Extended Drought Analysis

John Boyer

Agenda Item 4a

Resequencing Historical Flows to Investigate Potential Future Droughts

Methods

- Supply-side investigation to quantify sensitivities to hydrologic non-stationarity (aka "the past may not be a good predictor of the future")
- Each scenario constructed with repeating sequences of monthly flows and reservoir evaporation rates extracted from historical hydrology
- Used **2070 High Demand Scenario** projections
- Used current reservoir operation rules

Resequencing Historical Flows to Investigate Potential Future Droughts

Methods

Three (3) constructed scenarios:

1. Repeating 5-year drought constructed by splicing together the **five driest water years** in the hydrologic period of record with respect to mainstem total annual flow. These were **2001, 2008, 1981, 1988**, and **2017**.

2. **Repeating single year drought** corresponding to the **second driest water year (2008)** and identified as the critical single year drought with respect to Lake Thurmond water supply availability

3. **Repeating synthetic drought year** constructed by splicing together the **twelve driest calendar month flows** in the hydrologic period of record.

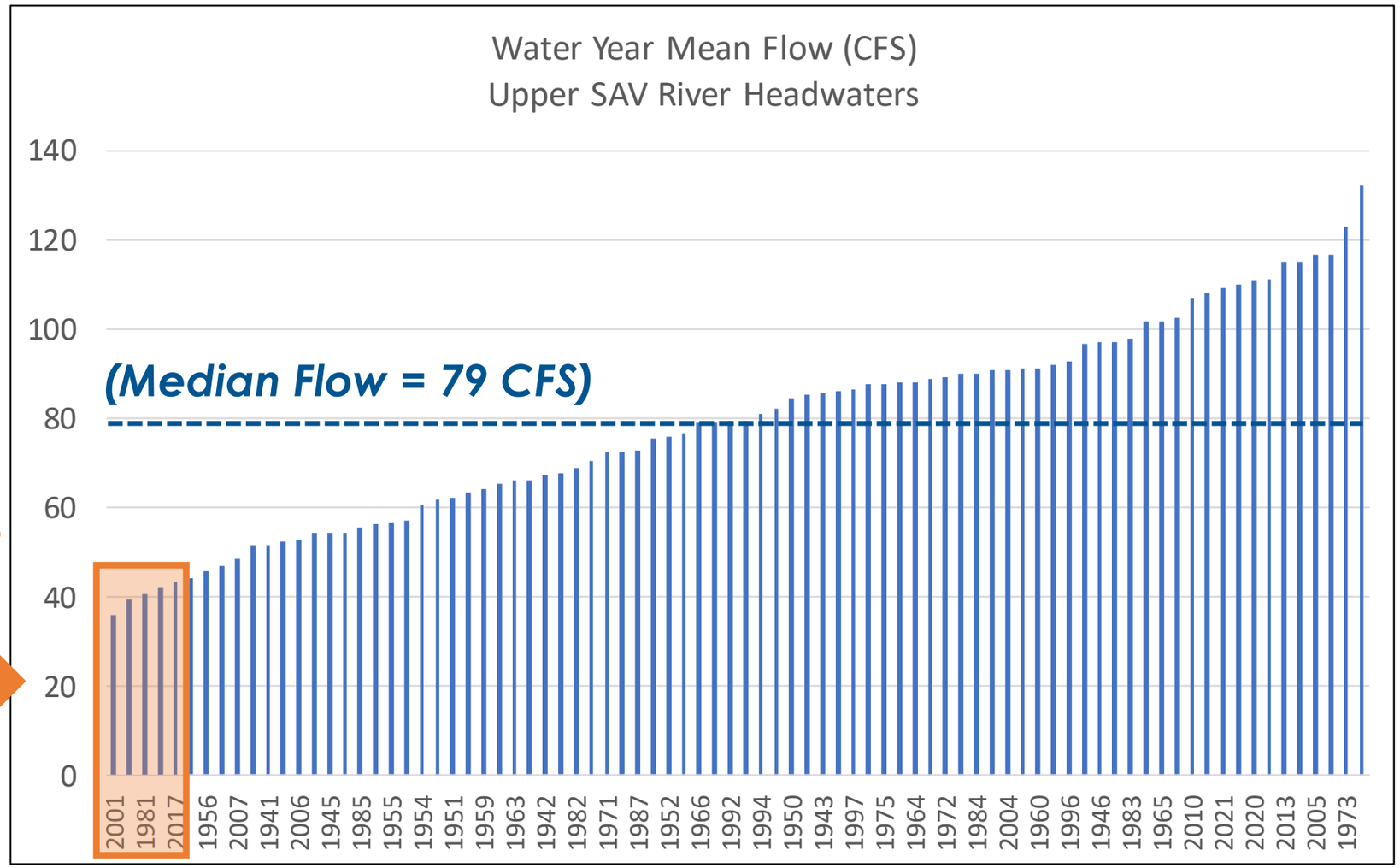
Resequencing Historical Flows to Investigate Potential Future Droughts

