R Markdown and Quarto: *VERY* beginner steps in automating reports and handouts

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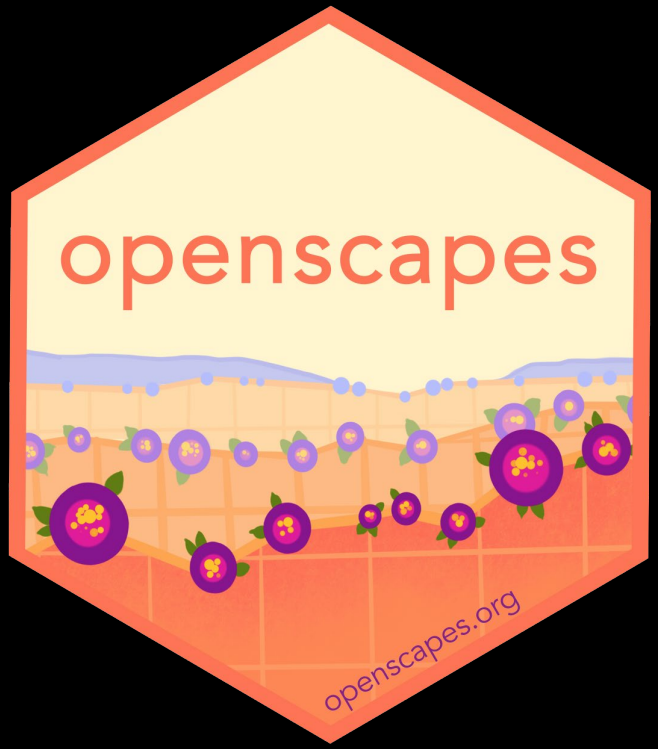
Data Science PWT | February 9, 2023

OUTLINE

1. Openscapes
2. Potential report automation products
3. Quick R Markdown and Quarto background
4. Simple “report” examples in R Markdown & Quarto

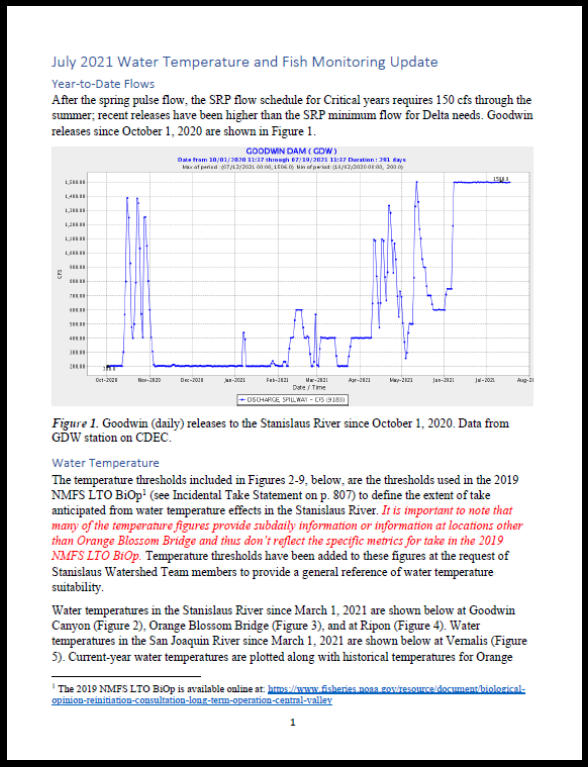
I was inspired by my Openscapes experience in Fall 2022



- "Openscapes **is an approach for doing better science for future us.** We offer mentorship, teaching, coaching and community organizing centered around open data science: we help teams develop collaborative practices that are more reproducible, transparent, inclusive, and kind."
- Fall 2022 NOAA Fisheries Openscapes cohorts – read about it here.

Potential applications

- Stanislaus Watershed Team



July 2021 Water Temperature and Fish Monitoring Update

Year-to-Date Flows

After the spring pulse flow, the SRP flow schedule for Critical years requires 150 cfs through the summer; recent releases have been higher than the SRP minimum flow for Delta needs. Goodwin releases since October 1, 2020 are shown in Figure 1.

GOODWIN DAM (GDW)

Figure 1. Goodwin (daily) releases to the Stanislaus River since October 1, 2020. Data from GDW station on CDEC.

