Grand Canyon Intervening Flows

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Description

This is an R Markdown document. This document uses the USBR Natural Flow Database (1907 to 2016) and USGS data (1990 to present) to show Grand Canyon Intervening Flows from Lake Powell to Lake Mead. This analysis includes variations in flows, correlations to Lee Ferry natural flows, and sequence average values using the method of Salehabadi and Tarboton (2020).

The Natural Flow data include:

1. Paria River
2. Little Colorado River
3. Virgin River
4. Seeps, springs, etc. into the Colorado River between Lee Ferry and Lake Mead

The same intervening flows are estimated from USGS data as: + (Colorado River near Peach Springs [9404200] - Colorado River at Lees Feery [9382000] + Virign River at Littlefield [9415000])

Four plots show:

1. Box and whiskers of total intervening flow by the two methods. The Natural Flow data are split before and after 1990.
2. Correlation of Grand Canyon intervening flows to Lee Ferry natural flow. Again by method and
3. Sequence Average plot of intervening flow from the Natural Flow dataset using code of Salehabadi and Tarbotton (2020)
4. Sequence Average plot of intervening flow from the USGS data using code of Salehabadi and Tarbotton (2020)

Findings

1. Grand Canyon tributary flows are commonly discussed as 0.8 to 1.0 maf per year. That range is reasonable for the USGS data and Natural Flow data set from 1905 to 1989. Natural flow dataset from 1990 to 2016 is much lower (Figure 1)
2. There are variations of +/- 0.25 maf per year or larger in the USGS gaged flows. That is, it may not be possible to forecast Grand Canyon intervening flows for the next year more precisely than 0.25 maf per year. That is a forecast error of ~ 25%
3. There are 3-, 4- and 5- year sequences in the USGS data, including periods starting in 2000, 2001, and 2002, when Grand Canyon intervening flows averaged 0.6 to 0.7 maf per year for the period. That is 0.3 to 0.4 maf per year lower than the average value.
4. There were similar 3-, 4-, and 5- year sequences in the Natural Flow data where intervening flow hovered around 0.25 maf per year.
5. Grand Canyon intervening flows are a critical component of inflow to Lake Mead . Their variability and uncertainty should be considered in Lake Mead operations.

Requested Citation

David E. Rosenberg (2021), "Grand Canyon Intermediary Flows." Utah State University. Logan, Utah. https://github.com/dzeke/ColoradoRiverCoding/blob/main/GrandCanyonInterveningFlow/ GrandCanyonTribFlow.pdf

References

Homa Salehabadi and David Tarboton (2020), "Sequence-Average and Cumulative Flow Loss Analyses for Colorado River Streamflow at Lees Ferry." Hydroshare. http://www.hydroshare.org/resource/ bbe8dffacb07458783b2e6924aa615bb.