Methods

Ranked data based on mainstem headwater flows

5 Driest Years in terms of mainstem flow:

2001
2008
1981
1988
2017

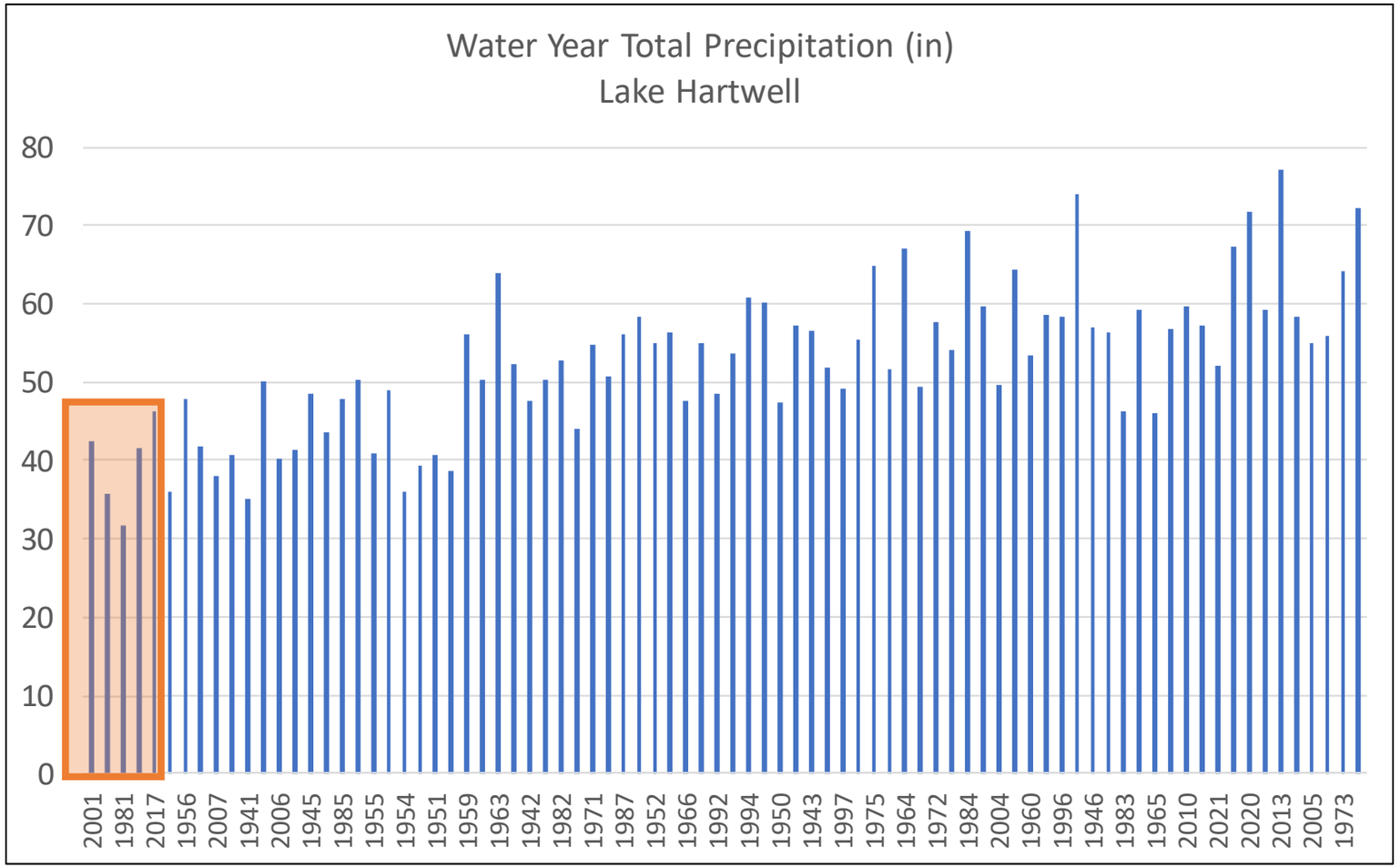


Resequencing Historical Flows to Investigate Potential Future Droughts

Methods

Reference data

Precip



Resequencing Historical Flows to Investigate Potential Future Droughts

