Tree-Ring Perspectives on the Colorado River: Looking Back and Moving Forward

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WRRC Seminar Series: Severe Sustained Drought in the Colorado Basin Revisited, April 12, 2023


Photo: Brad Udall

lake powell research project bulletin

number 18
march 1976

long-term surface-water supply and streamflow trends in the upper colorado river basin

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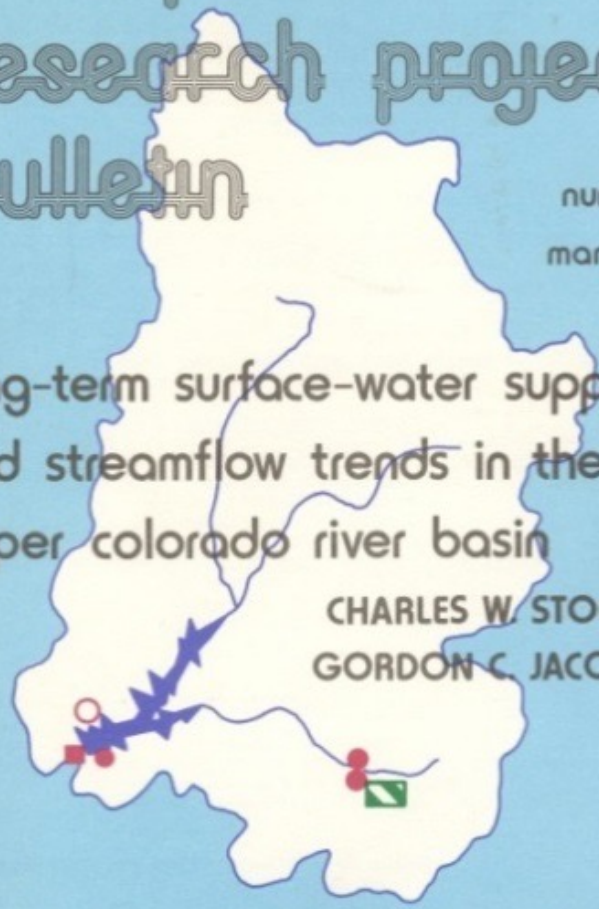

