ARIZONA DEPARTMENT OF ENVIRONMENTAL QUALITY

# How Arizona Uses R to Automate Assessments and TMDLs

# R Training

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**R Courses**

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Project

=

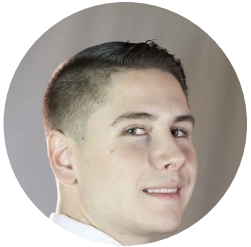
Results

# R Courses

1. Introduction to R (Week 1)
2. Data manipulation and joining data with dplyr (Week 2&3)
3. Data visualization with ggplot (Week 4&5)
4. Project (Weeks 6 to 10)

# Project Questions

“What if” we change our E. Coli standard?



What is the contribution of point sources and non-point sources for impaired waters?

Which states use narratives to list impairments?

What is the average annual air quality for PM10, PM2.5, O3, SO2?

# Arizona's Index of Biological Integrity

## Macroinvertebrates

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# Macroinvertebrate Data

- 2,084 samples collected between 1993-2023
- 557 sample sites
- 1,215,464 individuals
  - 896 unique taxa
    - 32 Orders
    - 143 Families
    - 512 Genera

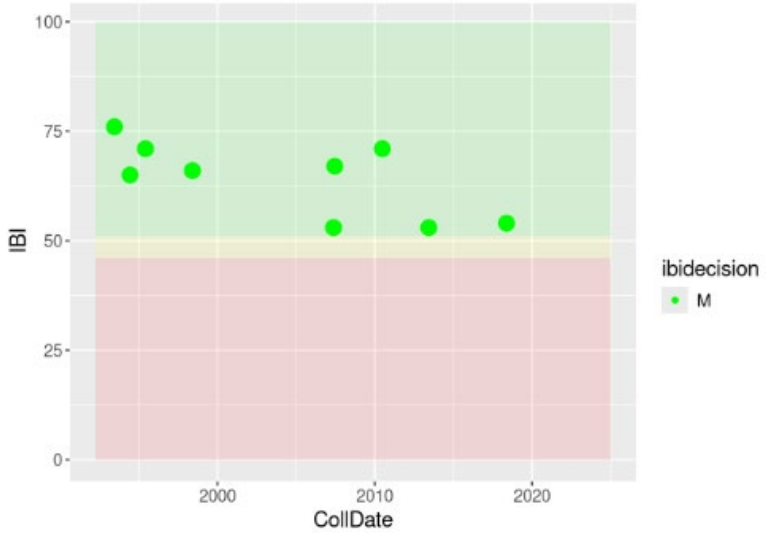
# Index of Biological Integrity (IBI)

- Requirements: Wadeable, perennial, riffle/run habitat, sampled during the index period
- Cold Vs Warm water
  - Cold water IBI: 7 metrics
  - Warm water IBI: 9 metrics

```
315 #### 2 - Number of Ephemeroptera Taxa ----
316 m.w.ephtaxa <- mats %>%
317   filter(is.na(exclude)) %>%
318   filter(Order == "Ephemeroptera") %>%
319   group_by(StationID, CollDate, RepNum) %>%
320   summarize(NumEphTaxa = n()) %>%
321   select(StationID, CollDate, RepNum, NumEphTaxa) %>%
322   mutate(M.NumEphTaxa = ifelse(NumEphTaxa >= R.W.NumEphTaxa, 100,
323                                (NumEphTaxa/R.W.NumEphTaxa)* 100))
```

# IBI Assessment and Visualization

- Determine if IBI scores are meeting or violating standards
- Plot all IBI scores for a Waterbody




```r
## 3.1.1 - Exceedances ----
# Determine if samples are meeting the standard
ibi.warm <- ibi_agg %>%
  filter(InvertReg == "Warm") %>%
  group_by(WBID) %>%
  mutate(count = n()) %>%
  mutate(ibidecision = ifelse(IBI < 40, "V",
                              ifelse(IBI >= 40 & IBI <= 49, "I", "M")))
```