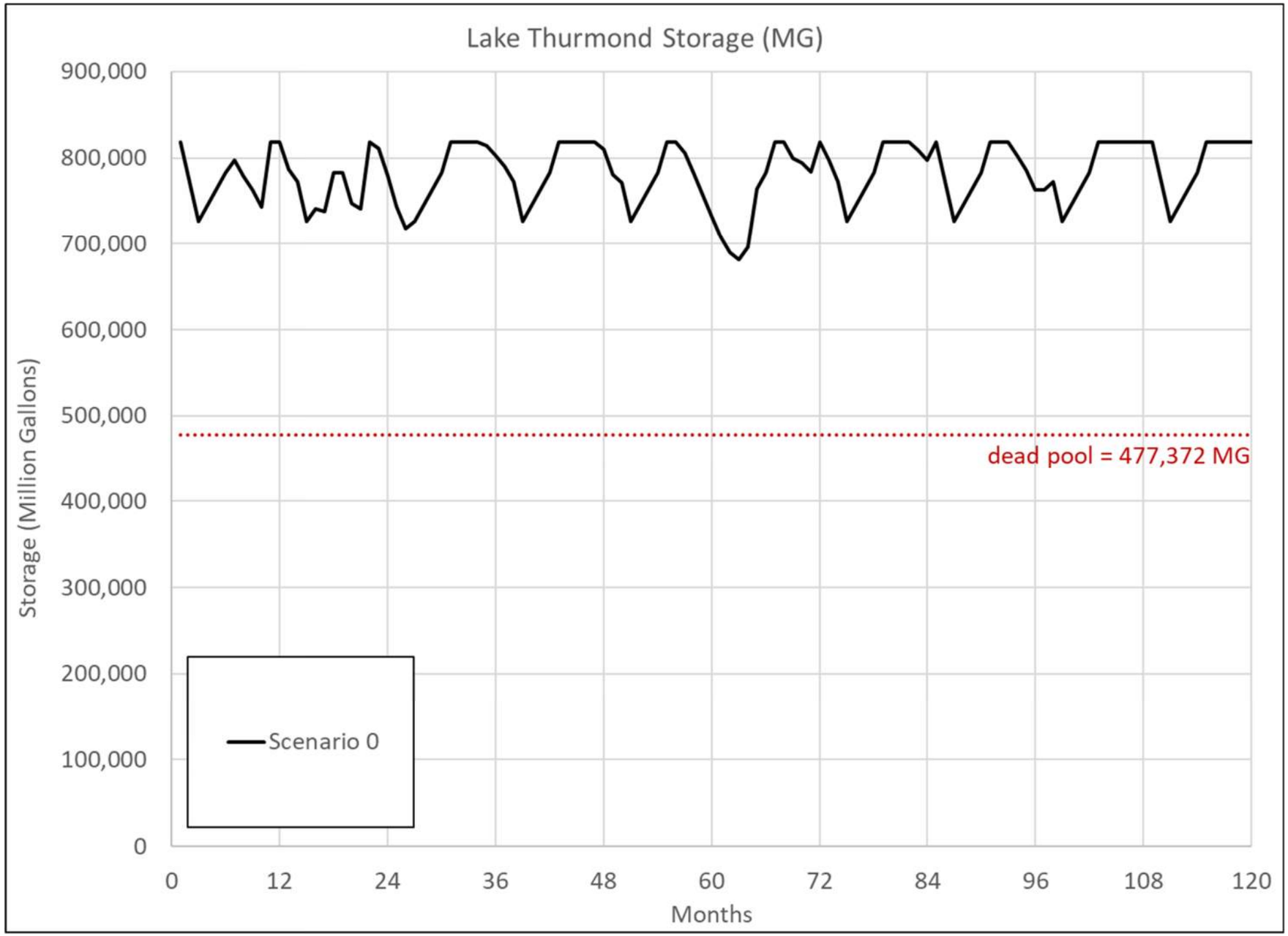
Methods

Scenario 3: 12 driest calendar months (Mainstem headwater flow)

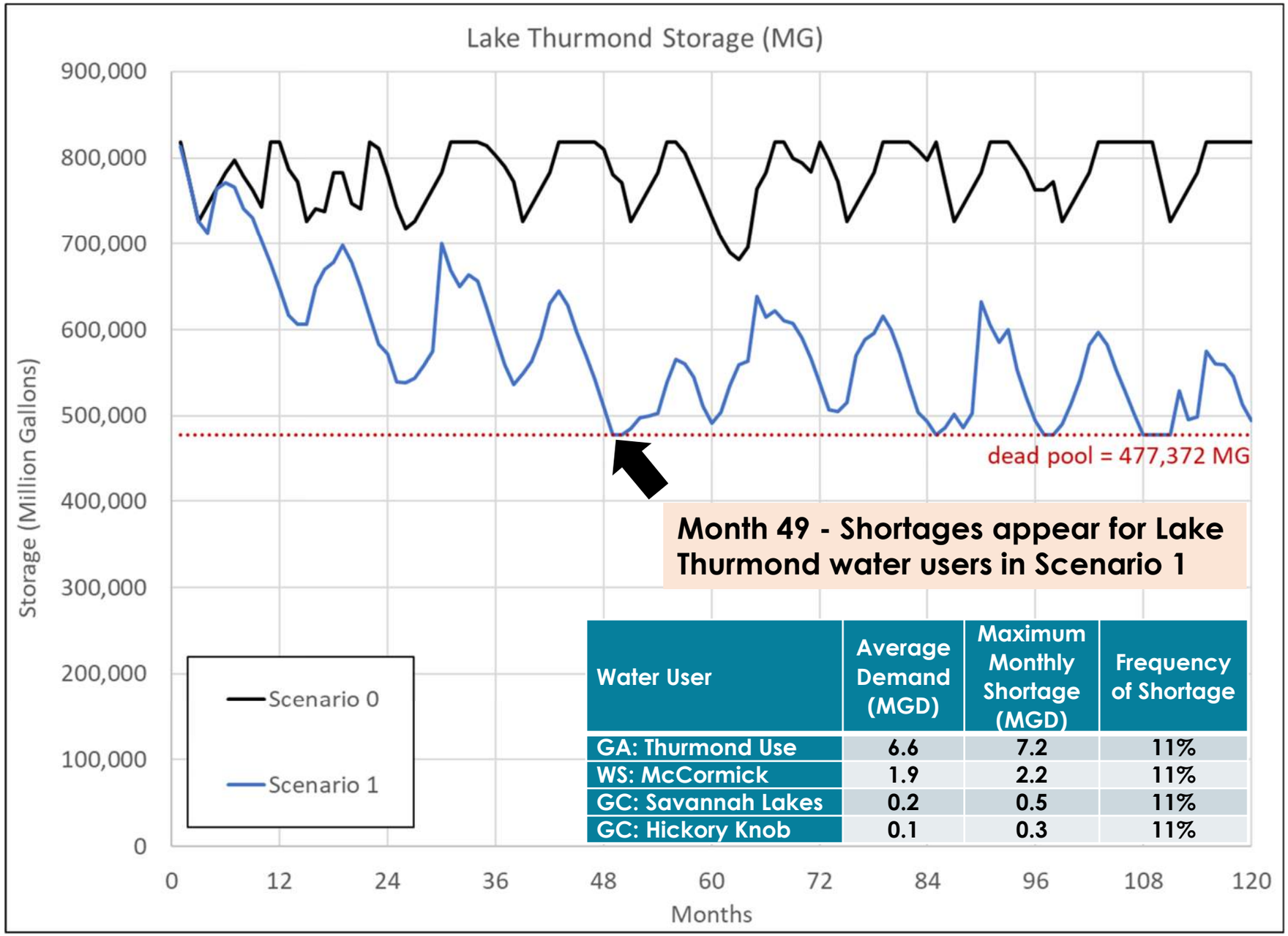
Mean annual flow = 22.5 CFS

Jan	1956
Feb	2017
Mar	2017
Apr	1986
May	2001
Jun	2008
Jul	2008
Aug	2007
Sep	1954
Oct	1954
Nov	2016
Dec	1955