Water Temperature

The temperature thresholds included in Figures 2-9, below, are the thresholds used in the 2019 NMFS LTO BiOp[1] (see Incidental Take Statement on p. 807) to define the extent of take anticipated from water temperature effects in the Stanislaus River. *It is important to note that many of the temperature figures provide subdaily information or information at locations other than Orange Blossom Bridge and thus don't reflect the specific metrics for take in the 2019 NMFS LTO BiOp.* Temperature thresholds have been added to these figures at the request of Stanislaus Watershed Team members to provide a general reference of water temperature suitability.

Water temperatures in the Stanislaus River since March 1, 2021 are shown below at Goodwin Canyon (Figure 2), Orange Blossom Bridge (Figure 3), and at Ripon (Figure 4). Water temperatures in the San Joaquin River since March 1, 2021 are shown below at Vernalis (Figure 5). Current-year water temperatures are plotted along with historical temperatures for Orange

[1] The 2019 NMFS LTO BiOp is available online at: https://www.fisheries.noaa.gov/resource/document/biological-opinion-reinitiation-consultation-long-term-operation-central-valley

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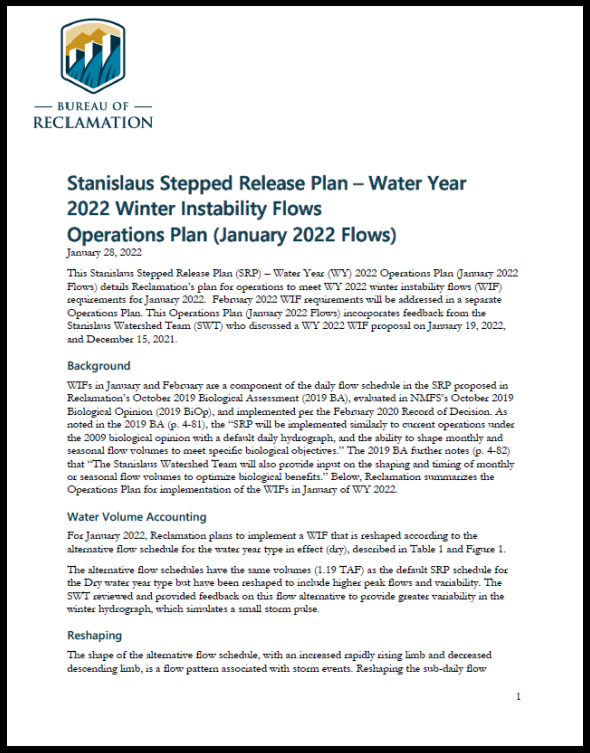
Monthly handouts



— BUREAU OF —
RECLAMATION

Stanislaus Stepped Release Plan – Water Year 2022 Winter Instability Flows Operations Plan (January 2022 Flows)

January 28, 2022

This Stanislaus Stepped Release Plan (SRP) – Water Year (WY) 2022 Operations Plan (January 2022 Flows) details Reclamation's plan for operations to meet WY 2022 winter instability flows (WIF) requirements for January 2022. February 2022 WIF requirements will be addressed in a separate Operations Plan. This Operations Plan (January 2022 Flows) incorporates feedback from the Stanislaus Watershed Team (SWT) who discussed a WY 2022 WIF proposal on January 19, 2022, and December 15, 2021.

Background

WIFs in January and February are a component of the daily flow schedule in the SRP proposed in Reclamation's October 2019 Biological Assessment (2019 BA), evaluated in NMFS's October 2019 Biological Opinion (2019 BiOp), and implemented per the February 2020 Record of Decision. As noted in the 2019 BA (p. 4-81), the "SRP will be implemented similarly to current operations under the 2009 biological opinion with a default daily hydrograph, and the ability to shape monthly and seasonal flow volumes to meet specific biological objectives." The 2019 BA further notes (p. 4-82) that "The Stanislaus Watershed Team will also provide input on the shaping and timing of monthly or seasonal flow volumes to optimize biological benefits." Below, Reclamation summarizes the Operations Plan for implementation of the WIFs in January of WY 2022.

Water Volume Accounting

For January 2022, Reclamation plans to implement a WIF that is reshaped according to the alternative flow schedule for the water year type in effect (dry), described in Table 1 and Figure 1.