# Arizona's Automated Assessment

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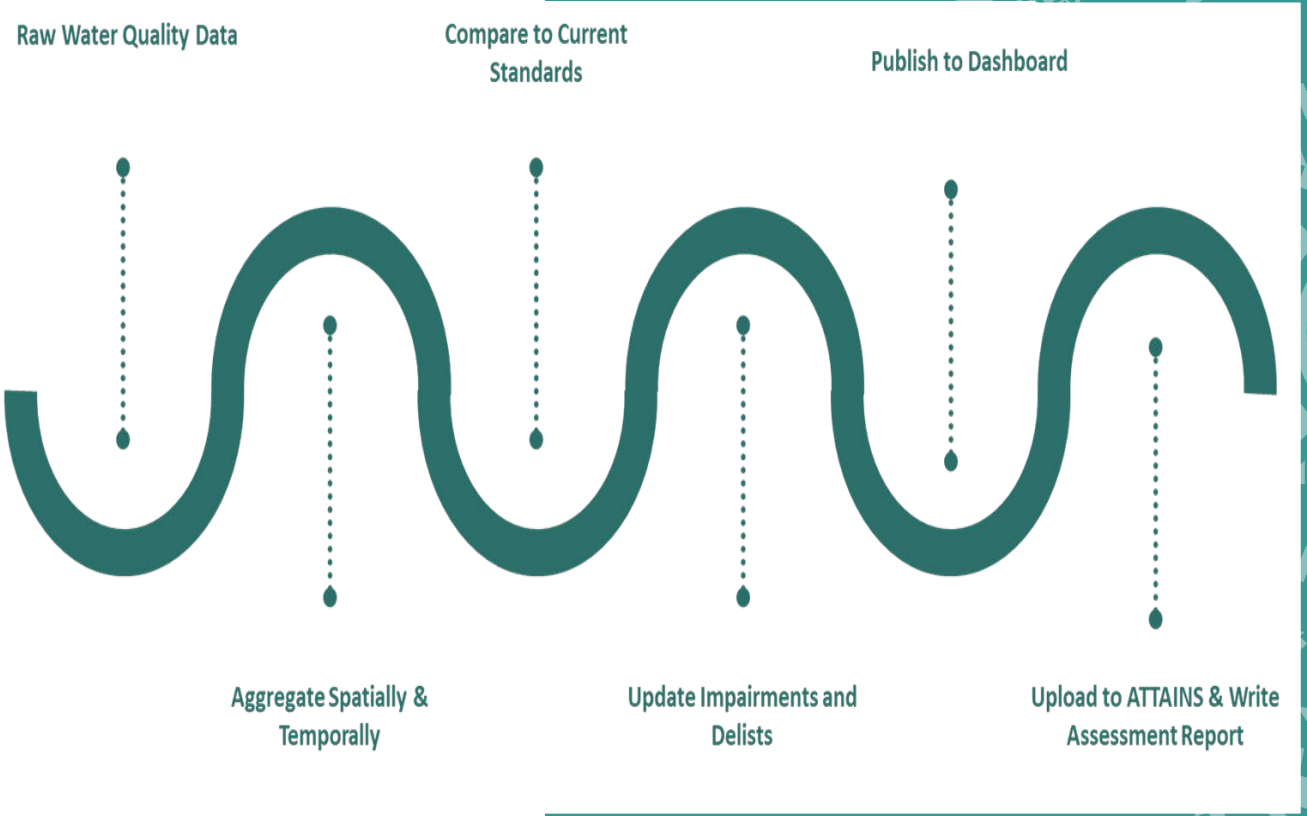
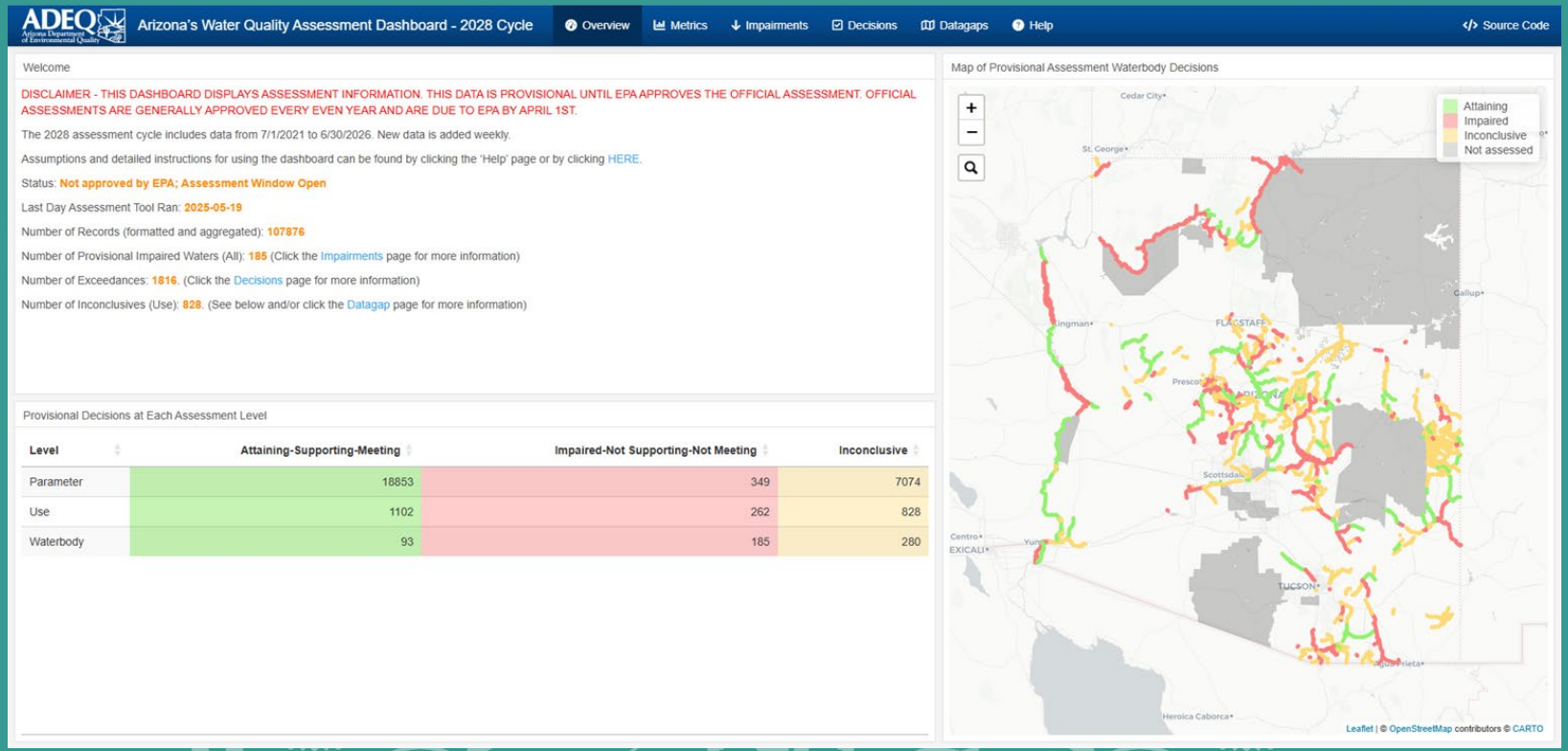
# The Assessment Calculator

