USING R TO CONDUCT HYDROSTATISTICAL ANALYSIS AT THE VIRGINIA DEPARTMENT OF ENVIRONMENTAL QUALITY

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[1]Virginia Department of Environmental Quality
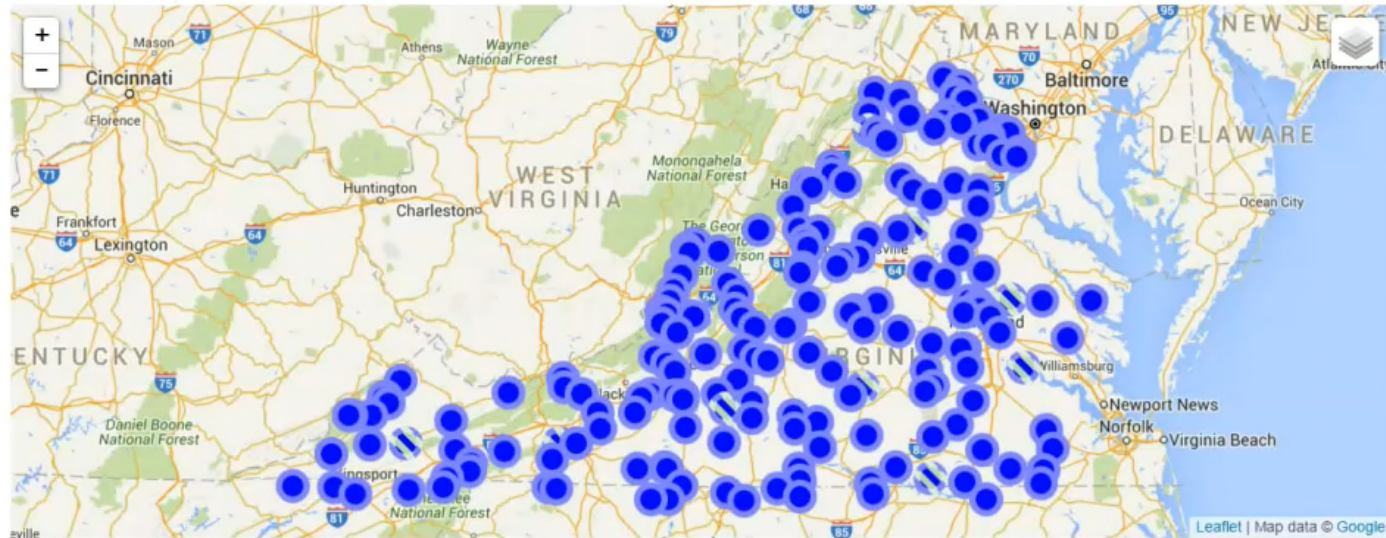[2]USGS Office of Water Information

Drought Management Tool

Outline

Why R?

