

Interactive Water Quality Data Visualization: Case Study Longhorn Stream Team

Elisa Friedmann, Department of Geography, e.r.friedmann@utexas.edu

“No Natural Resource has Greater Significance for the Future of Texas than Water.”

–Andrew Sansom, Executive Director of the Meadows Center for Water and the Environment

Background

Texas rivers are important to sustain and maintain quality of life, but increasing population and diminishing health has transformed water into a precious and scarce resource.^{1,2,3} Unfortunately, the Texas Commission for Environmental Quality (TCEQ) is only able to assess 11.7% of river miles with an increasing fraction deemed having “impaired” aquatic life, recreation, or general use from 2012-2014.⁴ To help mitigate these growing problems, Texas must:

- 1) Widen research and citizen science programs to establish baseline water quality values around the state
- 2) Bridge the gap between data collection and public understanding of water resources

I propose that data visualization, especially of citizen science data, can provide the missing link to quickly and reliably ascertain the condition of a variety of waterways and inform public policy.

Research Question

Can we create an interactive water quality visualization tool that is:

- Easy to use**
- Accurately portrays quantitative data from a variety of sources**
- Effective at conveying the story or state of a waterway**

Methods and Materials

Data Acquisition

Citizen science data is acquired on Extech DO610: ExStik® II DO/pH/Conductivity Kits by the Longhorn Stream Team (LST), a UT Austin student organization that trains and teaches citizen scientists to paddle Texas rivers, collect water quality data, and promote conservation to ensure the longevity of Texas.⁵

