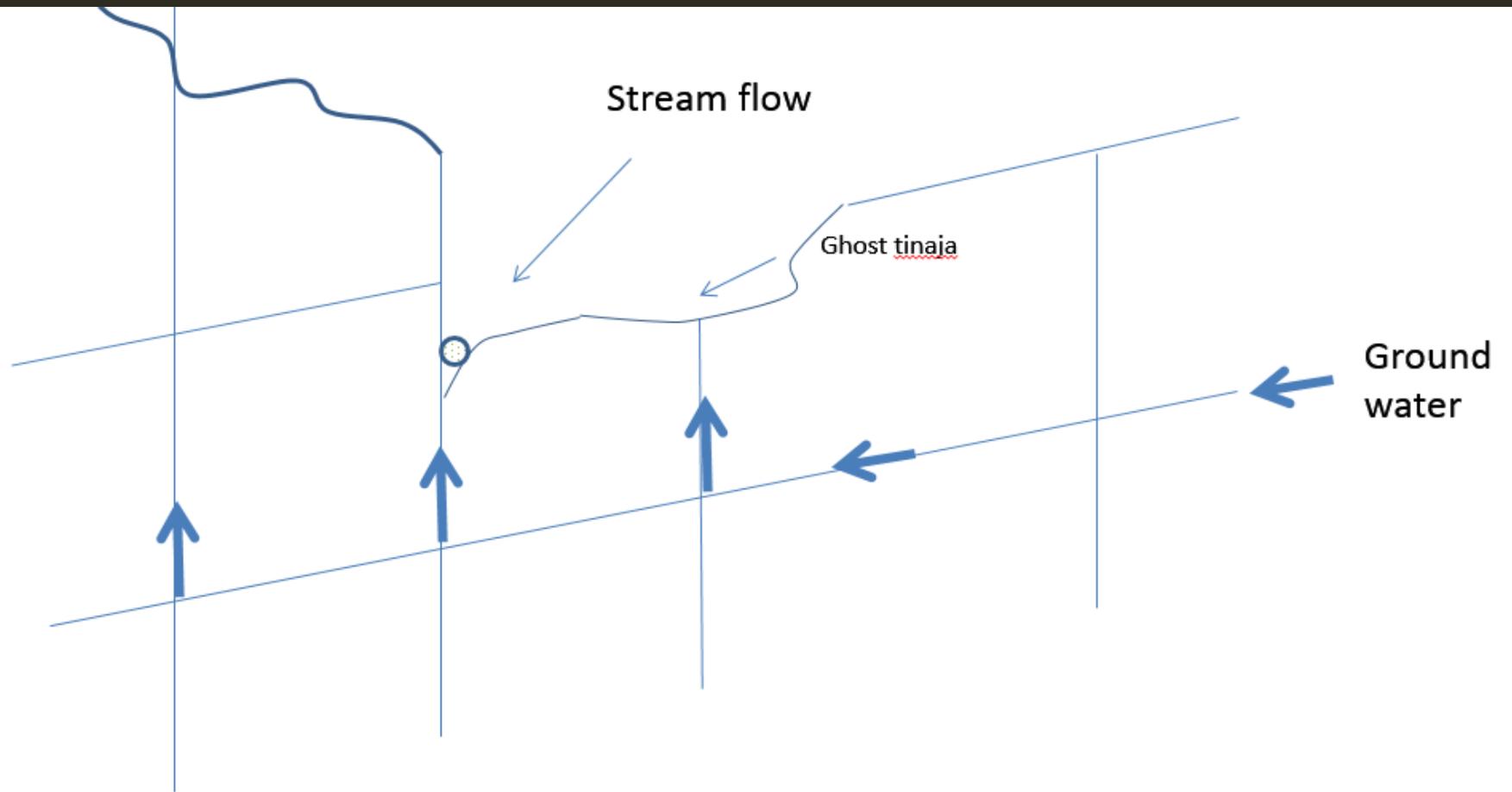


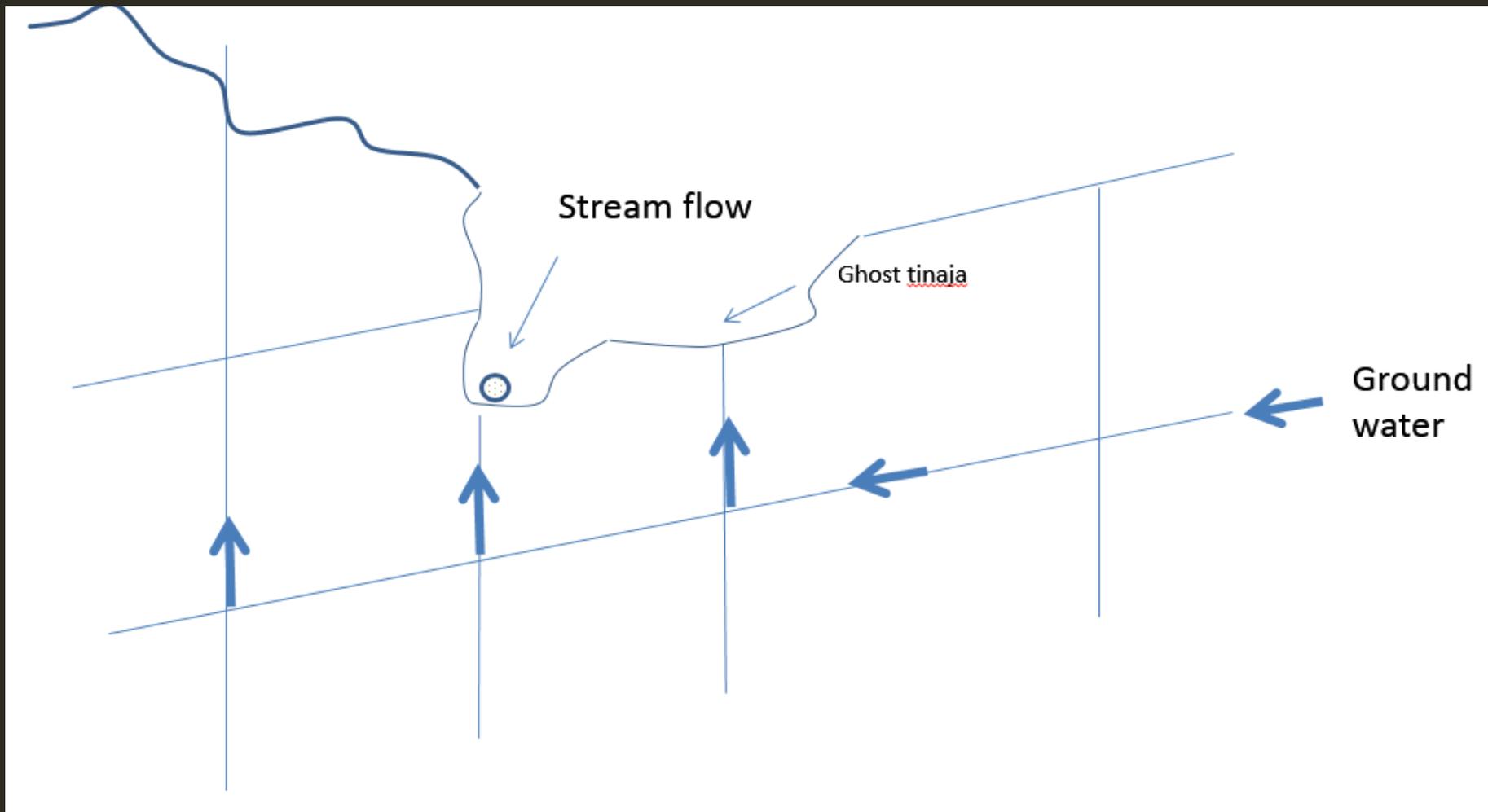


Adapted from Swann *et al.* 2013









WHO USES TINAJAS?

Terrestrial and aquatic flora and fauna depend on tinajas during the dry season.

Tinajas have also been utilized by humans for hundreds (possibly thousands) of years

- Ancient Hohokam and present-day Tohono O'odham peoples
- Mexican, Spanish, and American ranchers and their cattle



This stone could have been used for grinding mesquite pods into flour!



Reconstructed pottery (left, below) and tools (below) crafted in ancient Hohokam tradition.





Sonoran Desert toads (left) lay thousands of eggs in tinajas during the monsoon season...

...and garter snakes (right) gorge themselves on hundreds of newly-hatched tadpoles!



WHY STUDY TINAJAS IN SAGUARO NATIONAL PARK?