Resequencing Historical Flows to Investigate Potential Future Droughts



Resequencing Historical Flows to Investigate Potential Future Droughts

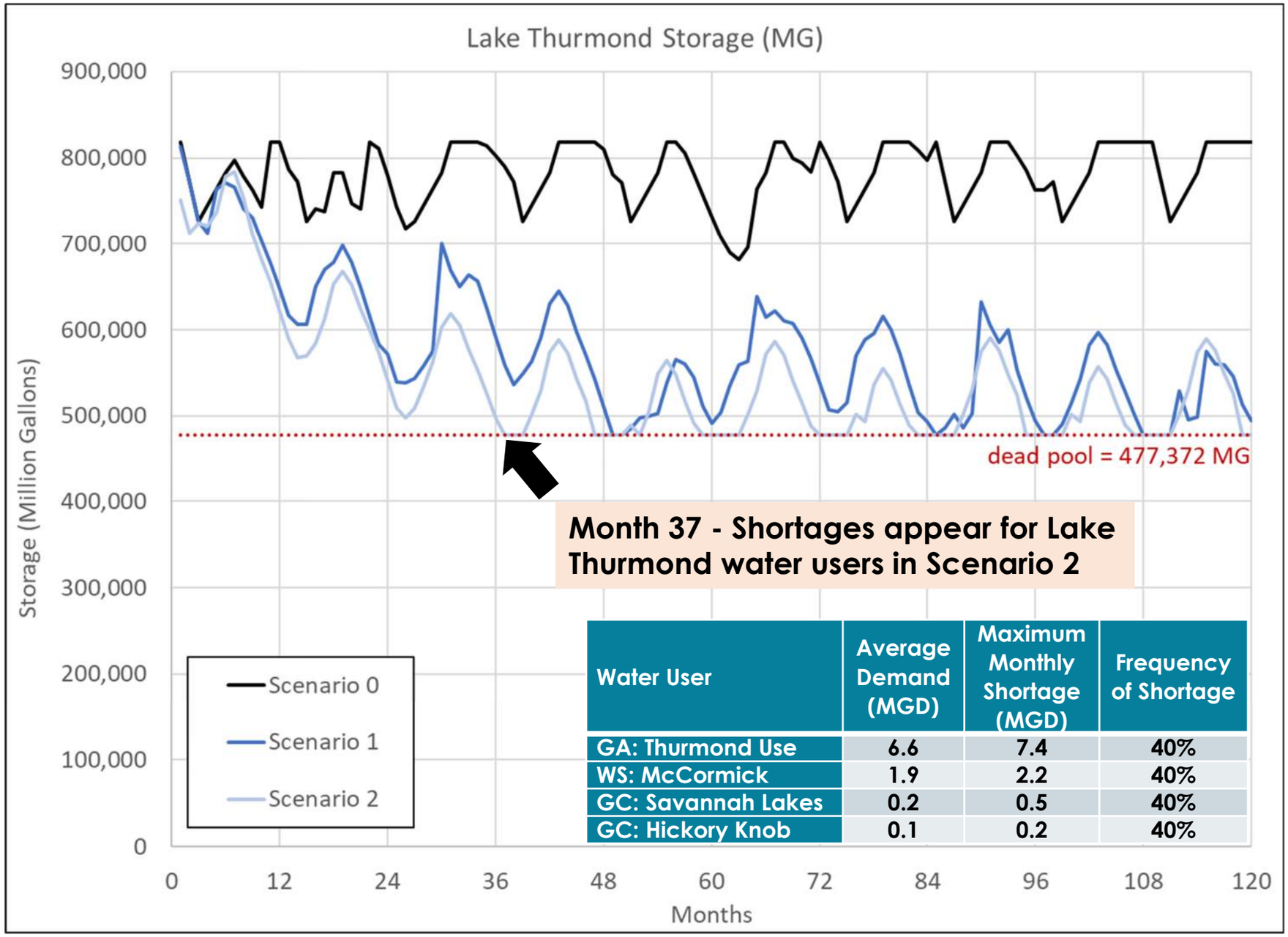


Month 49 - Shortages appear for Lake Thurmond water users in Scenario 1

Water User	Average Demand (MGD)	Maximum Monthly Shortage (MGD)	Frequency of Shortage
GA: Thurmond Use	6.6	7.2	11%
WS: McCormick	1.9	2.2	11%
GC: Savannah Lakes	0.2	0.5	11%
GC: Hickory Knob	0.1	0.3	11%