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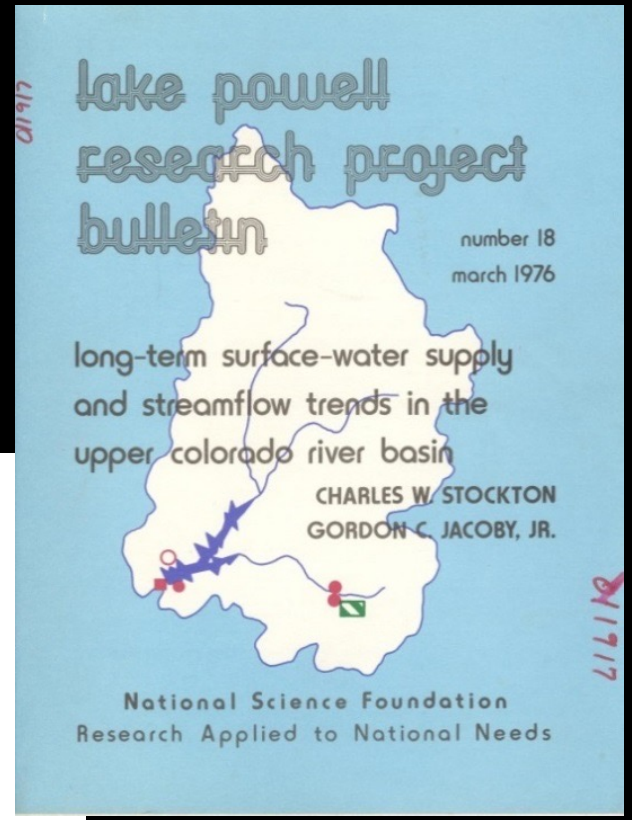
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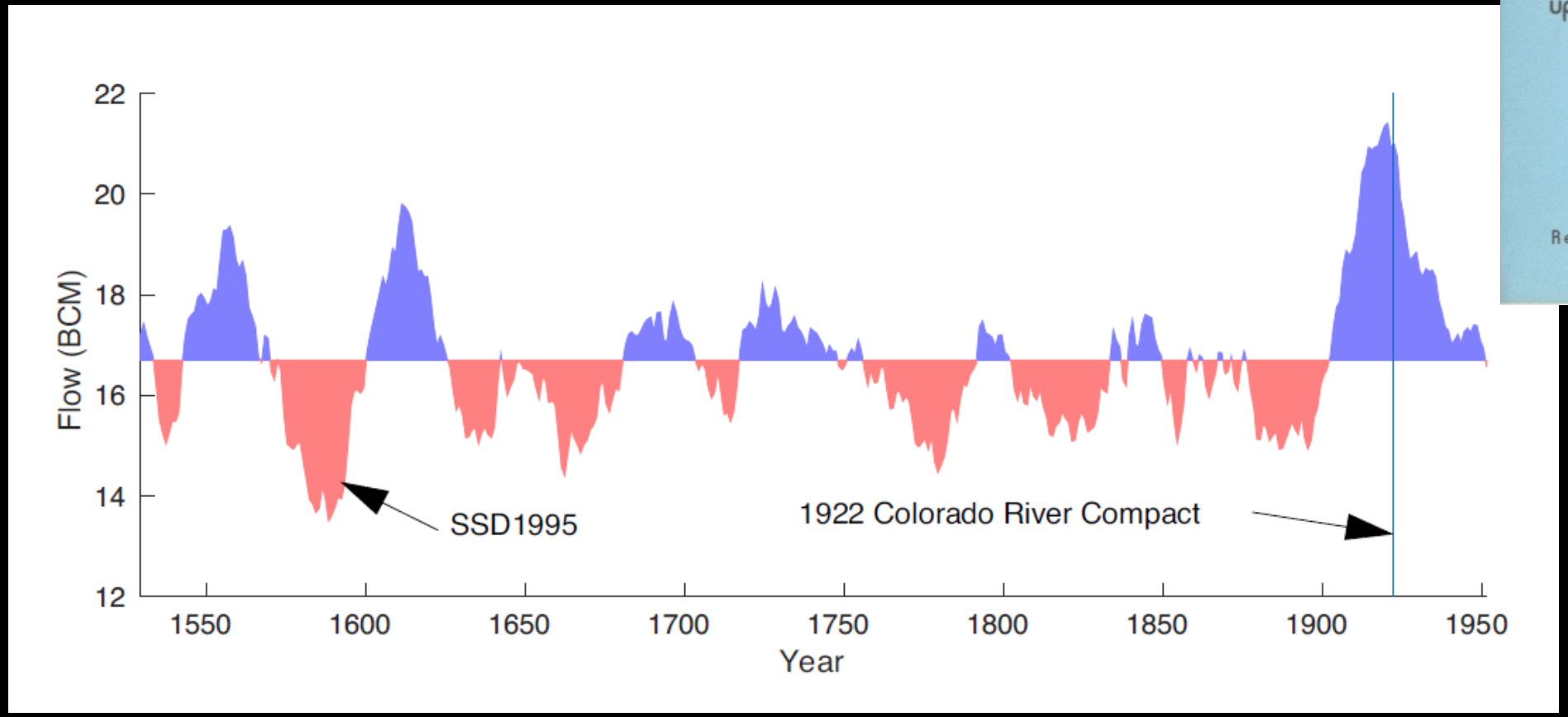
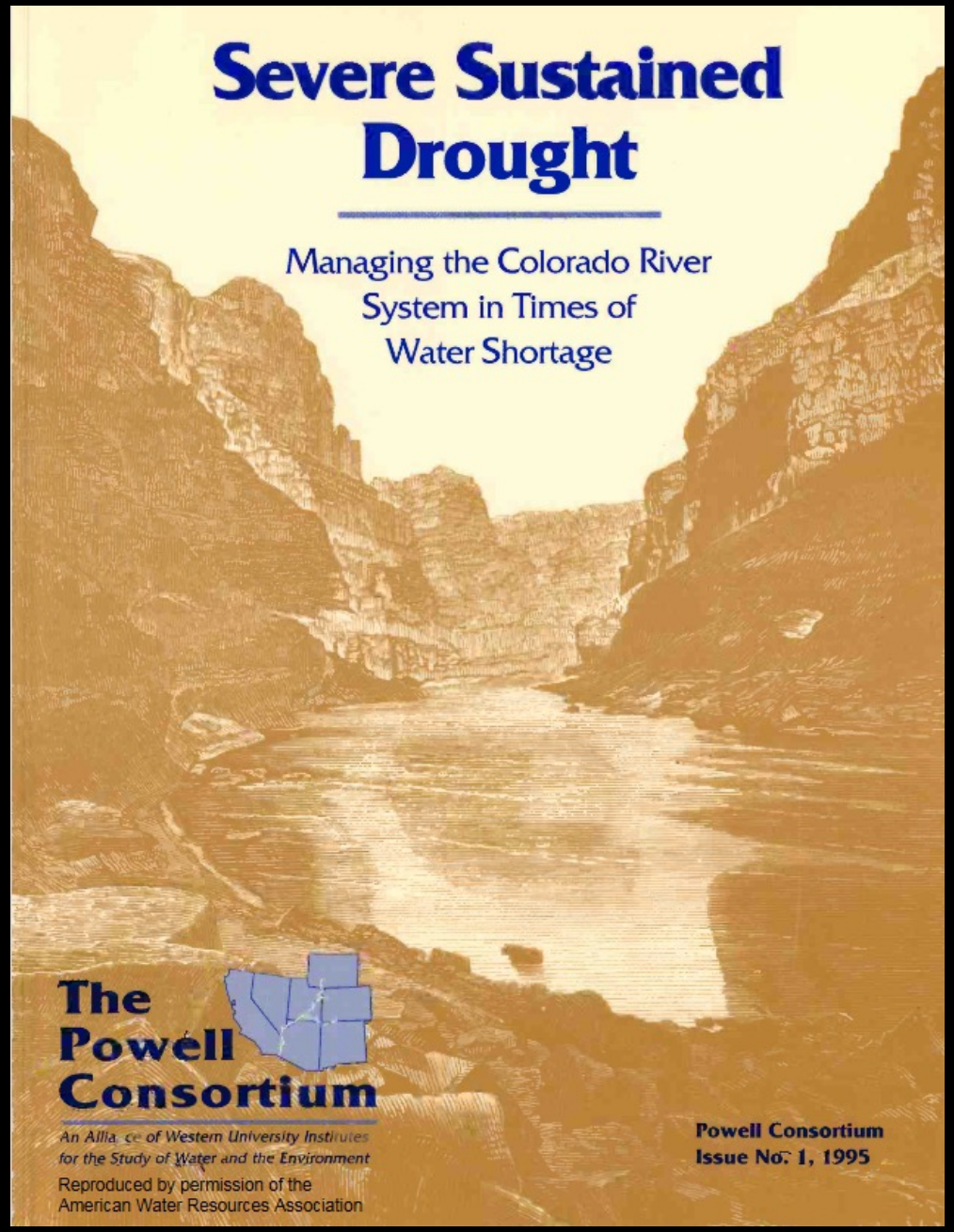