TCEQ data is acquired from the website CRP Tool Data Tool.⁶

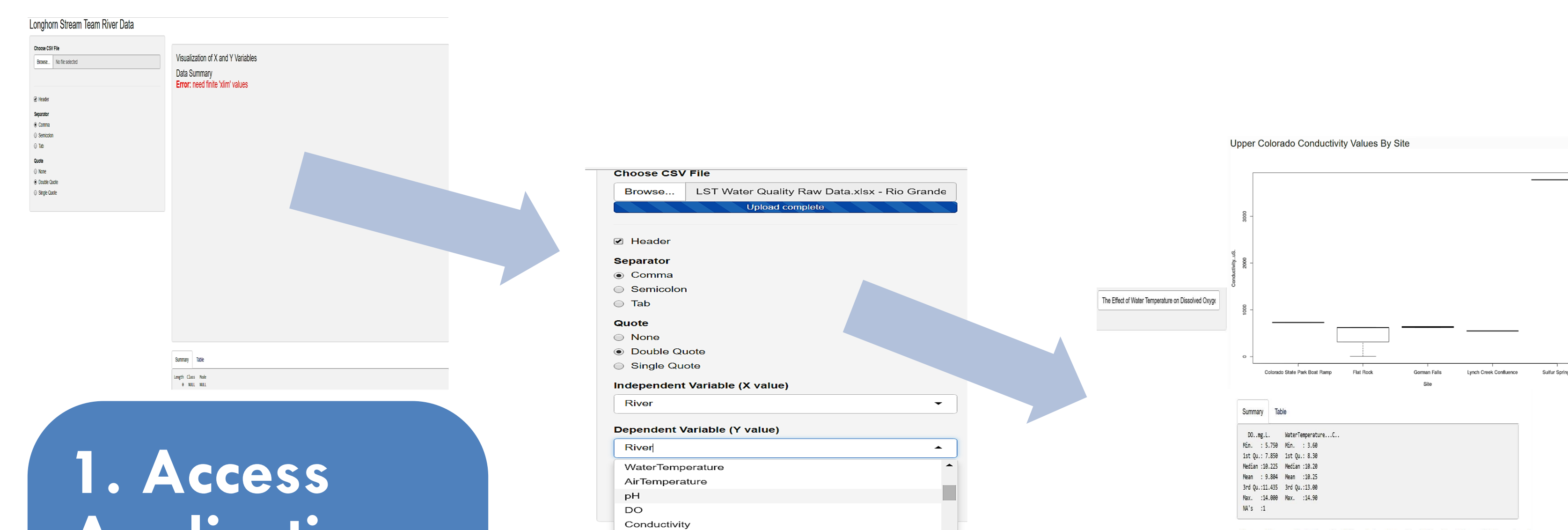
Application Development

All code is written in R using R shiny, a web application platform converting R code to HTML and hosted in the cloud using Rstudio. The application can be found at: https://bevobevo.shinyapps.io/LST_WQ_Data/

References

1. Texas Water Development Board. (2012). *Water For Texas 2012 State Water Plan (Chapter 3)*. Retrieved from: https://www.twdb.texas.gov/publications/state_water_plan/2012_03.pdf.
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3. Vega, M., Pardo, R., Barrado, E., & Deban, L. (1998). Assessment of seasonal and polluting effects on the quality of river water by exploratory data analysis. *Water Research*, 32(12), 3581–3592. article: [http://dx.doi.org/10.1016/S0043-1354\(98\)00138-9](http://dx.doi.org/10.1016/S0043-1354(98)00138-9).
4. Texas Water Quality Assessment Report. (2014). Prepared by TCEQ for the EPA. Rvtd from https://iaspub.epa.gov/waters10/attains_index.control?area=TX#STREAM/CREEK/RIVER.
5. Jones, C., Hsia, S., Scamardo, J., Nguyen, K., & Papendieck, A. (n.d.). Extended Abstract Longhorn Stream Team: An Experiential Environmental Science and Engineering Learning Community. 2016.
6. CRP Data Tool. (2016, Sep 06). The Texas Clean Rivers Program. Retrieved from: <http://www80.tceq.texas.gov/SwqmisWeb/public/crpweb.faces>.

How can you visualize your water quality data?



1. Access Application

You need:

1. Application URL
2. A .csv with headers explaining water quality parameters

Application provides:

- “Browse” button to upload a .csv
- Table of raw data
- Visualization of up to two parameters (X,Y)
- Interactive title
- Data table
- Summary statistics (if quantitative)

2. Upload .csv and choose variables of interest from drop-down menu that uses .csv headers

Options include:

- Format uploaded .csv
- X variable
- Y variable
- Title

3. Application Automatically Generates Plot of chosen variables

Different variables can be selected and plot will automatically update

- Click on tabs to see your data summary and statistics (if applicable)



Figure 1. Members of the Longhorn Stream Team monitor water quality on the Rio Grande River

Acknowledgements

I would like to thank my advisor Dr. Sheryl Luzzadder-Beach for her support and guidance as well as the members of the Longhorn Stream Team and its advisor, Christopher Burnett.