Scenario 1 Shortages

Resequencing Historical Flows to Investigate Potential Future Droughts

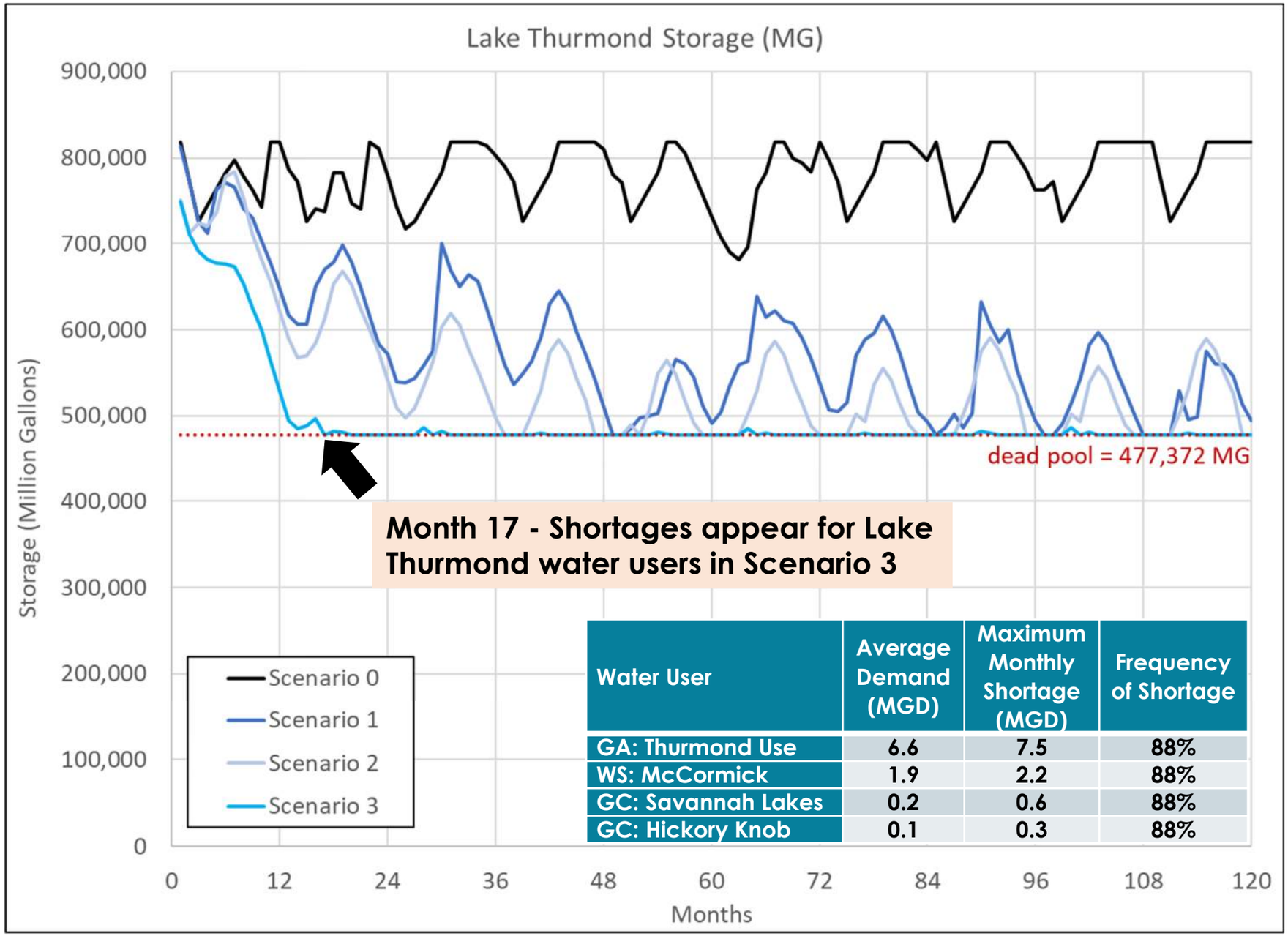


Month 37 - Shortages appear for Lake Thurmond water users in Scenario 2

Water User	Average Demand (MGD)	Maximum Monthly Shortage (MGD)	Frequency of Shortage
GA: Thurmond Use	6.6	7.4	40%
WS: McCormick	1.9	2.2	40%
GC: Savannah Lakes	0.2	0.5	40%
GC: Hickory Knob	0.1	0.2	40%