Flow (BCM)
22
20
18
16
14
12
1550
1600
1650
1700
1750
1800
1850
1900
1950
Year
SSD1995
1922 Colorado River Compact



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Introduction | Free Access

Featured Collection Introduction: Severe Sustained Drought Revisited: Managing the Colorado River System in Times of Water Shortage 25 Years Later — Part I & Part II

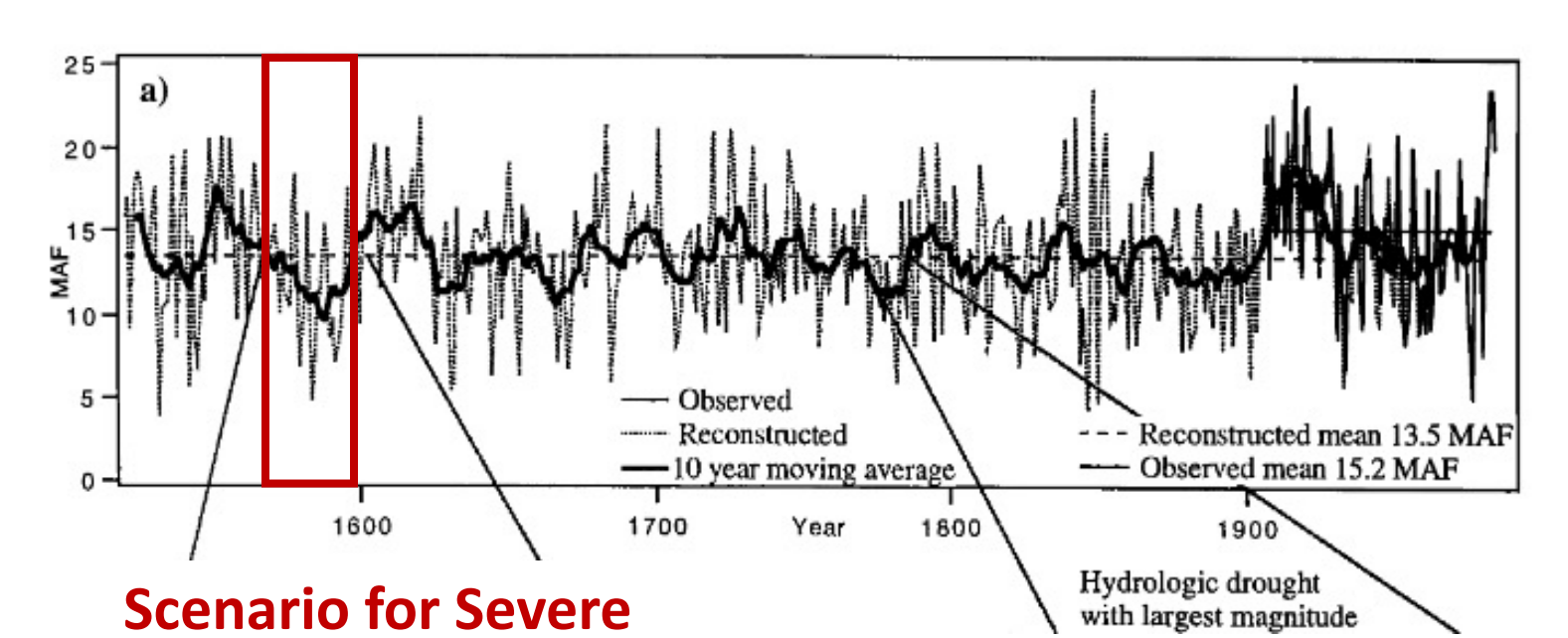
George B. Frisvold, Linda M. Fernandez, Flavio Lehner, Stephanie A. McAfee, Sharon Megdal, Elizabeth Payton, Jack Schmidt, Julie Vano, Connie Woodhouse