Components of hydrostats analysis

Website tour

Use case: drought predictions

Future work
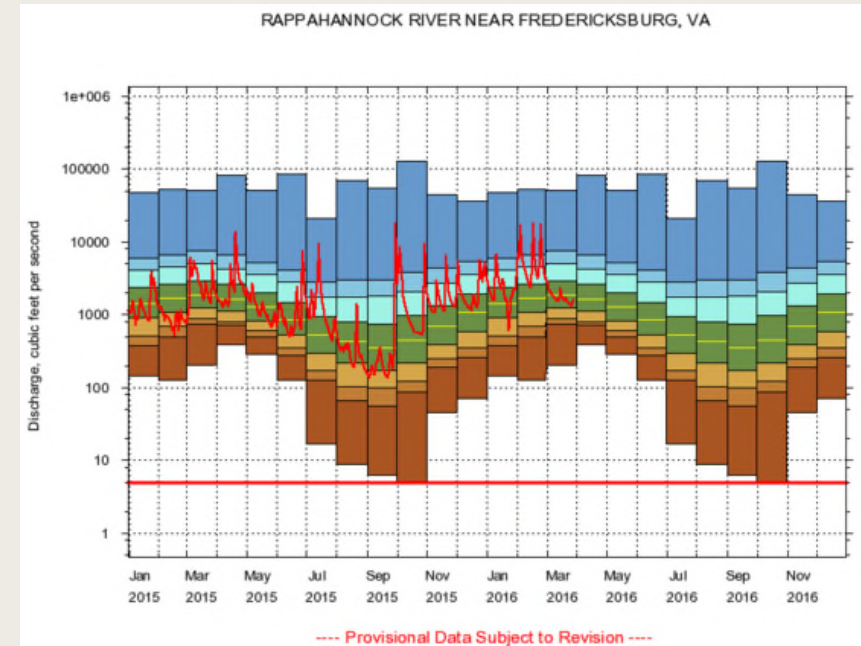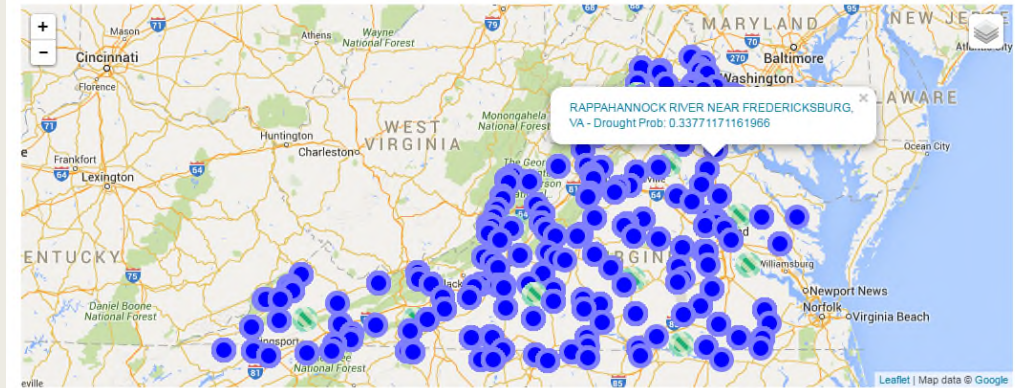
Hydrostatics Project Goals:

Assess Virginia water supply impact and availability

Communicate data analyses with colleagues
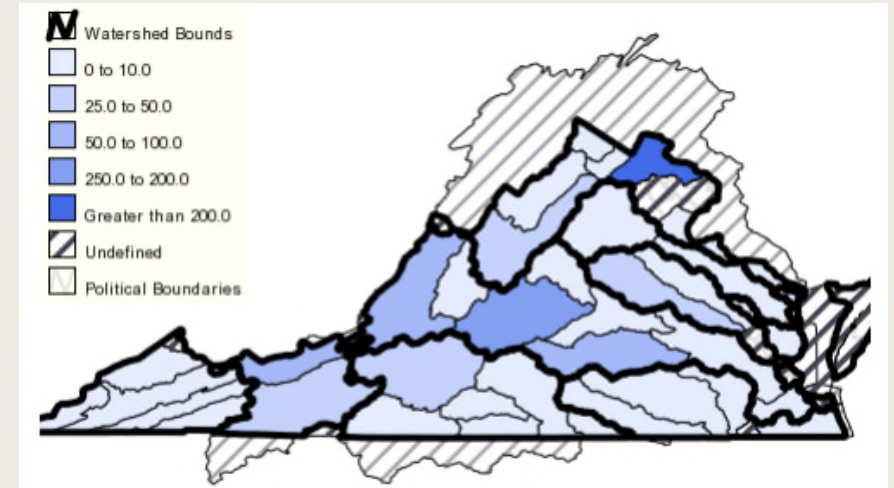
Current water use (MGD) by HUC8 | VA DEQ State Water Resources Plan 2015

Top: R-Project logo| Bottom: RStudio logo

Why R?