Scenario 2 Shortages

Resequencing Historical Flows to Investigate Potential Future Droughts

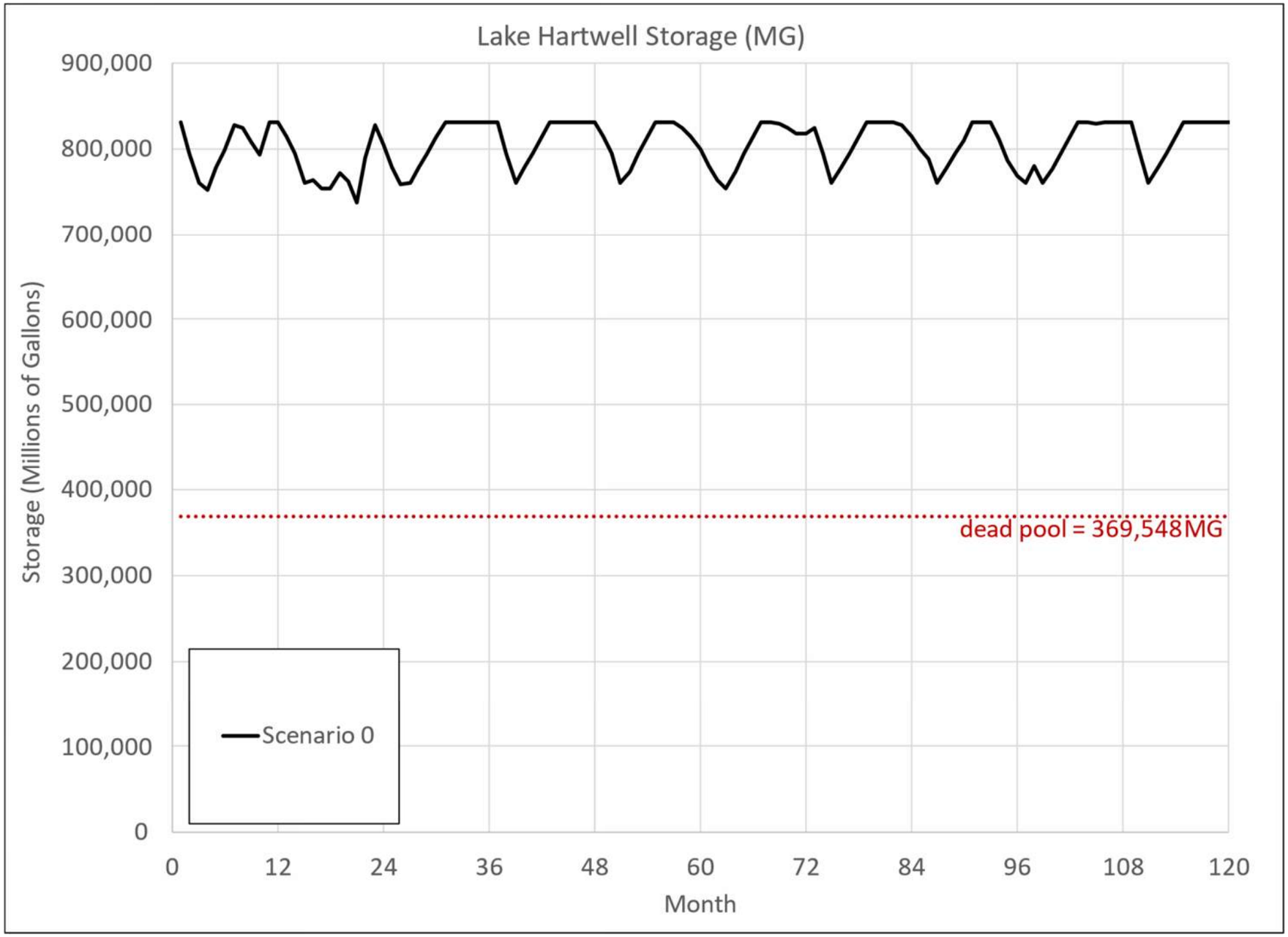


Month 17 - Shortages appear for Lake Thurmond water users in Scenario 3

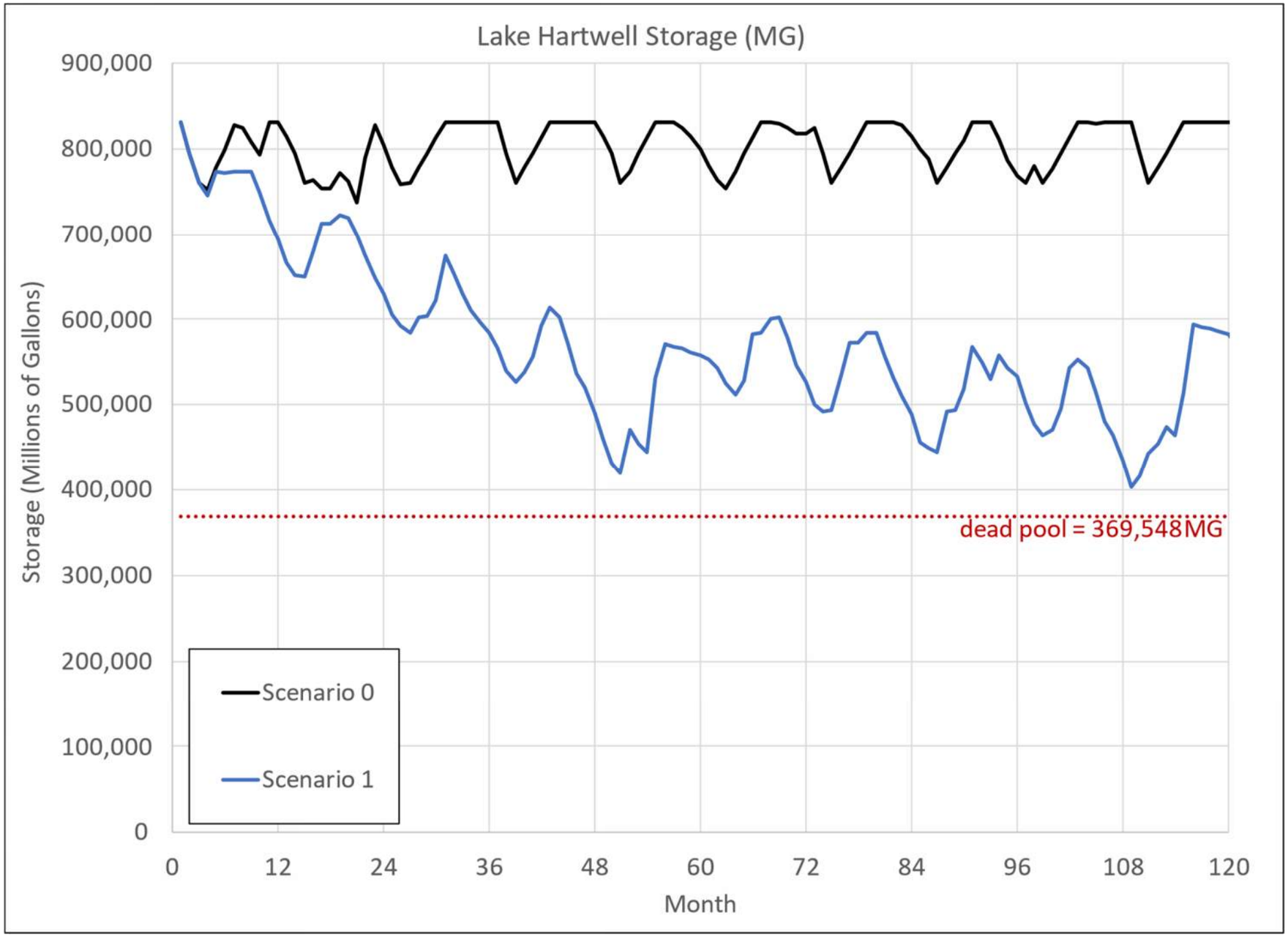
Water User	Average Demand (MGD)	Maximum Monthly Shortage (MGD)	Frequency of Shortage
GA: Thurmond Use	6.6	7.5	88%
WS: McCormick	1.9	2.2	88%
GC: Savannah Lakes	0.2	0.6	88%
GC: Hickory Knob	0.1	0.3	88%