The alternative flow schedules have the same volumes (1.19 TAF) as the default SRP schedule for the Dry water year type but have been reshaped to include higher peak flows and variability. The SWT reviewed and provided feedback on this flow alternative to provide greater variability in the winter hydrograph, which simulates a small storm pulse.

Reshaping

The shape of the alternative flow schedule, with an increased rapidly rising limb and decreased descending limb, is a flow pattern associated with storm events. Reshaping the sub-daily flow

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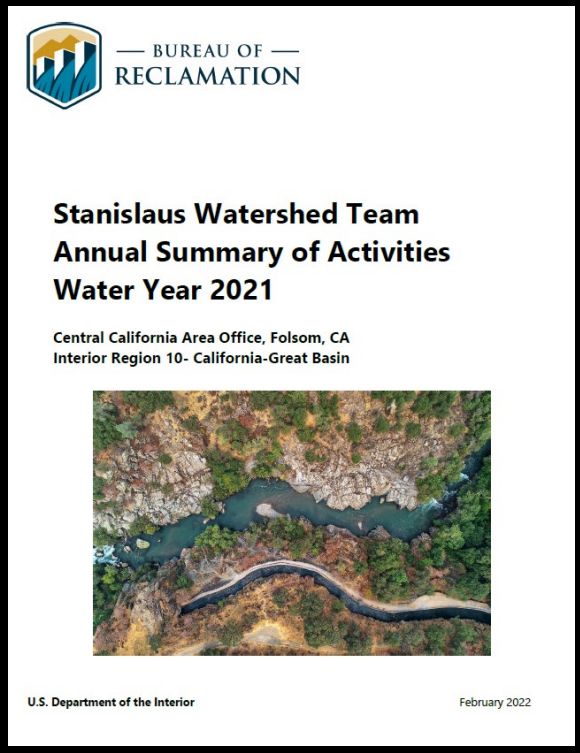
Seasonal Operation Plans



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RECLAMATION

Stanislaus Watershed Team
Annual Summary of Activities
Water Year 2021

Central California Area Office, Folsom, CA
Interior Region 10- California-Great Basin

U.S. Department of the Interior

February 2022

Annual reports

Potential applications

- Stanislaus Watershed Team

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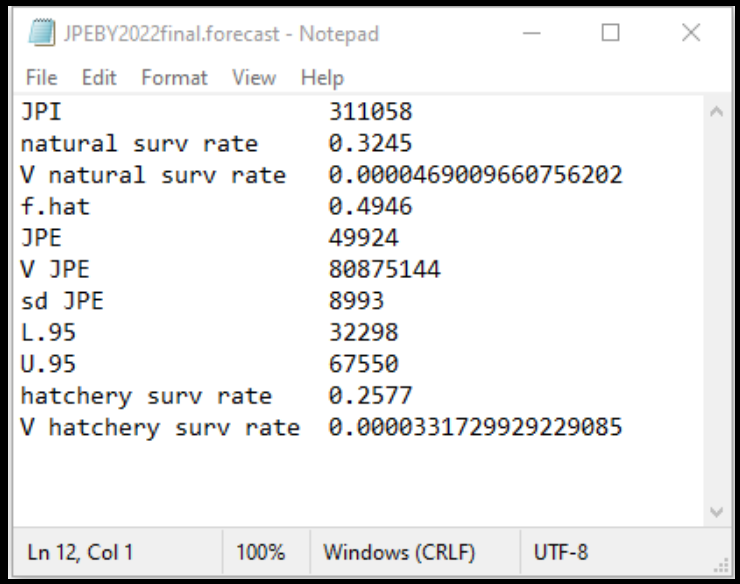
Monthly handouts

New SWT dashboard on SacPAS: https://www.cbr.washington.edu/sacramento/workgroups/stanislaus_watershed.html

***Thank you**, UW (especially Susannah Iltis) and Reclamation (especially Cat Pien and Elissa Buttermore)!*

Potential applications, continued

- Summary of Variance-weighted mean survival and final calculation for winter-run Juvenile Production Estimate (JPE)




```
52  ##=============================================================================
53  ## Forecast natural-origin JPE
54
55  JPE <- JPI * f.hat * round(s.nat.mean, 4) #JPE forecast
56                                            #enforce 4 sig digits for surv rate
57
58  V.JPE <- (JPI^2 - V.JPI) *                #JPE variance (Gray 1999)
59      ((f.hat^2 * s.nat.var) + (round.s.nat.mean^2 * V.f) - (V.f * s.nat.var)) +
60          (f.hat^2 * round.s.nat.mean^2 * V.JPI)
61
62  sd.JPE <- sqrt(V.JPE)                     #JPE standard deviation
63
64  lci <- JPE - (1.96 * sd.JPE)              #lower 95% confidence interval
65  uci <- JPE + (1.96 * sd.JPE)              #upper 95% confidence interval
66
67  ##=============================================================================
```