Easily evaluate large hydrologic datasets

Take advantage of existing tools

Analyze data + create beautiful graphs

Components of Hydrostats Analysis

- Data sources (NWIS, VaHydro)

- Batch processing of hydrologic statistics in R
  - *7 day minimum average flow*
  - *August Low Flow*
  - *In-stream Flows Incremental Methodology (habitat index)*
  - *Drought predictions: Maximum likelihood logistic regression (MLLR)*

- Display and visualization of data (R: ggplot2)

- Content management system
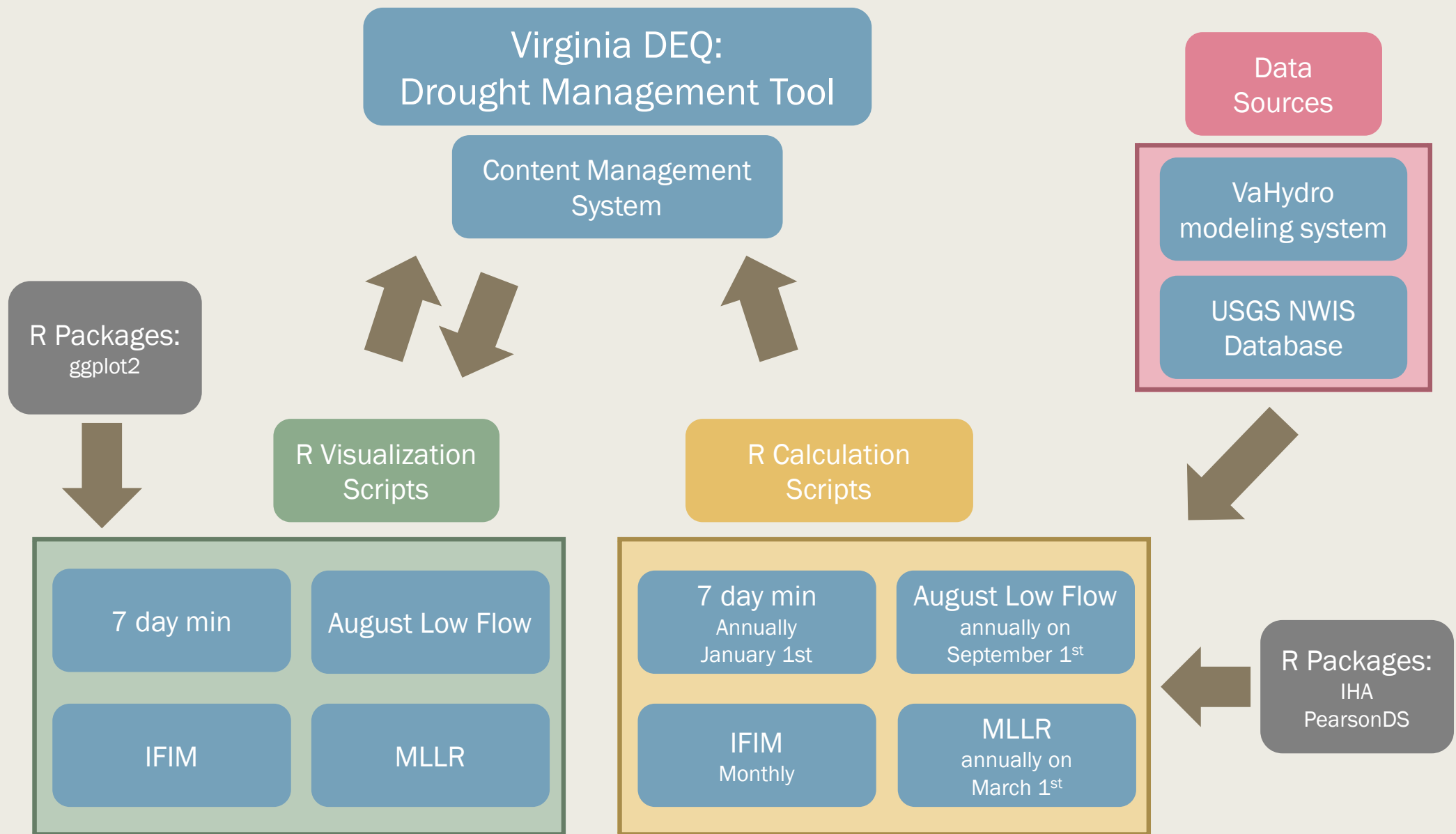
Drought Management Tool Website
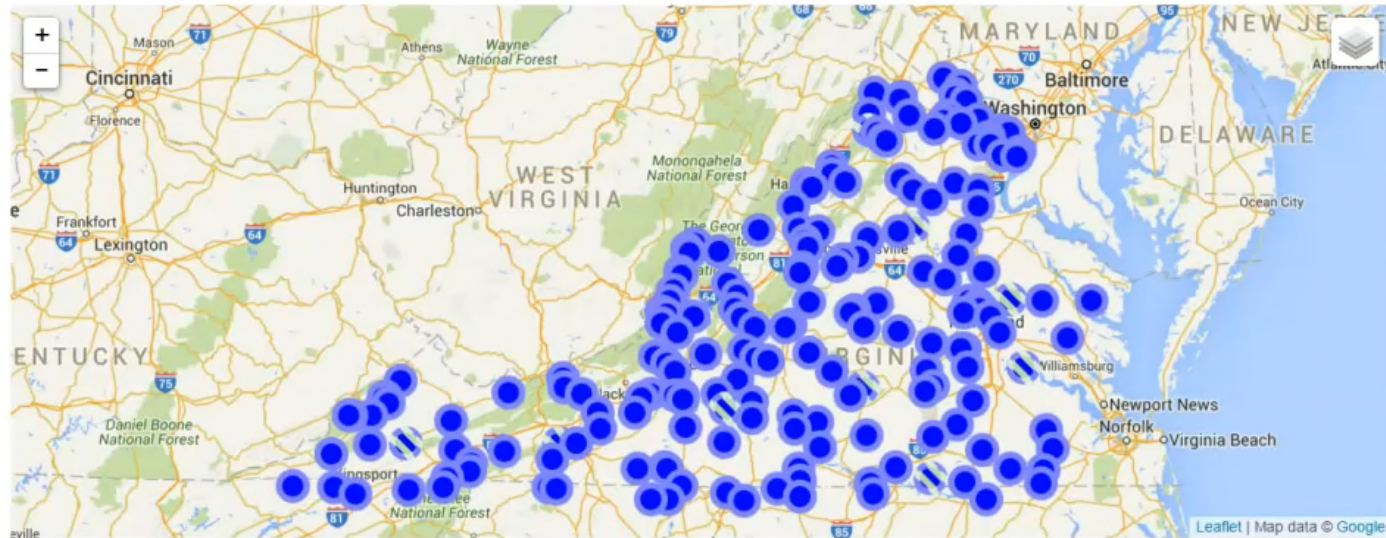
Use case: drought predictions