- Pulls data from the WQP using dataRetrieval
- Converts data to common schema
- Determines exceedances
- Assesses waterbodies
- Outputs decisions on Shiny dashboard and in files for ATTAINS



# Assessment Dashboard




https://azdeq.shinyapps.io/assessment_dashboard_2028_Prod/#section-dashboard

# Using R to Streamline TMDL Processes

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# ADEQ's TMDL Unit R Processes

- Data management & analysis
  - Find, clean, graph, analyze
  - Ex: Pull data from the Water Quality Portal
- Modeling
  - Analyze trends
  - Seasonality and flow variation
  - Ex: Load Duration Curve template
- Shiny and Flexdashboard apps
  - Create customizable apps in R
  - Ex: ADEQ's live apps

*The Salt River above Roosevelt Lake*

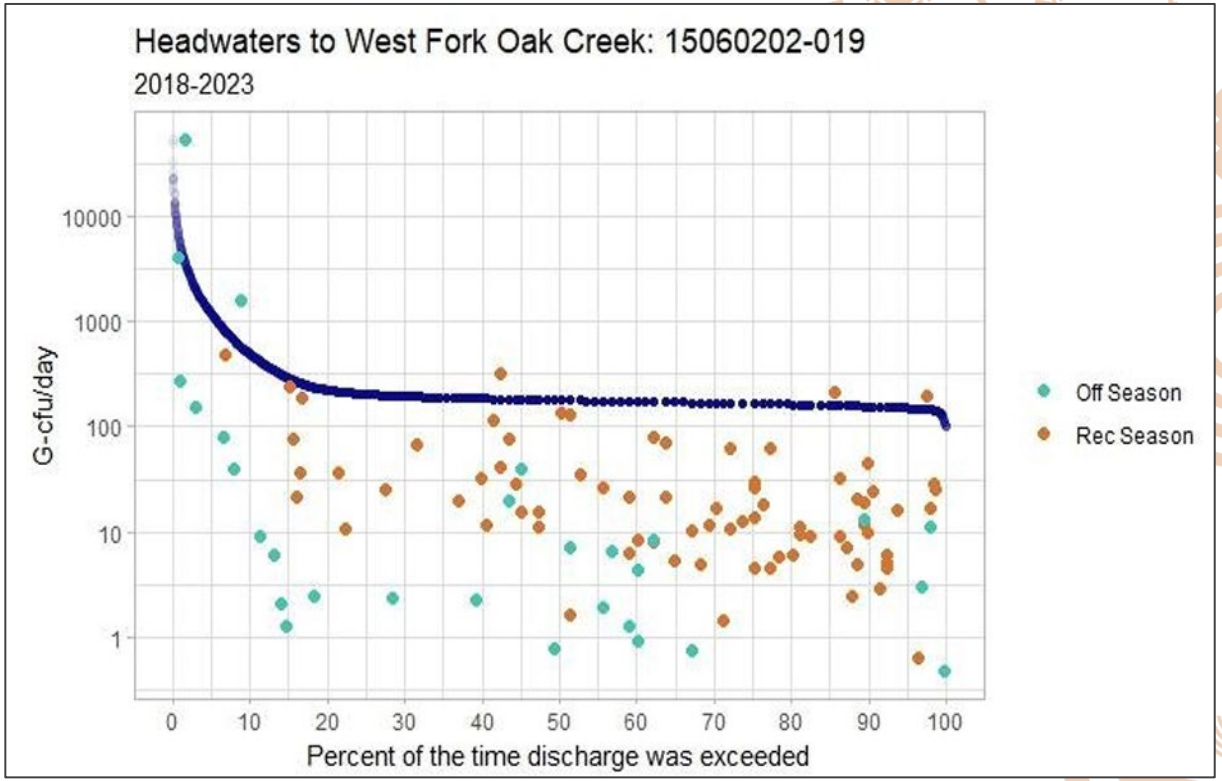
# Data Management - Pulling Data from the Water Quality Portal

## Preparing Water Quality Data for Analysis

1. **Load dataRetrieval package**
2. **Pull WQP data using dataRetrieval package script**
   a. Waterbody(ies)
   b. Pollutant(s)/Parameter(s)
   c. Sample time period
3. **Clean/QC/Graph/Analyze Results**
   a. Remove duplicates & erroneous data
   b. Standardize units
   c. Graph trends
   d. Statistical analysis

# R Modeling - Load Duration Curves (LDCs)

- Uses for LDCs:
  - Critical conditions
  - Pollutant load reductions
- Requirements:
  - LDC template on Github
  - Water quality data
  - Flow/discharge data
  - Tidyverse package
    - Statistical analysis
  - Ggplot2 package
    - Graph results