Figure 1. Grand Canyon intervening flow (Lees Ferry to Lake Mead) (time series)
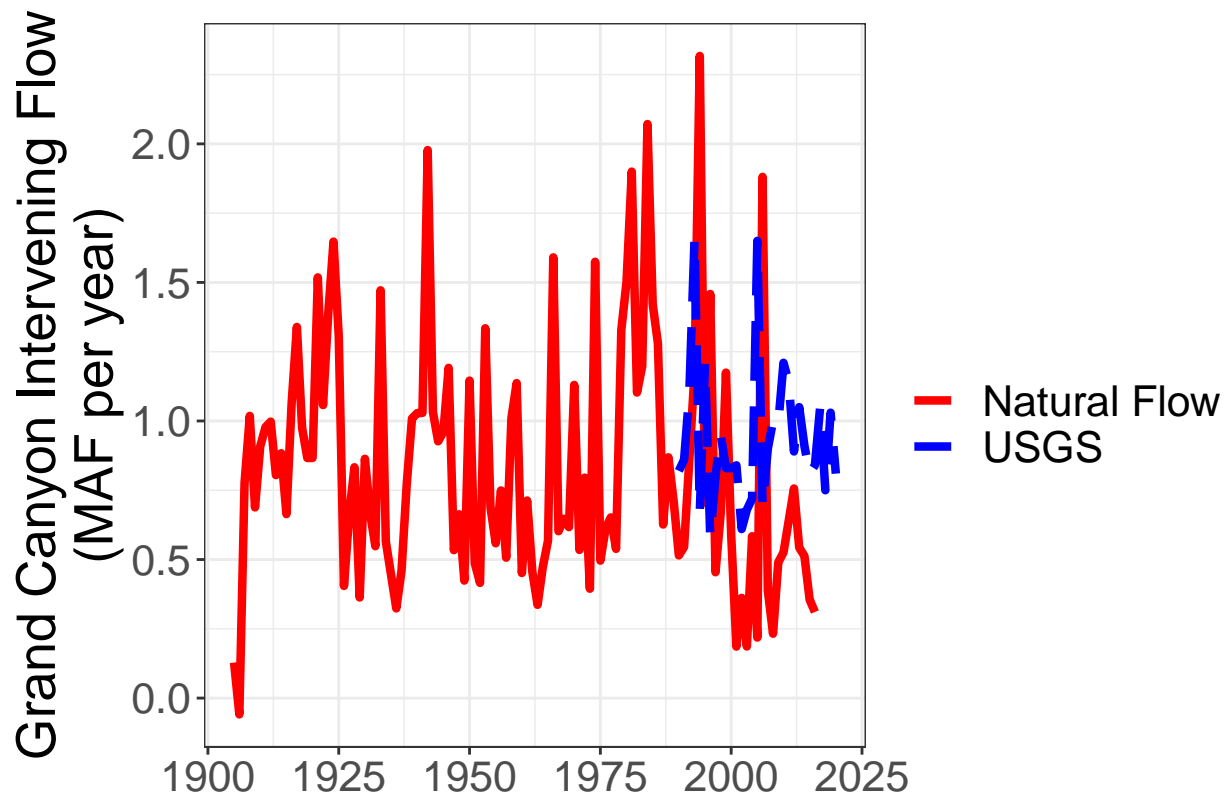
Figure 2. Grand Canyon intervening flow (Lees Ferry to Lake Mead) (box plot)
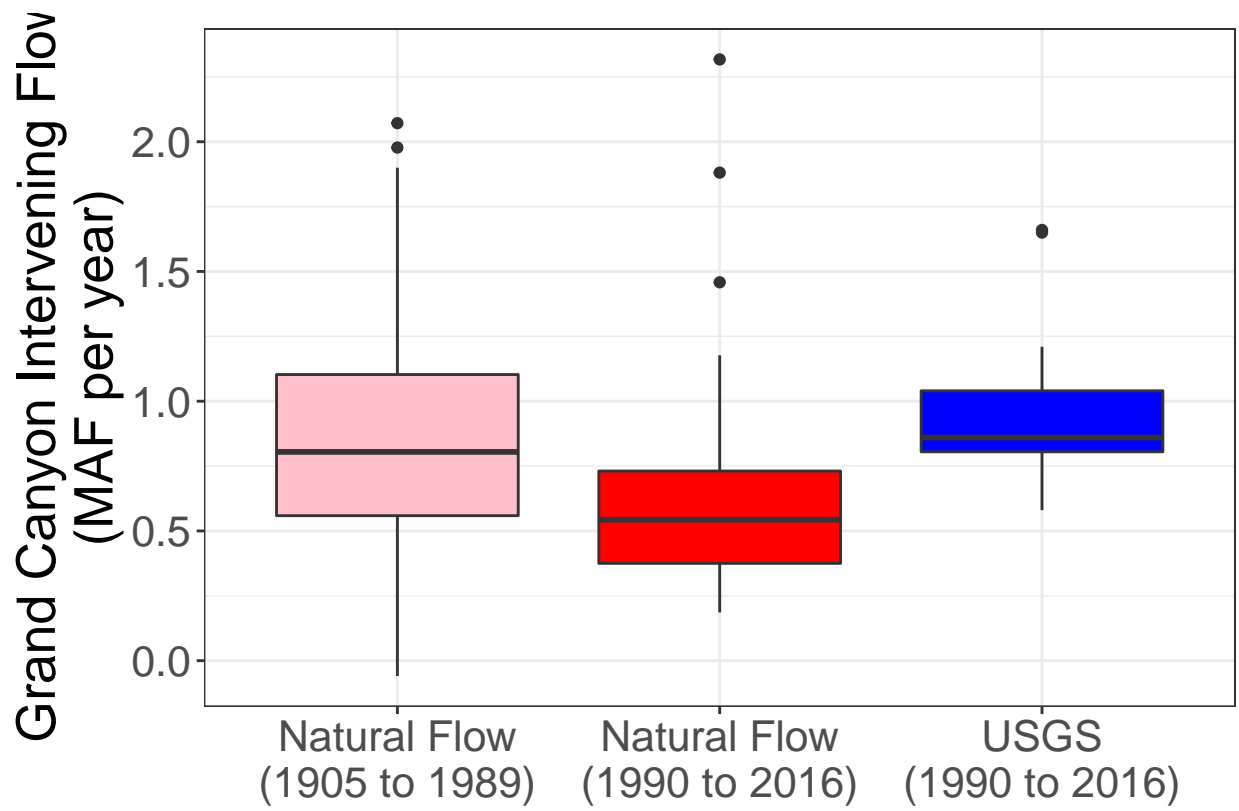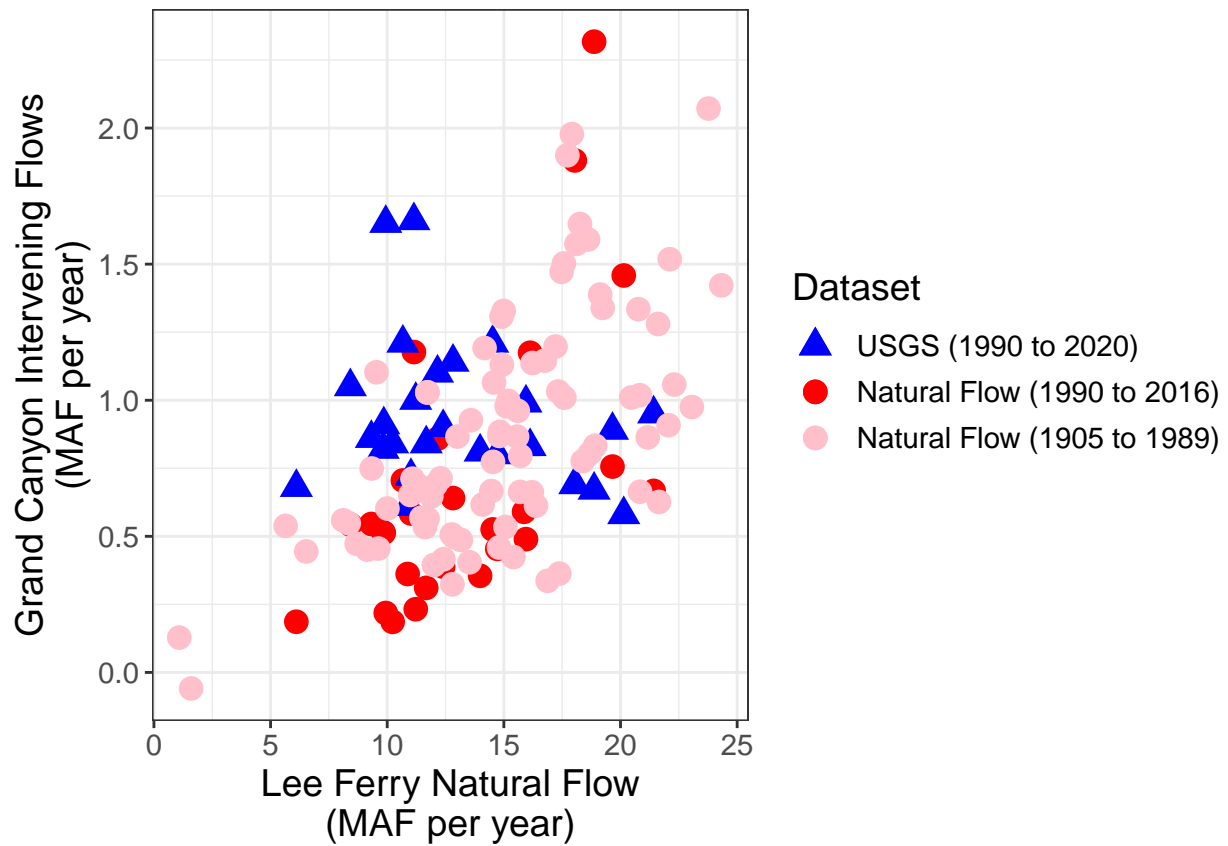
Figure 3. Correlation between Grand Canyon intervening flow and Lee Ferry natural flow


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## [1] "Correlation in Natural Flow after 1990 =  0.59"

## [1] "Correlation in USGS after 1990 =  NA"
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Figures 4 and 5. Sequence average flows for USGS (1990-2020) and Natural Flow (1905-2016) data sets

Grand Canyon Tributary Flow (Powell to Mead), Period: 1990–2020
USGS Data

Legend:
- ○ Full Period (1990–2020)
- ● Post–2000(2000–2020)
- — Long term mean (1990–2020)
- — Long term mean (2000–2020)

0.93

0.92

Mean flow (maf) vs Length of sequence (year)

Grand Canyon Tributary Flow (Powell to Mead), Period: 1905–2016
Natural Flow Data

Legend:
- ○ Full Period (1905–2016)
- ● Post–2000(2000–2016)
- — Long term mean (1905–2016)
- — Long term mean (2000–2016)

0.83

0.52

Mean flow (maf) vs Length of sequence (year)