Results-The Rio Grande River

Plots are unmodified examples from web application

pH Measurements by Site on the Rio Grande River

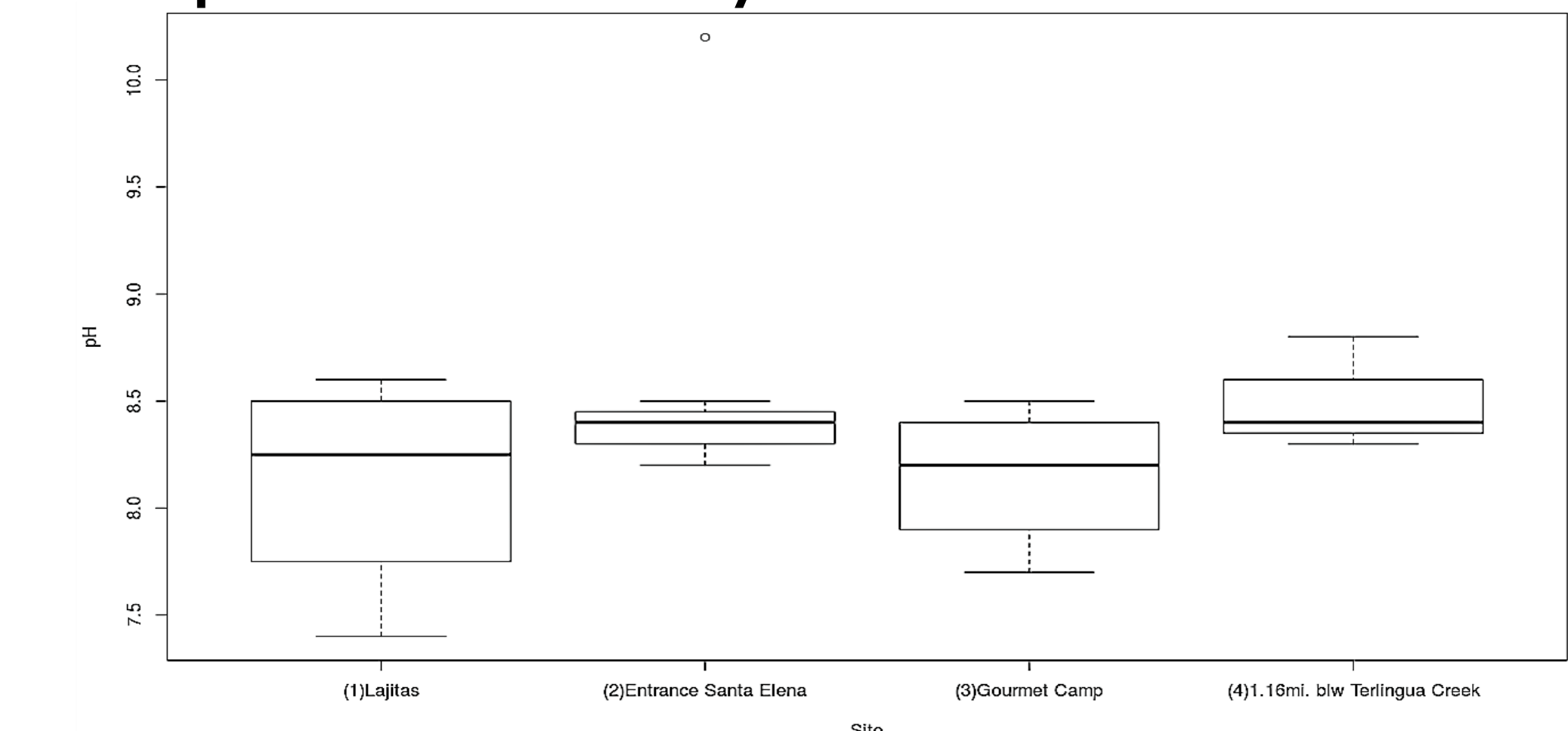


Figure 2. Stream Team pH values 2014-2015. Sample size: (1) and (4) use 4 data points, (2) with 7, and (3) with 6