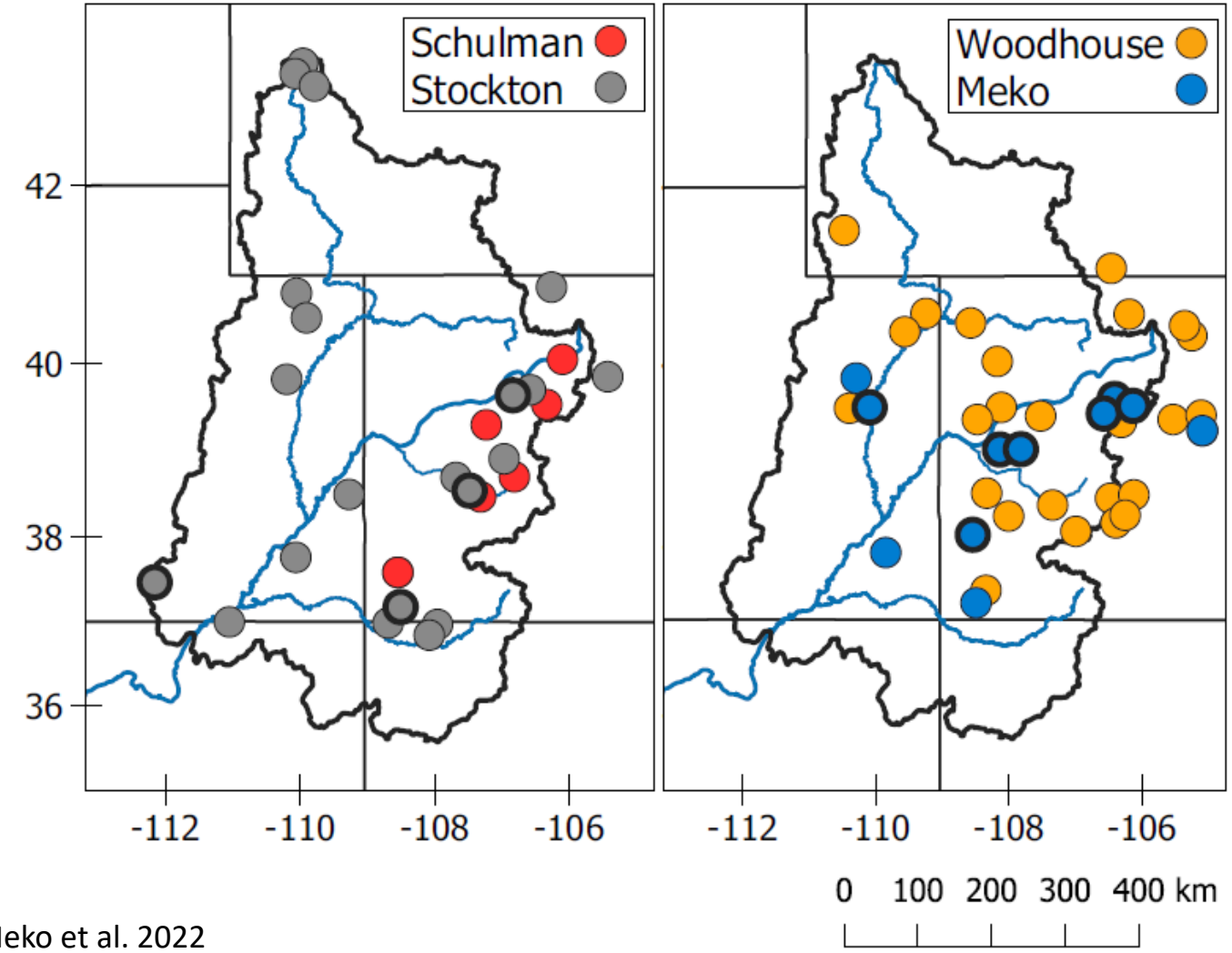
First published: 20 September 2022 | https://doi.org/10.1111/1752-1688.13062