Pathway excerpt for winter-run survivals for JPE

	TOPIC	NOW	NEXT STEPS	STATUS
Reproducibility	Data storage	Arnold and maybe ERDAPP, Barb's computer, e-mail	Need to check with SWFSC re: all survival data; could capture WR survivals in admin record with tech memo?	not done
	Metadata	partial in JPE letter and O'Farrell paper; Barb's working files on laptop	Capture with annual tech memo to the record?	Have rough draft of memo content
	Data prep	Arnold	Check with SWFSC	not done
	Data analysis	Excel worksheet and R (use as cross-check on each other; share the excel with the JPE subteam)	Develop clean and well-documented R script for (a) variance-weighted-mean survivals and (b) JPE.	Mostly there already; should implement some of the advice re: filepaths
	Version control	Often several sent to JPE subteam; final in e-mail and Barb's laptop	Should probably use github but so few versions not sure is necessary.	May just capture final version in tech memo.
	Organization	discussion scattered in e-mails and JPE subteam notes	Centralize all data and survival estimates and brief rationale in an annual tech memo -- ideally set up to auto-generate in Quarto for ease and year-to-year consistency.	Not Quarto-ized yet.

Quick R Markdown and Quarto background

What are the various R things?

“To put it simply - R is the actual programming language, RStudio is a convenient interface in which to use it, and R Markdown is a specific type of file format designed to produce documents that include both code and text.”

From: https://bookdown.org/josiesmith/labbook/introduction-to-r-rstudio-and-r-markdown.html

What is Quarto?

From quarto.org:

Supports R…and also Python, Julia, and Observable JavaScript

"Quarto is a multi-language, next generation version of R Markdown from RStudio, with many new new features and capabilities. Like R Markdown, Quarto uses Knitr to execute R code, and is therefore able to render most existing Rmd files without modification."

Quarto or R Markdown?

- If you only use R, no *need* to use Quarto, since
  - R Markdown can deal with R code chunks.
  - R Markdown will continue to be maintained and supported.
  - …but there are some features of Quarto that might be useful. See details at: https://www.jumpingrivers.com/blog/quarto-rmarkdown-comparison/

Examples in R Markdown and Quarto

From the very beginning…

- Download R: https://cran.r-project.org/
- Download R Studio: https://posit.co/products/open-source/rstudio/
- Install some packages:
  - `Install.packages("quarto")`
  - …along with all dependencies
  - *Note:* Unlike R Markdown, Quarto isn't an R package. Quarto is a command line interface. The {quarto} package provides an R interface to Quarto, and also gets you {rmarkdown} as a dependency.

Let’s start with a Markdown example

Three important types of content

- An (optional) YAML header surrounded by ---
- Chunks of R code surrounded by ```
- Text mixed with simple text formatting like # heading and _italics_

https://rmarkdown.rstudio.com/lesson-2.html

Code Chunk Options

Chunk output can be customized with knitr options, arguments set in the {} of a chunk header. Above, we use five arguments:

- include = FALSE prevents code and results from appearing in the finished file. R Markdown still runs the code in the chunk, and the results can be used by other chunks.
- echo = FALSE prevents code, but not the results from appearing in the finished file. This is a useful way to embed figures.
- message = FALSE prevents messages that are generated by code from appearing in the finished file.
- warning = FALSE prevents warnings that are generated by code from appearing in the finished.
- fig.cap = "..." adds a caption to graphical results.