Scenario 3 Shortages

Resequencing Historical Flows to Investigate Potential Future Droughts



Resequencing Historical Flows to Investigate Potential Future Droughts



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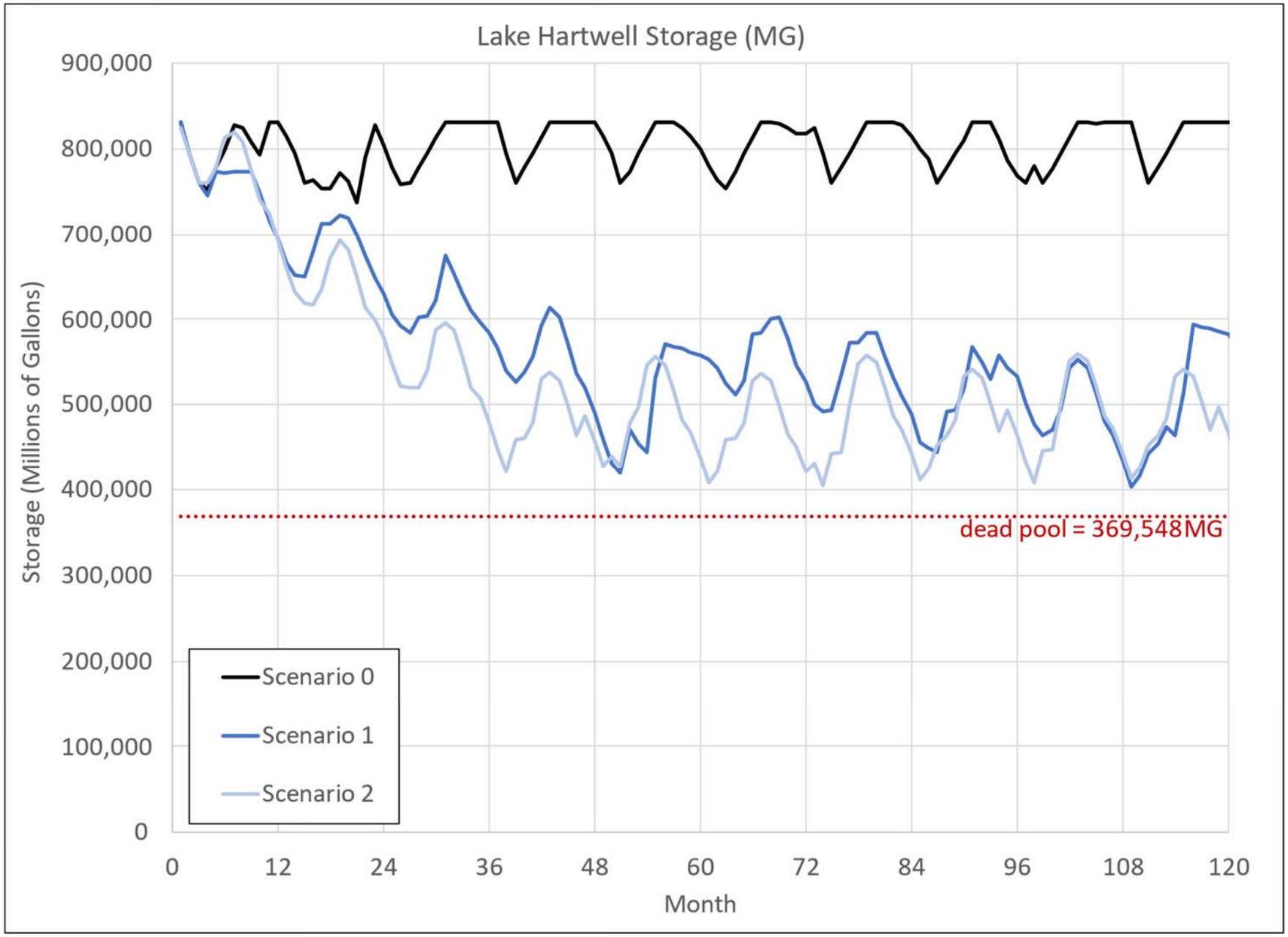