# Customizing Load Duration Curves

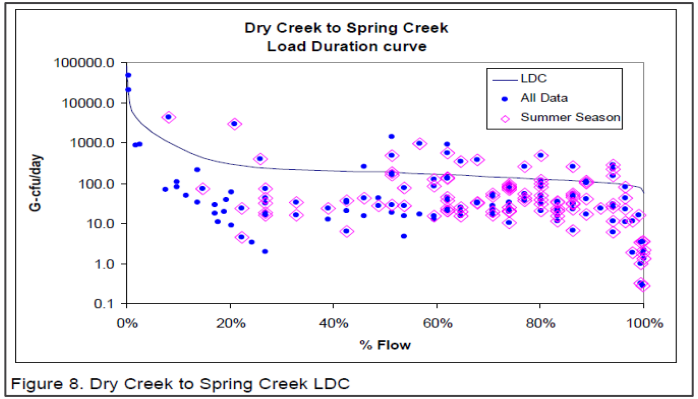


Figure 8. Dry Creek to Spring Creek LDC

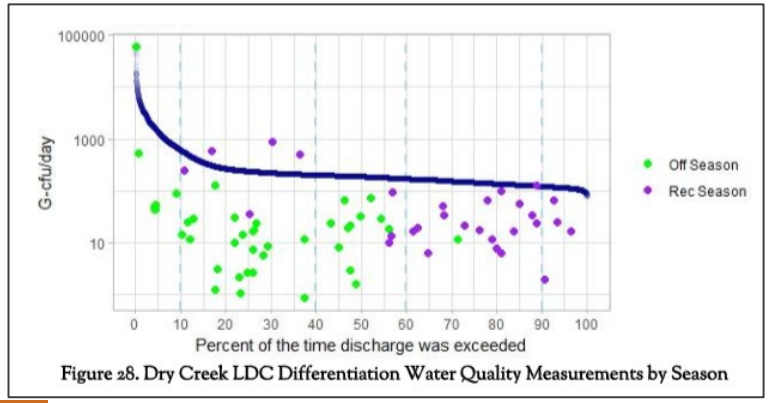
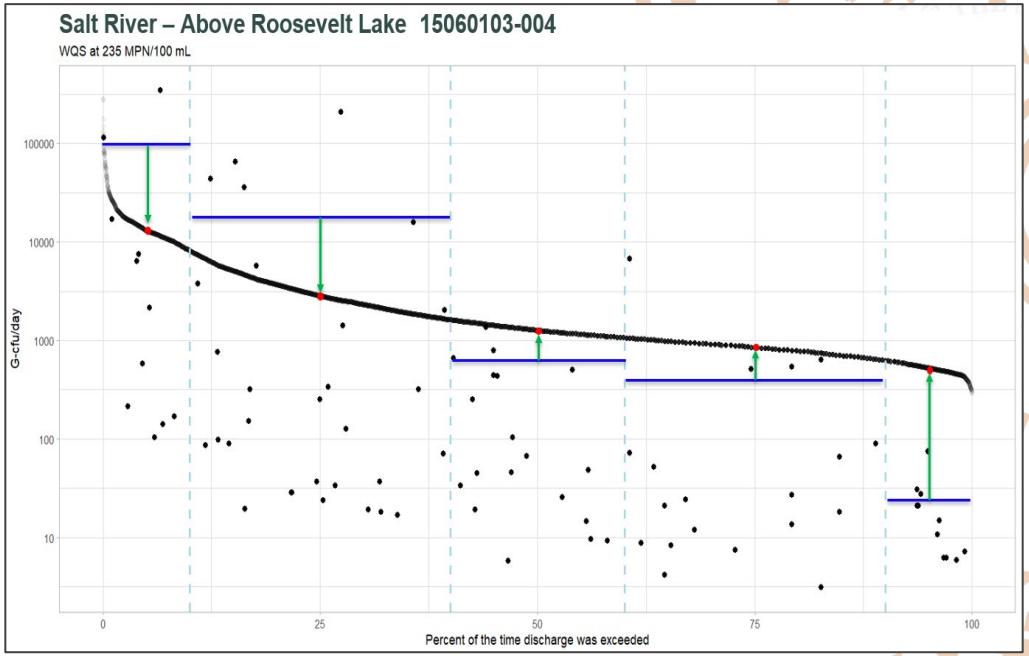


Figure 28. Dry Creek LDC Differentiation Water Quality Measurements by Season

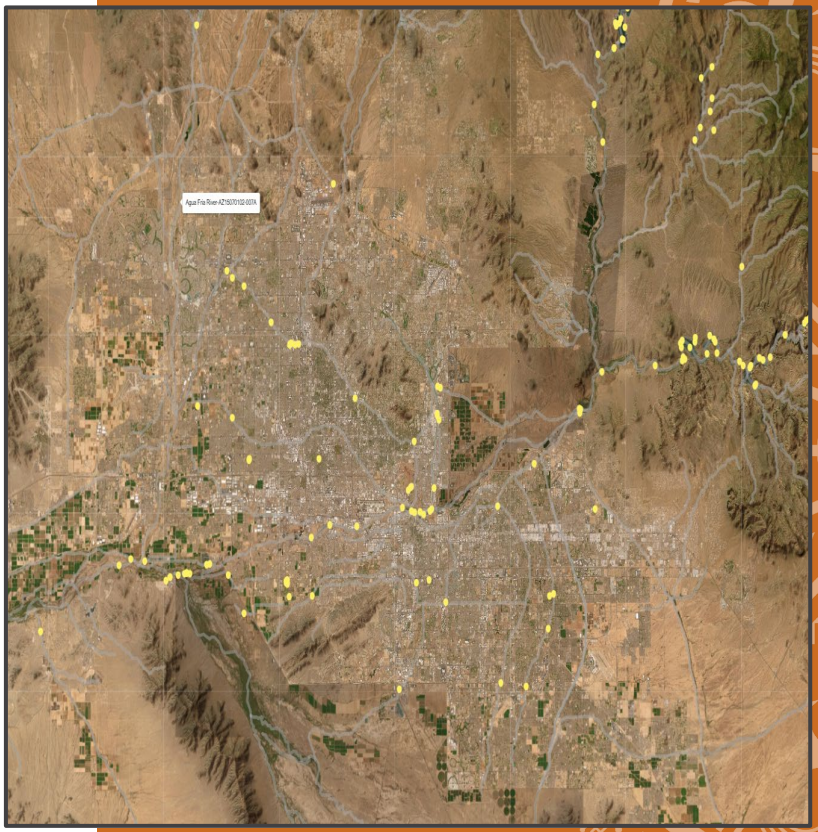
ggplot2 customization allows for LDCs tailored for each project