GOAL

4-6 month advanced knowledge of drought flows

- Better water resource management/planning during drought-prone months
- Predictions for each specific drought condition:
    - *emergency: <5%*
    - *warning: <10%*
    - *watch: <25%*

METHOD

tool developed by Sam Austin (USGS VA WSC)

- Uses maximum likelihood logistic regressions (MLLR)
- Winter streamflow relates to summer base flow
- Summer base flow indicates drought in absence of rainfall

Use case: drought predictions

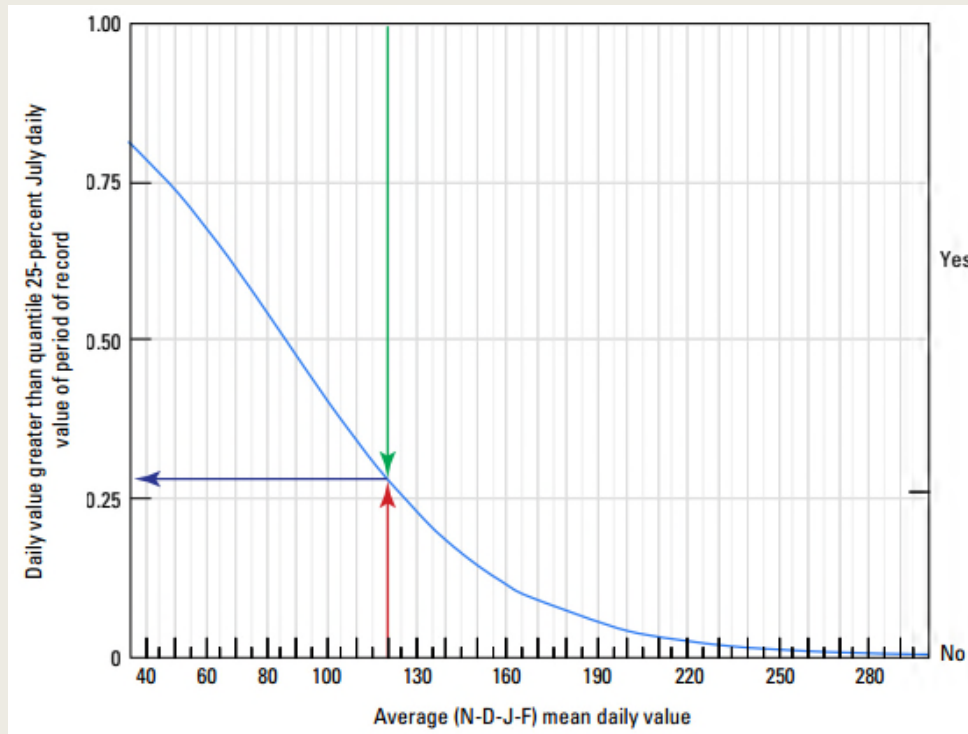Drought model equation for July