Conductivity Measurements by Site on the Rio Grande River

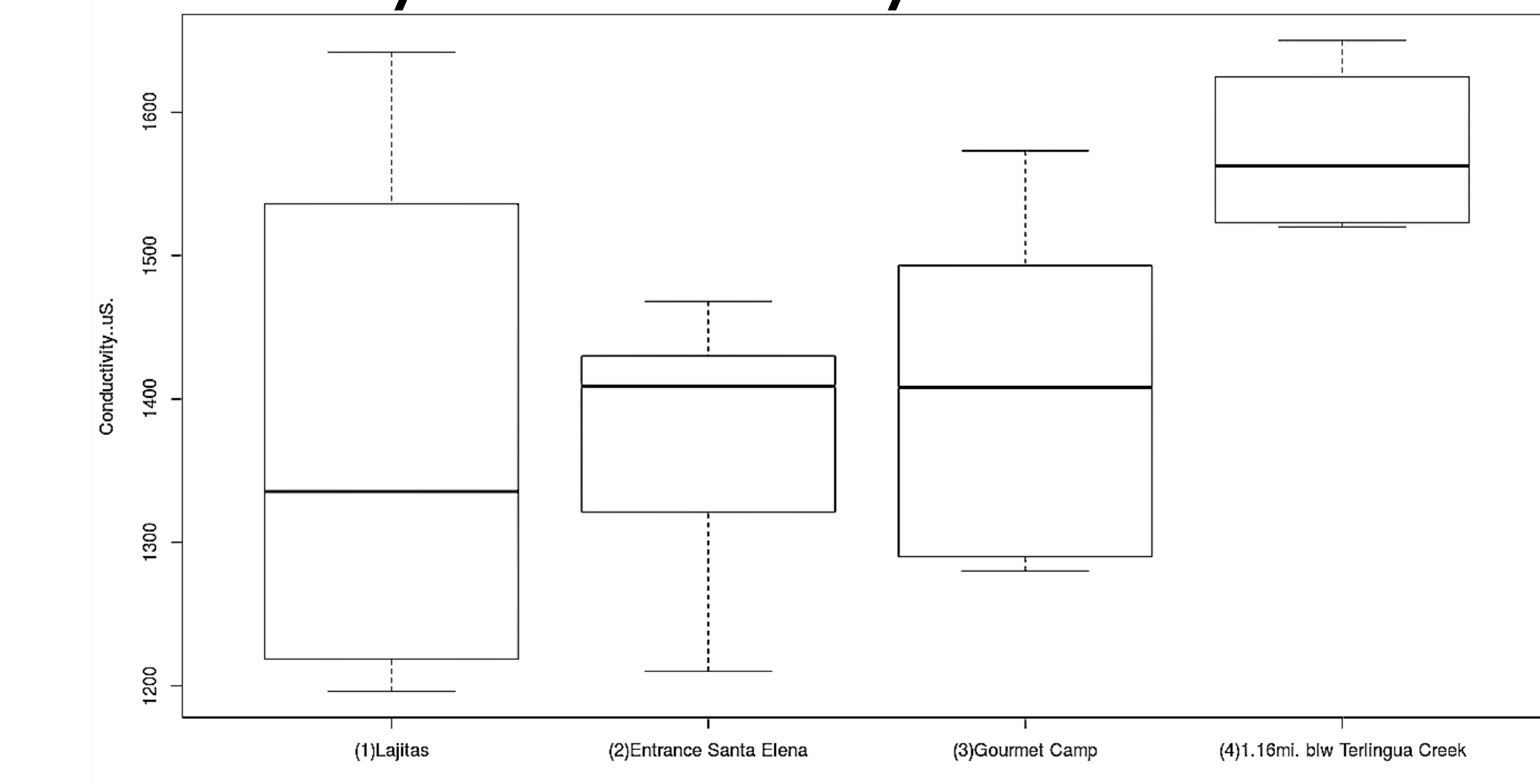


Figure 3. Stream Team Conductivity values 2014-2015. Sample size: (1) and (4) use 4 data points, (2) with 7, and (3) with 6

Application as a Comparison Tool (TCEQ to Citizen Science Data:

Comparison of TCEQ and LST Conductivity Values by Date

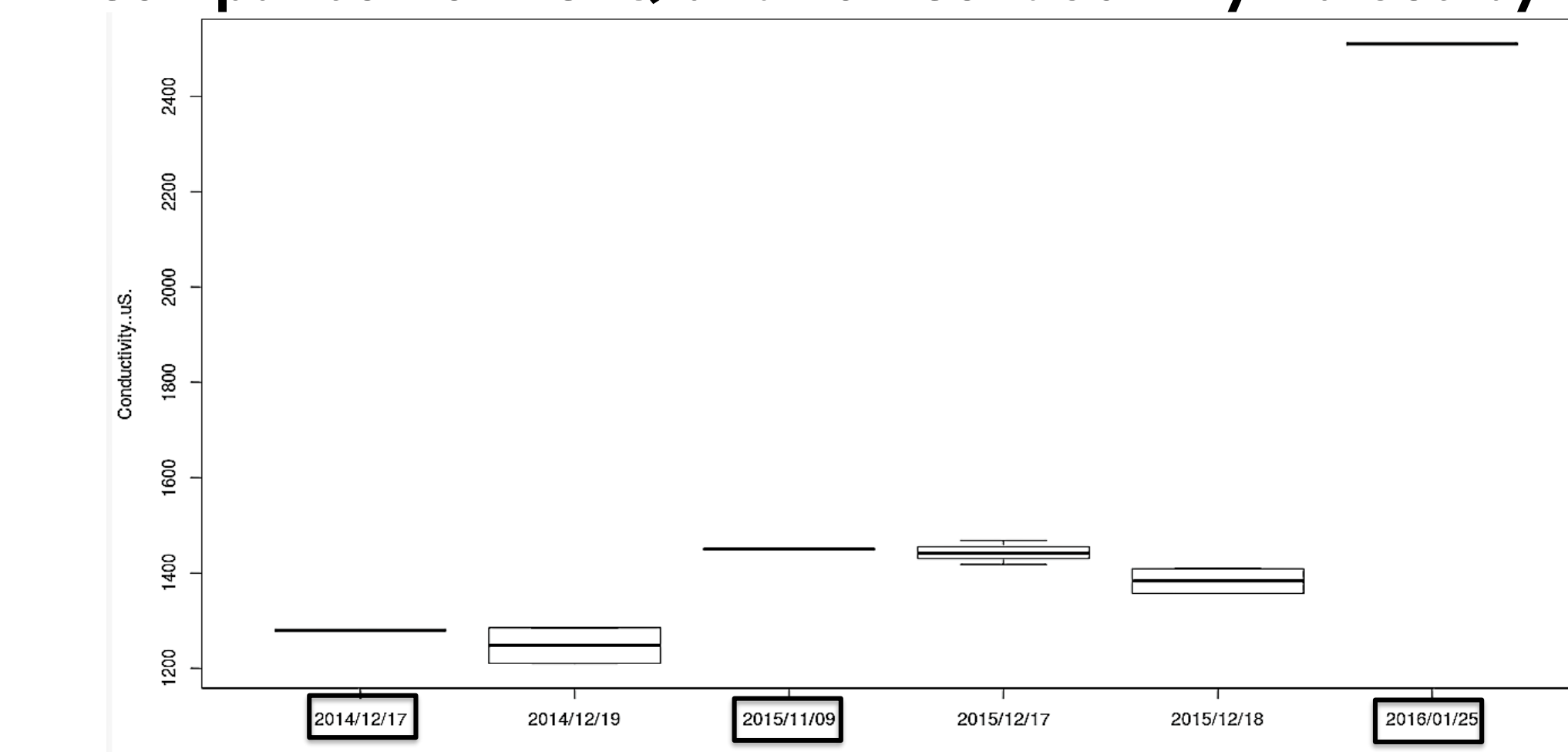


Figure 4. TCEQ (date outlined in black, one data point each) and Stream Team conductivity values at Santa Elena Canyon (2-3 -2 data points ea.)

Discussion

Does this web application answer the fundamental Research Questions?

- Easy to use:** three steps needed to produce a plot (requires .csv)
- Accurately portrays quantitative data from variety of sources:** Can visualize LST and TCEQ data but defaults to a boxplot
- Effective at conveying the story or state of a waterway:** Shows outliers (Fig. 2), suggests instrument error (Fig. 3) and indicates significant deviation (Fig. 4)

Conclusions/Future Directions

This app can be used to inform policy decision, projects and direct action

- Write a script to converts regulatory body data into a format friendly to this application
- Add mapping capabilities, data sorting and plot layout options