Two drought scenarios were identified (Tarboton 1995):

1. The most severe drought based on the largest cumulative deficit below the mean, the greatest modeled reservoir depletion, and visual inspection: 1579-1600.

2. The same 22-year drought rearranged so that the annual flows were in descending order, with drought worsening over time.

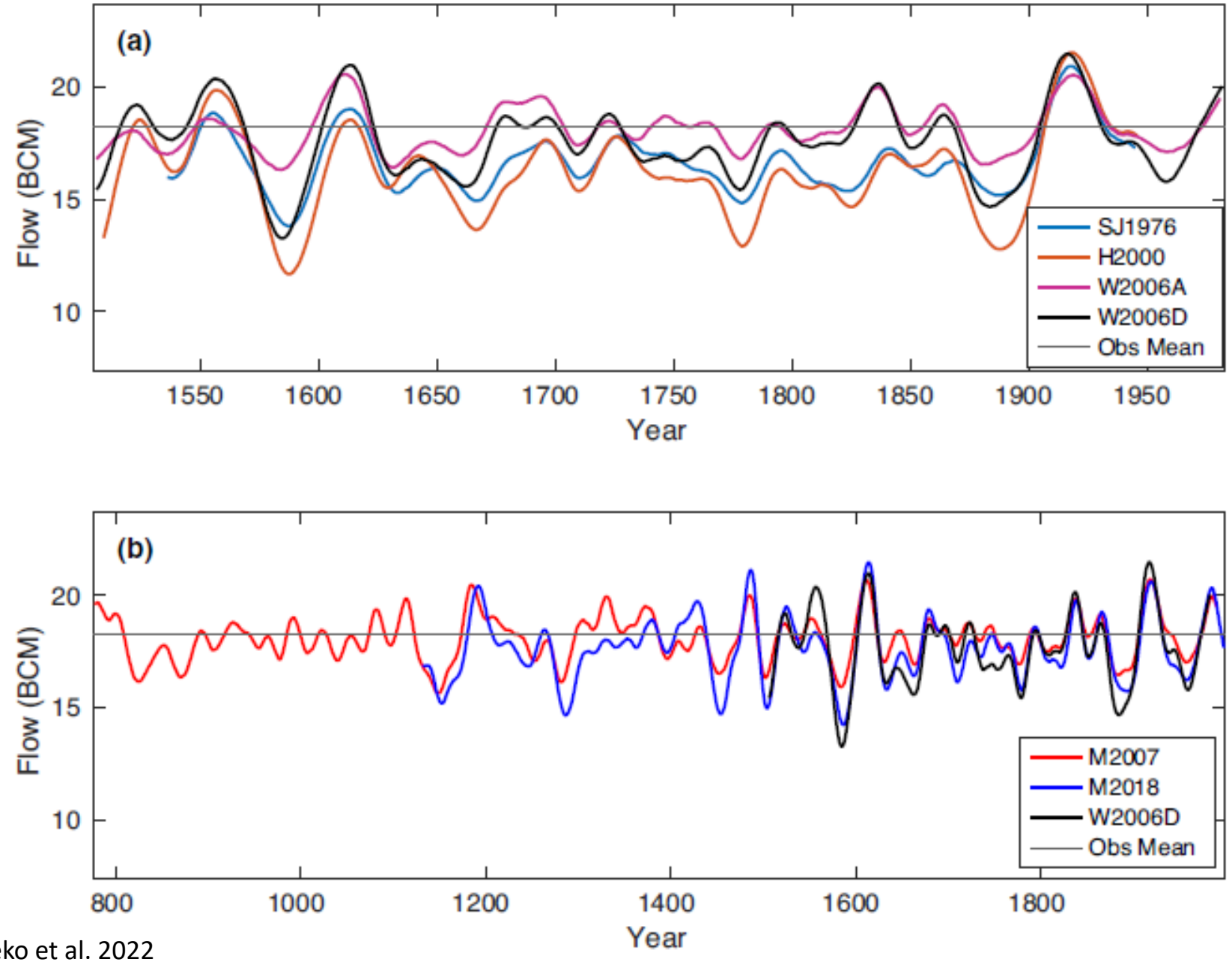




Meko et al. 2022

Since 1995, a number of additional reconstructions of Colorado River have been generated