https://rmarkdown.rstudio.com/lesson-3.html

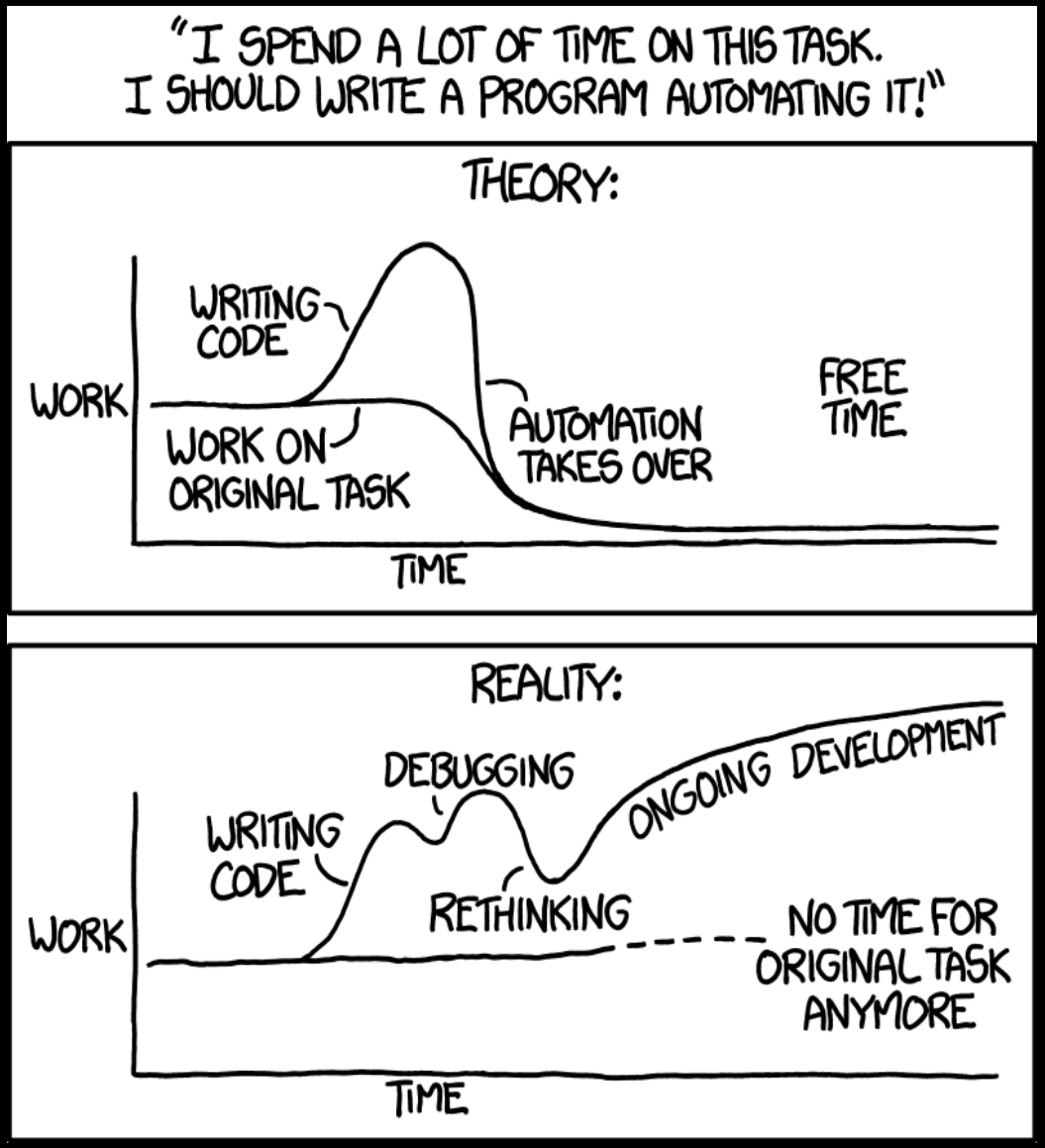
Now lets do it using Quarto

Discoveries

- For meeting handouts, main value is in graphics updates linked to latest data. Updating text in the .rmd file is the same as updating in a Word template.
- My use cases may not benefit from Quarto capabilities, but Quarto seems to be no harder than R Markdown so I may just dive into Quarto.
- For now, may be greater R Markdown support online, and many of those tips will carry over to Quarto
- So much farther to go…

What (could be) next

- Getting fancier with automated content
- Working on formatting and 508 compliance
- Expanding from personal use into team workflow
- Sharing and versioning with GitHub



https://xkcd.com/1319/

Resources

- www.openscapes.org
- R Markdown Cheat Sheet
- R Markdown reference guide
- R Markdown tutorial: https://rmarkdown.rstudio.com/lesson-1.html
- https://quarto.org/