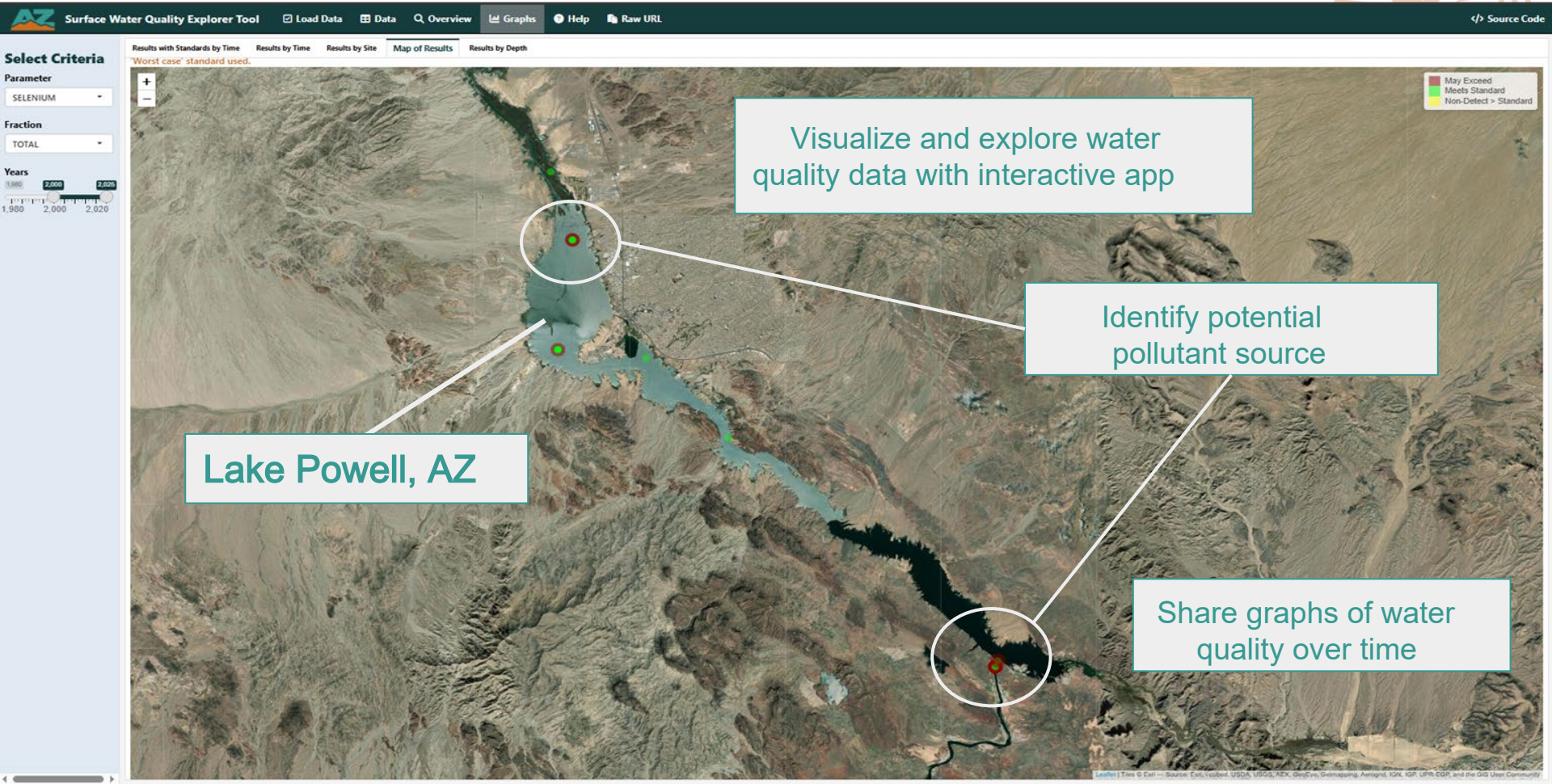
# Building Apps to Address Challenges

## R applications in TMDL processes?

- Identify data gaps
- Share datasets
- Impaired water prioritization
- Inform stakeholders, partner orgs



# Surface Water Quality Explorer Tool



# TMDL Prioritization App

Index of AZ's high priority waters based on state statutes, risk factors, agency metrics

## Arizona's TMDL Priority Application

Developed by: Jason Jones

Overview | Metrics & Sources | **Assign Weights** | Index

Weights determine how much influence each metric has when creating the index. Default values have been chosen but these can be adjusted by moving individual sliders. Overall weights should equal 1. Weights should be assigned based on agency priority. Human judgement is needed to pick what is important. The application is meant to help make the calculations fast and transparent but does not decide what is important for the user (although defaults are suggested).

1-Wilderness or OAW: 0.025 | 2-Environmental Justice: 0.075 | 3-Priority Uses: 0.1

4-Years Impaired: 0.15 | 5-Watershed Area: 0.1 | 6-KOUI: 0.075

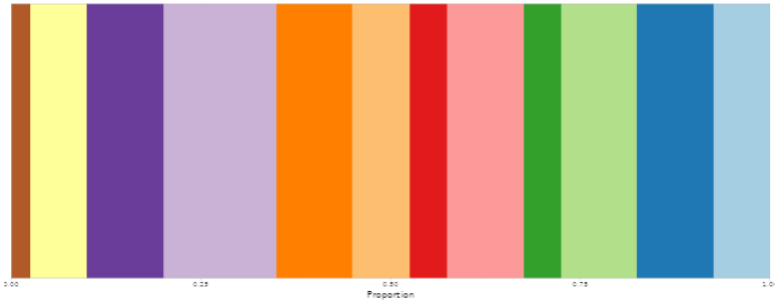
7-Number of Impairments: 0.05 | 8-Parameter: 0.1 | 9-Permits: 0.05

10-Magnitude Over Standard: 0.1 | 11-Exceedance Rate: 0.1 | 12-Confirmed Impairment: 0.075