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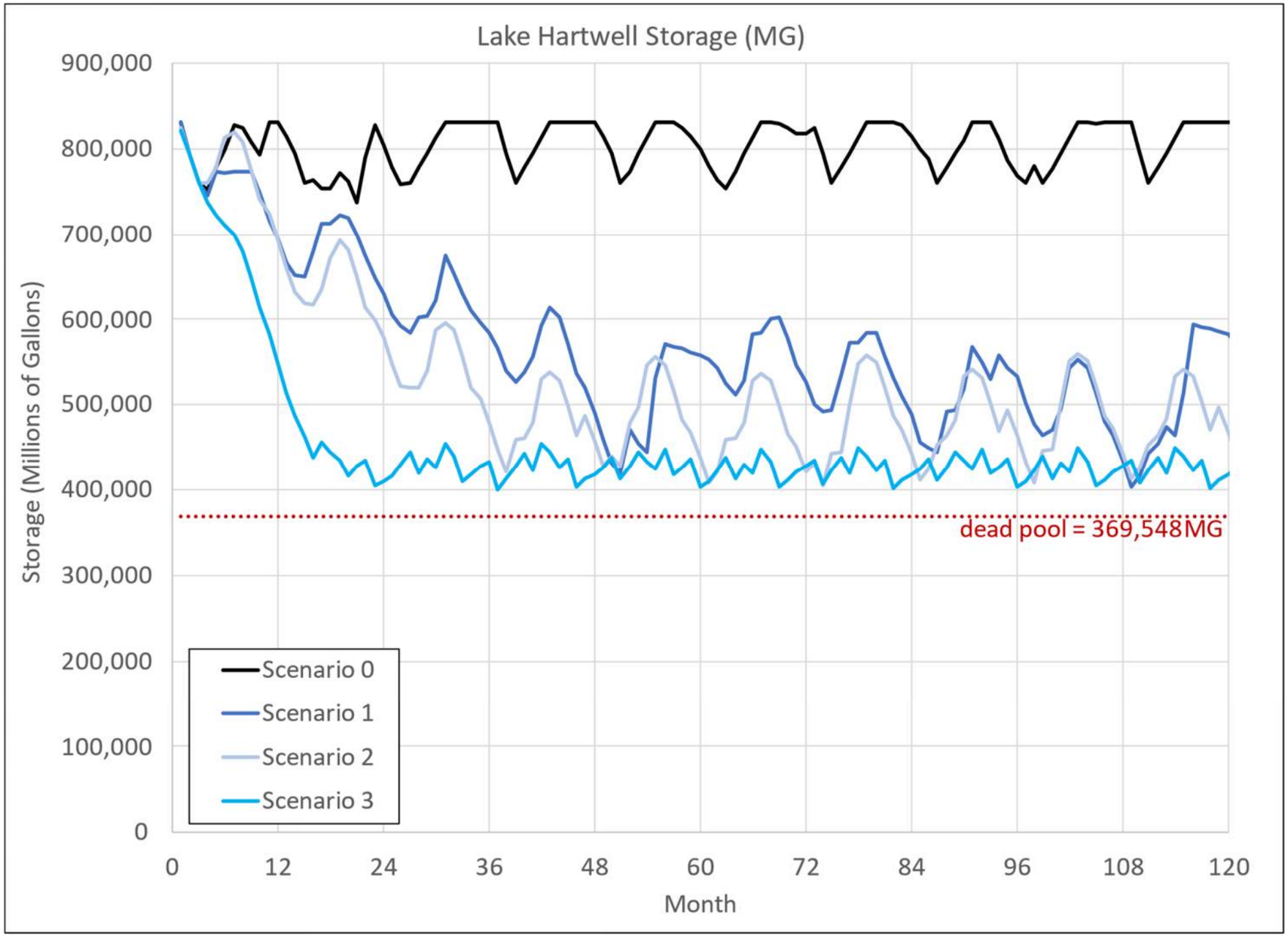

Resequencing Historical Flows to Investigate Potential Future Droughts

Results

Upper Savannah Basin	Scen 0	Scen 1	Scen 2	Scen 3
total basin annual mean shortage (MGD)	0.12	1.2	4.1	8.5
total basin annual mean shortage (%)[1]	0.05%	0.5%	1.8%	3.7%
percentage of water users experiencing shortage	7.5%	15.0%	15.0%	15.0%
average frequency of shortage (%)[2]	0.4%	2.0%	5.5%	10.5%

[1] = as a percentage of total water demand; [2] = for those experiencing shortages

Scenario 0, Baseline Hydrology

Scenario 1, 5-Year Repeating Sequence

Scenario 2, Single Year (2008) Repeating Sequence

Scenario 3, 12 Driest Calendar Months Repeating Sequence

Water Users with Shortages:
GA-side Lake Thurmond users
McCormick
Savannah Lakes Golf Club
Hickory Knob Golf Club
Vulcan
Hanson Aggregates

Resequencing Historical Flows to Investigate Potential Future Droughts

Results

Lower Savannah Basin	Scen 0	Scen 1	Scen 2	Scen 3
total basin annual mean shortage (MGD)	0.01	0.01	0.2	22.2
total basin annual mean shortage (%)[1]	0.0%	0.0%	0.03%	4.4%
percentage of water users experiencing shortage	5.6%	5.6%	5.6%	5.6%
average frequency of shortage (%)[2]	0.03%	0.09%	0.07%	1.2%

[1] = as a percentage of total water demand; [2] = for those experiencing shortages

Scenario 0, Baseline Hydrology

Scenario 1, 5-Year Repeating Sequence

Scenario 2, Single Year (2008) Repeating Sequence

Scenario 3, 12 Driest Calendar Months Repeating Sequence

Water Users with Shortages:
Graniteville
Dominion Urquhart Station

Resequencing Historical Flows to Investigate Potential Future Droughts

Discussion & Limitations

- Reservoir operations play a role, primarily with respect to the *location* of shortages
    - Altered operational rules could, at least partially, mitigate shortages
- No attempts have been made to directly incorporate future hydrologic or climate projections (e.g. increased evap)
- Neglects changes in groundwater-surface water interactions (e.g. reduced baseflow due to aquifer depletions)