Reconstruction		Reconstruction years	Long-term mean, MAF (1568-1961)	Variance explained
Stockton and Jacoby (1976)		1520-1961	13.4	0.76
Michaelsen et al. (1990)		1568-1962	13.8	0.83
Hidalgo et al. (2000)		1493-1962	13.0	0.82
Woodhouse et al. (2006)	A	1490-1997	14.7	0.81
	B	1490-1997	14.5	0.84
	C	1490-1997	14.6	0.72
	D	1490-1997	14.1	0.77
Meko et al. (2007)		762-2005	14.7	0.76
Meko et al. (2018)(most skillful)		1416-2015	14.2	0.81
Meko et al. (2018)(longest)		1116-2014	14.2	0.58



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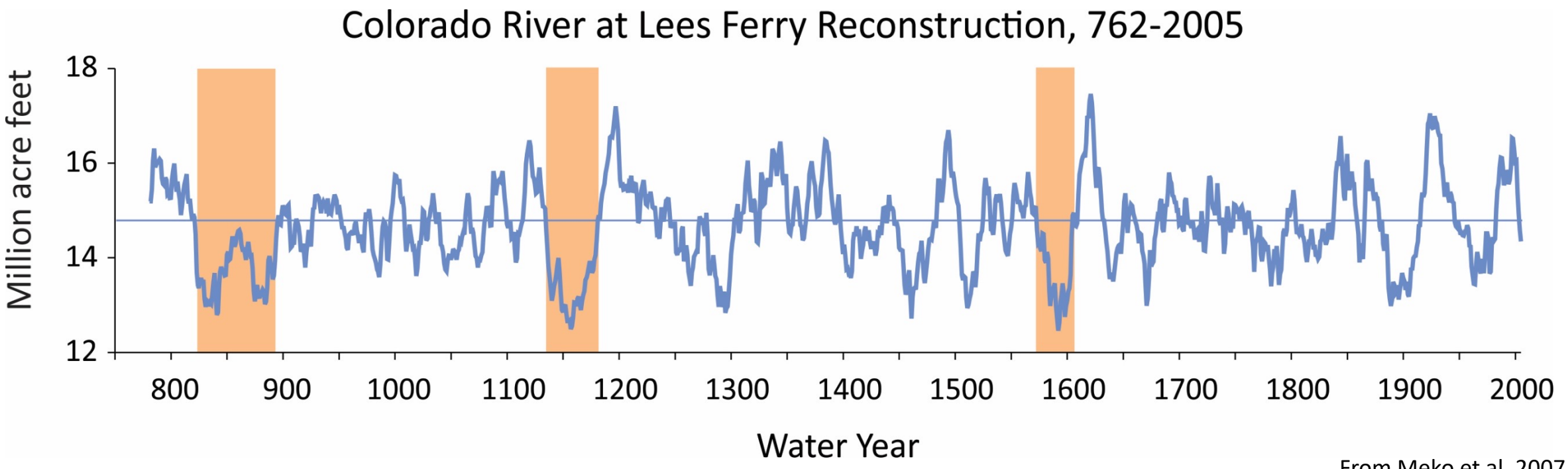

From Meko et al. 2007

Severe sustained drought scenarios revisited:

- Do these more recent reconstructions change the story? Is the late 16th century drought still a useful scenario?

- How does the 21st century Colorado River drought compare?

Severe sustained drought scenarios revisited:

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- How does the 21st century Colorado River drought compare?