Watch Condition at USGS 02030000| S. Austin 2014
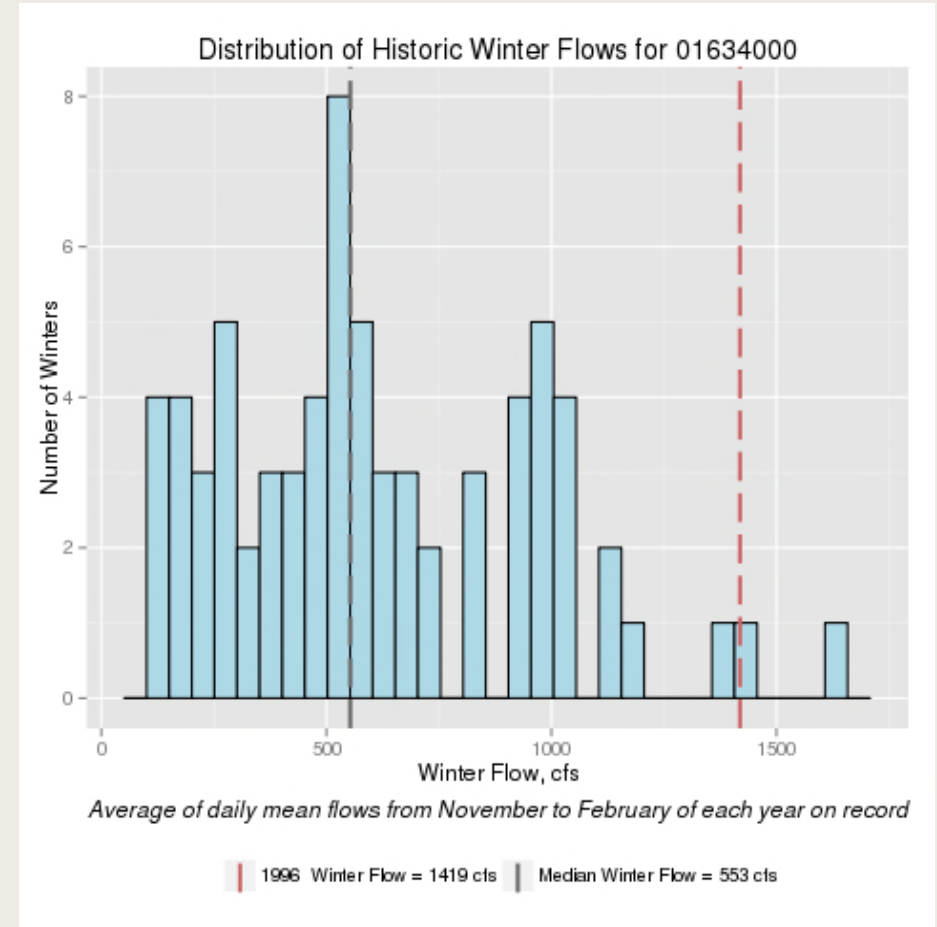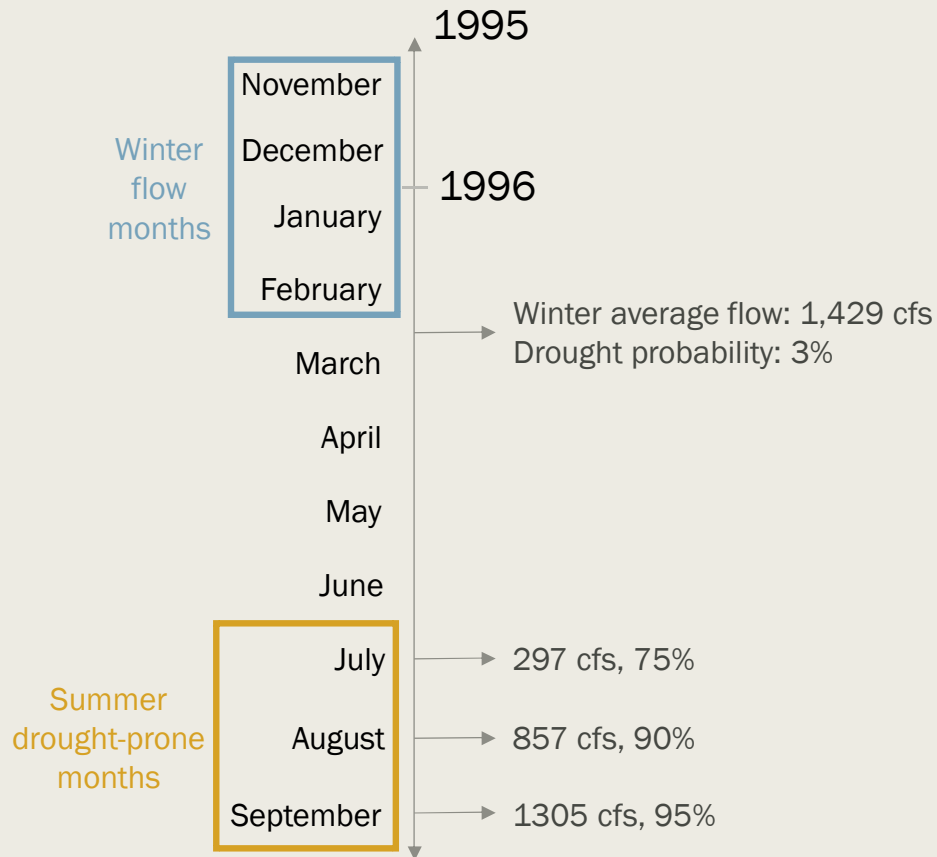
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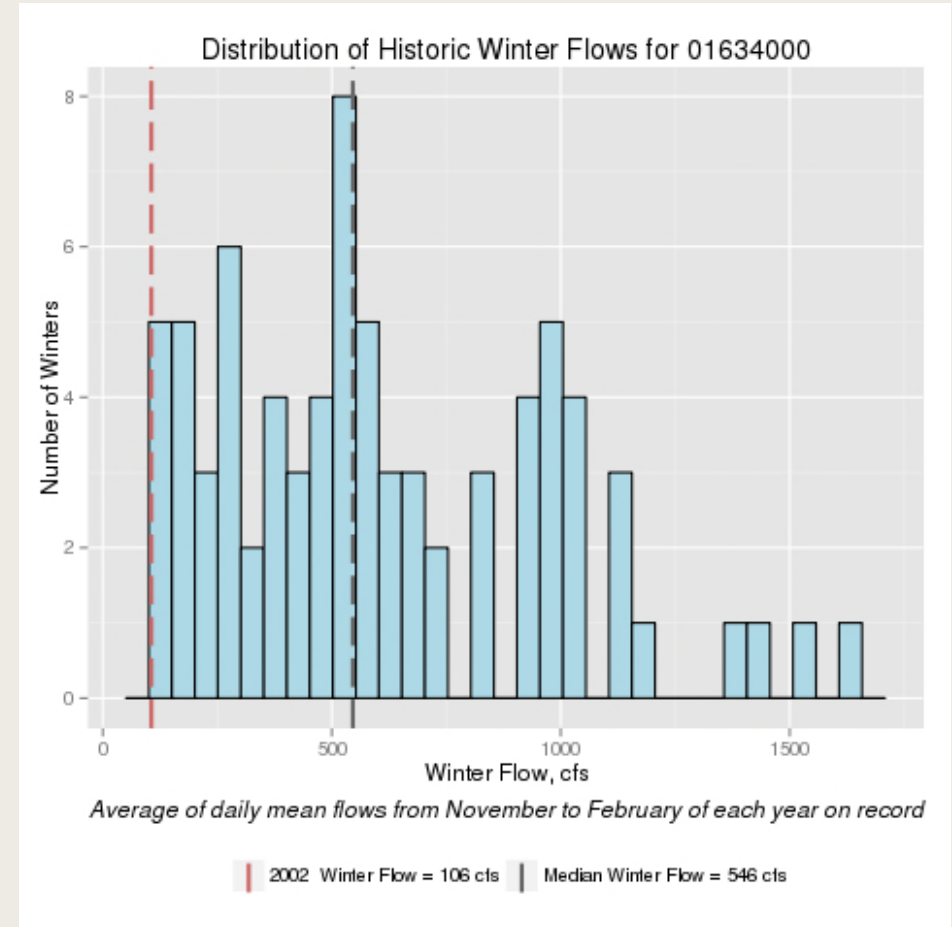- Summer base flow indicates drought in absence of rainfall