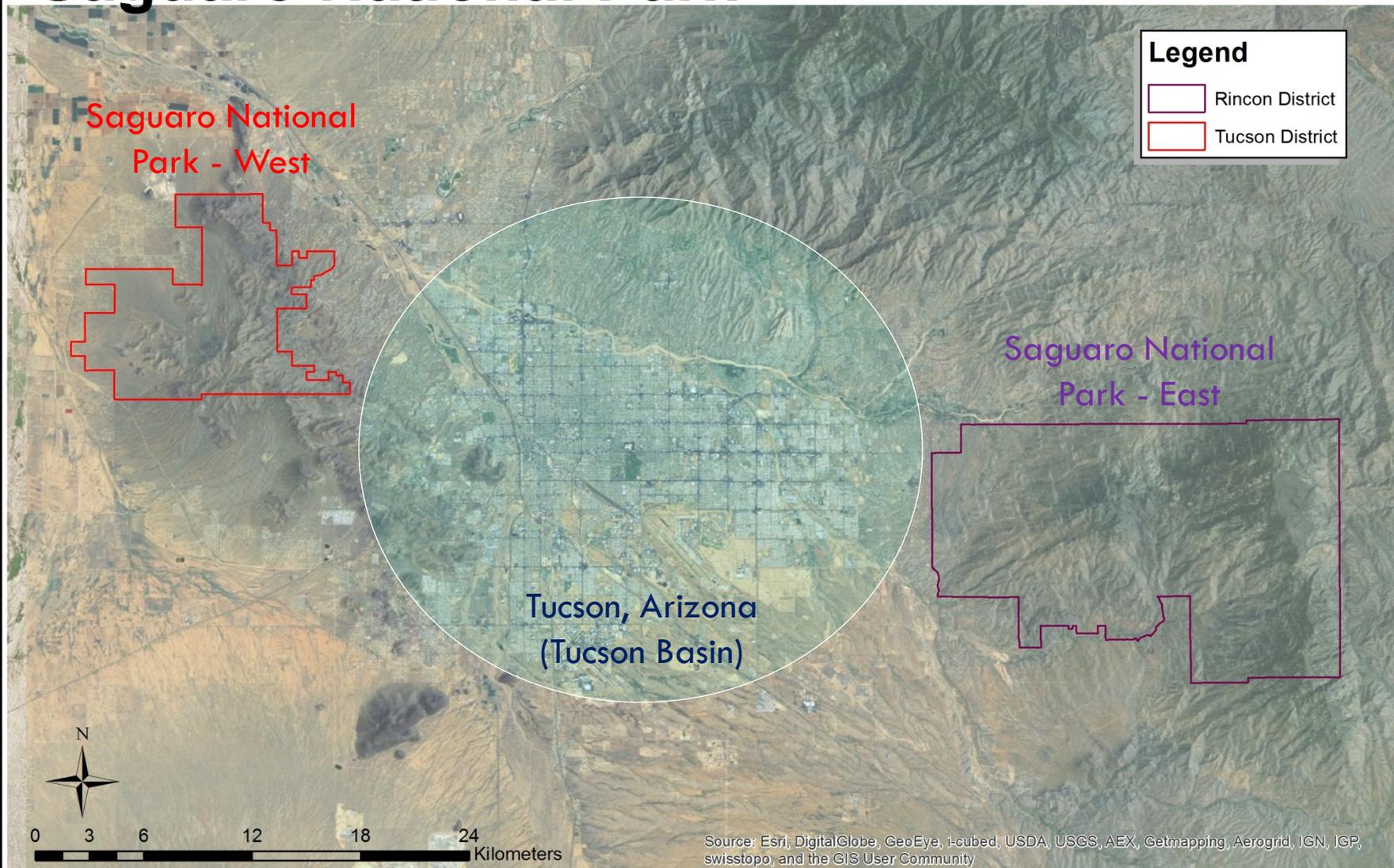
Tinajas in Saguaro NP face unique challenges, as the park is bisected by the city of Tucson, a booming desert metropolis of over 1 million people.

Tinajas (and associated wildlife) are threatened by:

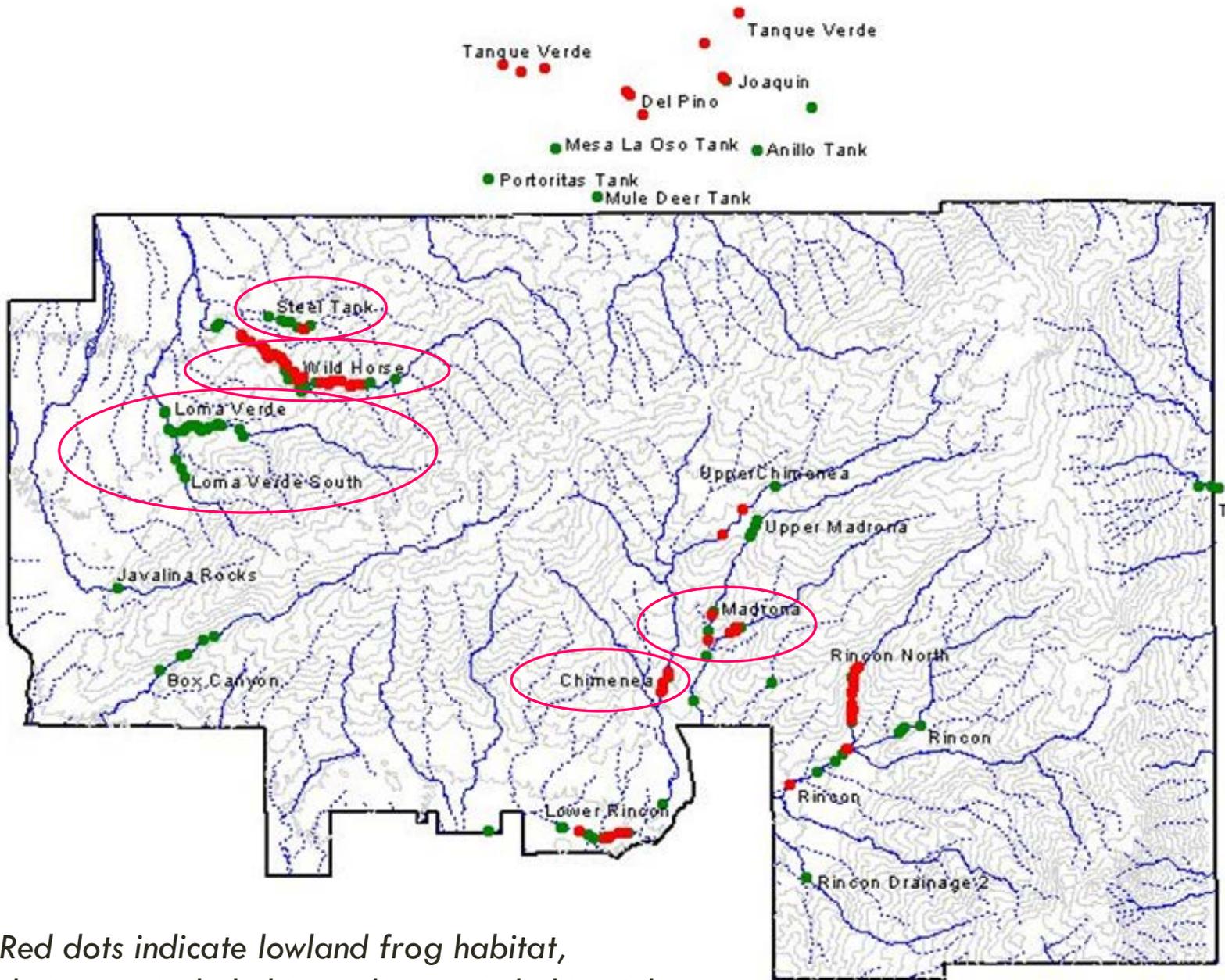
- urban sprawl and suburban development
- groundwater depletion,
- wildfires exacerbated by invasive species (buffelgrass)
- climate change



Saguaro National Park



Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community



*Red dots indicate lowland frog habitat,
drainages included in study are circled in pink.*



PURPOSE & GOALS

*Photo: Laura Palacios,
Biological Technician
(Loma Verde Pools,
Saguaro NP)*

PREVIOUS WORK

Previous tinaja studies have been conducted in the park, including:

Amphibian Surveys (1995- present)

Frog counts have only collected data about water quantity, not chemistry

Park Break (March 2013)

Week-long survey of Saguaro NP's water resources, including collection of some tinaja data



Canyon Treefrog, Madrona Pools, Saguaro NP

PROJECT GOALS

This project was the first attempt to monitor long-term changes in tinaja water quality in Saguaro NP.

Project goals include:

- Sampling for core parameters on a weekly basis during the dry (May – July) and monsoon (early July) seasons
- Photodocumenting changes in each pool over time
- Detecting thermally-distinct groundwater inputs in pool
- Collecting samples for isotopic ($\delta^2\text{H}$ and $\delta^{18}\text{O}$) analysis

TINAJAS AND CLIMATE CHANGE

Tinajas are thought to be vulnerable to climate change, which may cause:

- Increased fire activity, precipitation and erosion, causing sediment fill
- Higher temperatures and longer dry seasons, which change amphibian breeding patterns
- Small, non-spring fed pools usually disappear by the end of the season, diminishing aquatic habitat.