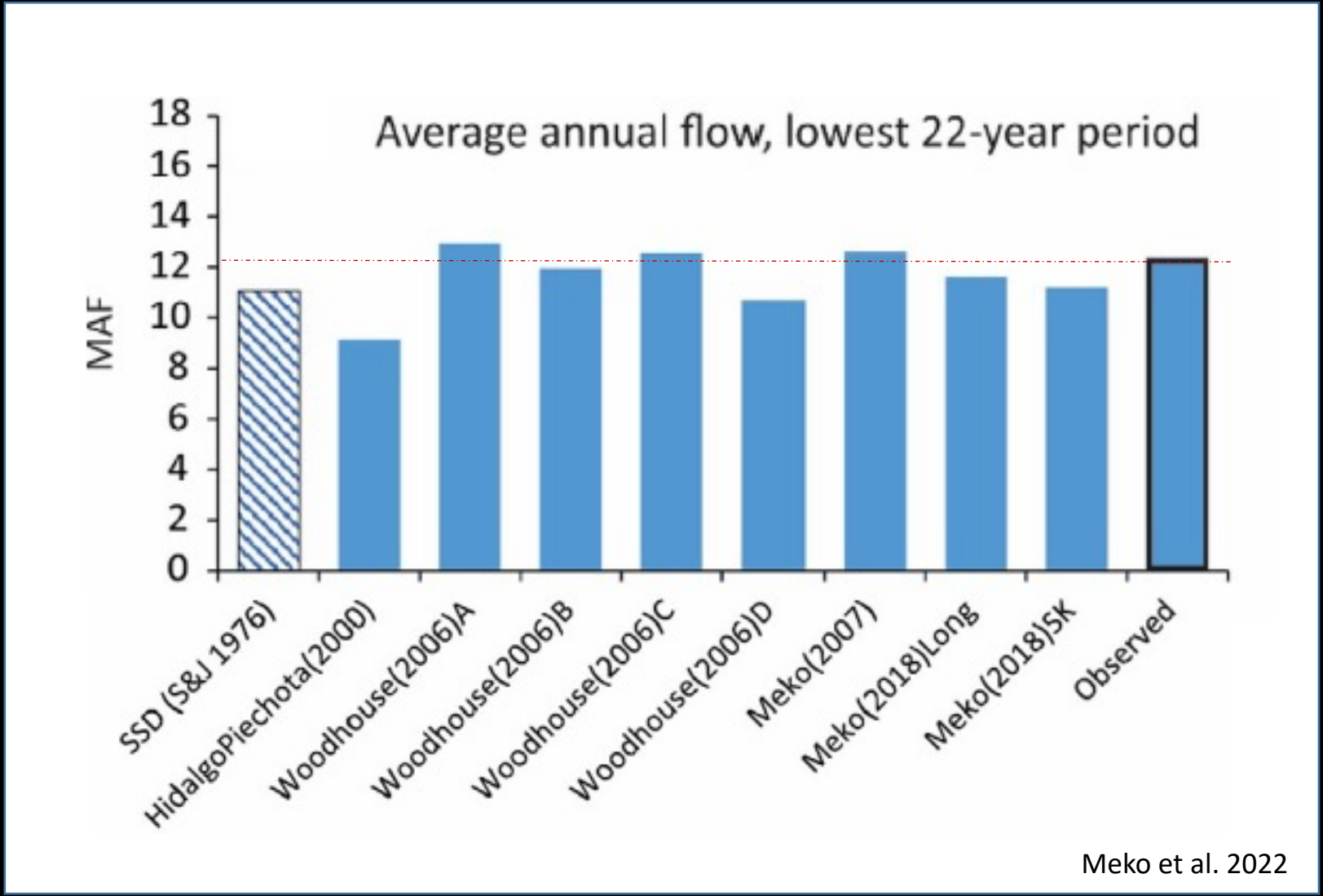
Going back to Tarboton's severe sustained drought definitions:

- The 22-year period with the lowest average annual flow
- Re-ordered lowest flow 22-year period:
    - Longest period of consecutive years below the long term flow mean
    - Average annual flow of the period of consecutive drought years

The 22-year periods with the lowest average annual flow in reconstructed and observed Colorado River flow

Reconstruction		Years of drought
Stockton and Jacoby (1976)		**1579-1600**
Hidalgo et al. (2000)		**1579-1600**
Woodhouse et al. (2006)	A	**1579-1600**
	B	1495-1516
	C	**1579-1600**
	D	**1579-1600**
Meko et al. (2007)		1137-1158
Meko et al. (2018)(most skillful)		**1579-1600**
Meko et al. (2018)(longest)		1276-1297
Observed		**2000-2021**

The 22-year periods with the lowest average annual flow in reconstructed and observed Colorado River flow