Weight must equal a total of 1

| w1 | w2 | w3 | w4 | w5 | w6 | w7 | w8 | w9 | w10 | w11 | w12 | total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.025 | 0.075 | 0.1 | 0.15 | 0.1 | 0.075 | 0.05 | 0.1 | 0.05 | 0.1 | 0.1 | 0.075 | 1 |

Distribution of Weights




## Index Results

See the Download Index - Raw Results to see the math behind how the index was calculated.

Show 10 entries  Search:

| WBID | WaterbodyName | CharacteristicName | TMDLPriorityRule | Index |
|---|---|---|---|---|
| All | All | All | All | All |
| 15050100-012B | MINERAL CREEK (MIN) | COPPER | High | 1 |
| 15060103-004 | SALT RIVER | ARSENIC | High | 0.97 |
| 15060202-016 | OAK CREEK | ESCHERICHIA COLI | High | 0.89 |
| 15060106B-0410 | CORTEZ PARK LAKE | PH | High | 0.89 |
| 15080301-090A | MULE GULCH | COPPER | High | 0.88 |
| 15050100-014A | QUEEN CREEK | COPPER | High | 0.86 |
| 15050301-011 | NOGALES WASH | COPPER | High | 0.86 |
| 15040004-003 | SAN FRANCISCO RIVER | ESCHERICHIA COLI | High | 0.83 |
| 15050301-500B | POTRERO CREEK | CHLORINE | High | 0.83 |
| 15050301-1070 | PENA BLANCA LAKE | MERCURY | High | 0.81 |

Showing 1 to 10 of 152 entries  Previous 1 2 3 4 5 … 16 Next

# Questions about our projects?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