This project will contribute to our understanding of how climate change affects surface and groundwater in Saguaro National Park.



METHODS

*Photo: Field equipment
(near Montezuma Well,
AZ).*

INFRARED & VISIBLE LIGHT PHOTOGRAPHY

FLIR infrared camera (pictured, right)

- Used to detect cooler, groundwater inputs flowing into tinajas
- Worked best when water levels were lowest

Visible light camera

- Used to photodocument changes from May - August





**Visible light photograph of pool
at Loma Verde locality**



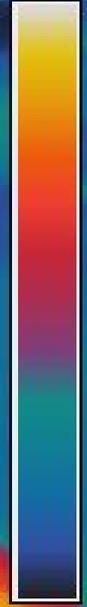
43.2

Groundwater input?



Cooler temperatures are blue and teal.

Warmer temperatures are red and orange.



20.3

Obj. d. 25m
Ext. t. 20
Ext. tr. 100%

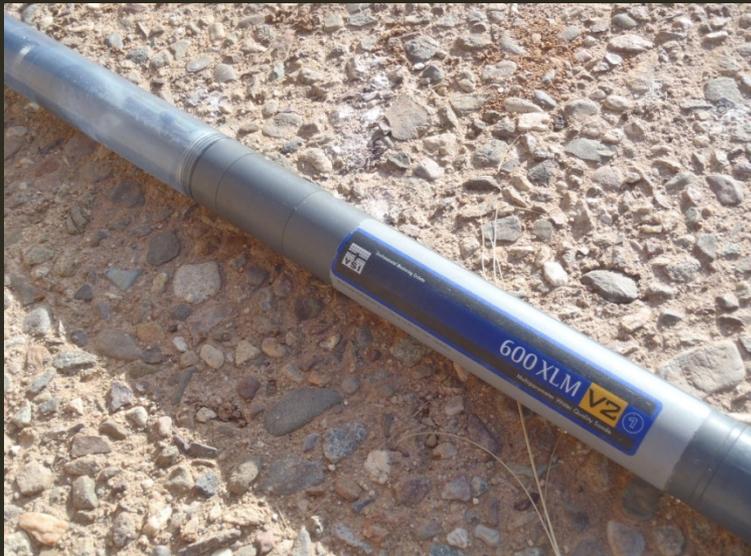
N32°11.954'
W110°41.722'

2014-07-01
08:37

WATER CHEMISTRY

Multiparameter data logger

Logged water quality in 15-minute intervals between May-July



YSI handheld multiprobe

Used to monitor parameters in each pool on a weekly basis





RESULTS & FURTHER RESEARCH

*Photo: Pool 1D, Madrona
Pools, Saguaro NP*

WHAT HAVE WE LEARNED SO FAR?

- Tinaja water chemistry changes drastically during the dry season
- There are lag times (2-3 weeks) between precipitation events and increases in tinaja water levels
- Water levels in one pool can predict water levels in other pools at nearby localities
- Isotopic analyses indicate that tinajas in the same localities are not necessarily fed by the same water source (???)
 - Tritium dating suggests water sources are “newer” (post-1950s)
- Springs turn “on” and “off” depending on the level of the aquifer
 - Springs turn “on” once the aquifer reaches a certain level

FUTURE RESEARCH

Plans (and recommendations) for future work:

- Aquatic macroinvertebrate surveys of tinajas
- Continued tinaja monitoring during fall and winter months
- Expansion of long-term and spot sampling monitoring to more pools
- Isotope analysis and thermal imaging of more spring-fed pools
- *E. coli* and total coliform of tinaja frequented by park visitors



ACKNOWLEDGEMENTS

*Photo: Pool 1E, Madrona
Pools, Saguaro NP*

GRACIAS A TODOS

Thank you to **Don Swann, Kara Raymond** and **Colleen Filippone** for their guidance and mentorship.

Many thanks to **Laura Palacios, Saguaro National Park, the AZCC, and Dr. Andy Hubbard and the Sonoran Desert Network** for assistance with fieldwork, data collection/analysis, and making me feel welcome in Arizona.

Special thanks to **Matt Dawson, Lisa Norby, Allison Kearny, GSA** and **NPS** for facilitating the Mosaics, Geocorps, and GIP programs—and for inviting me back for another year!





QUESTIONS?

*Thank you for your
attention!*