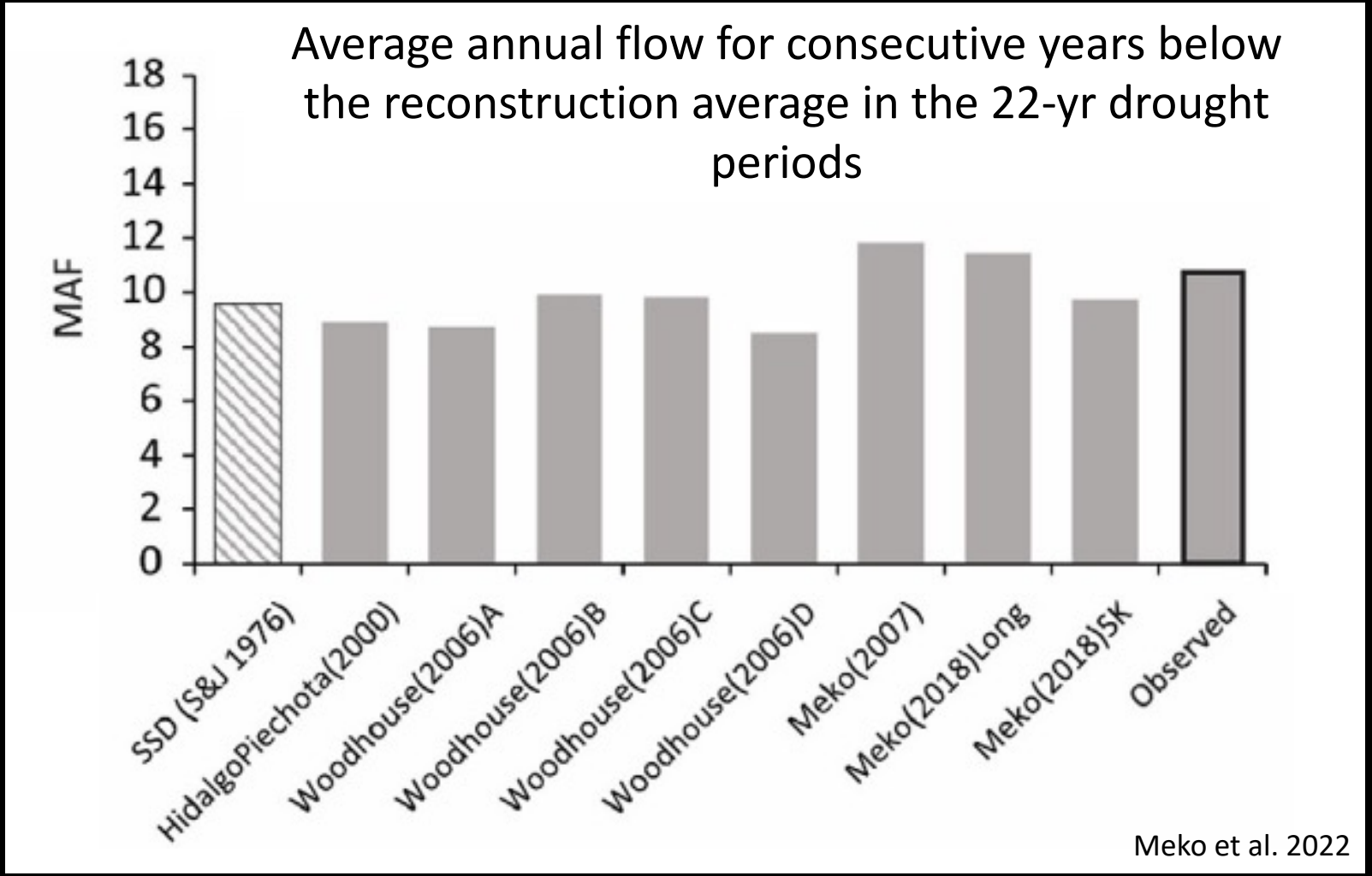


Meko et al. 2022

The 22-year periods with the lowest average annual flow, re-ordered from highest to lowest flow years

Reconstruction		Years of drought	Number of consecutive drought years
Stockton and Jacoby (1976)		**1579-1600**	16
Hidalgo et al. (2000)		**1579-1600**	21
Woodhouse et al. (2006)	A	**1579-1600**	12
	B	1495-1516	16
	C	**1579-1600**	14
	D	**1579-1600**	16
Meko et al. (2007)		1137-1158	17
Meko et al. (2018)(most skillful)		**1579-1600**	21
Meko et al. (2018)(longest)		1276-1297	17
Observed		**2000-2021**	**17**

The 22-year periods with the lowest average annual flow, re-ordered from highest to lowest flow years



Summary

- The Severe Sustained Drought, 1579-1600, stands out even among the more recent reconstructions.
- The 2000-2021 Colorado River drought appears to be comparable, with respect to 22-year drought periods.
- Reconstructions of Colorado River flow share similarities, but contain differences as well, reminding us that these are *plausible estimates* of the past.
- Scenarios from tree rings are not analogues for future….but the reconstruction still provide valuable context for assessing recent and ongoing Colorado River drought.

The 22-year periods with the lowest average annual flow, re-ordered from highest to lowest flow years