Script used for predicting drought in R

```r
97 ▾    for (j in 1:length(month)) {
98
99 ▾      for (k in 1:length(percentile)) {
100
101          # Grab beta values from URL
102          beta_0 <- paste("mllr_beta0", month[j], percentile[k], sep="_")
103          b0_url <- paste0("http://deq2.bse.vt.edu/om/remote/get_modelData.ph
104                          elid, "&variables=", beta_0)
105          b0_table <- try(read.table(b0_url, header=TRUE, sep=","))
106 ▾        if (class(b0_table)=="try-error") {
107            b0 <- "NA"
108            b1 <- "NA"
109            next
110          } else { b0 <- b0_table$dataval }
111
112          # ... (grabbing b1 value in same way)
113
114          # Calculating the probability
115          Probability_no <- 1/(1+exp(-(b0 + b1*n_f_flow)))
116          mllr_name <- paste("mllr", month[j], percentile[k], sep="_")
117
118          # Build the URL for stashing the new data
119          base_url <- paste0("http://deq2.bse.vt.edu/om/remote/setModelData.p
120          url_stash <- paste0(base_url, elid, "&dataname=", mllr_name, "&data
121          browseURL(url_stash)
122
123      }
124    }
```

1996: Predicted vs real

1995

Winter flow months

November
December

1996

January
February

Winter average flow: 1,429 cfs
Drought probability: 3%

March
April
May
June

July → 297 cfs, 75%

Summer drought-prone months

August → 857 cfs, 90%

September → 1305 cfs, 95%

Distribution of Historic Winter Flows for 01634000

Number of Winters

Winter Flow, cfs

Average of daily mean flows from November to February of each year on record

| 1996 Winter Flow = 1419 cfs | Median Winter Flow = 553 cfs |

2002: Predicted vs real

2001

Winter flow months
- November
- December
2002
- January
- February

→ Winter average flow: 105 cfs
Drought probability: 56%

- March
- April
- May
- June

Summer drought-prone months
- July → 110 cfs, 10%
- August → 92 cfs, 10%
- September → 83 cfs, 10%

Distribution of Historic Winter Flows for 01634000

Number of Winters / Winter Flow, cfs

Average of daily mean flows from November to February of each year on record

2002 Winter Flow = 106 cfs   Median Winter Flow = 546 cfs

Improving maintainability

- Job scheduler to automatically update hydrostats calculations

- Pull NWIS data using [dataRetrieval](#) R package

```
library(dataRetrieval)

va_active <- whatNWISsites(stateCd = "VA",
                           siteStatus='active',
                           parameterCd = "00060")

va_data <- lapply(va_active$site_no, function(site_no) {
  readNWISdata(siteNumber = site_no,
               startDate = "1800-01-01",
               parameterCd = "00060")
})
```

- Migrate drought model from SAS to R

- Use version control (Git + GitHub)

Questions?

Contact

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Lindsay Carr   lcarr@usgs.gov

Acknowledgements