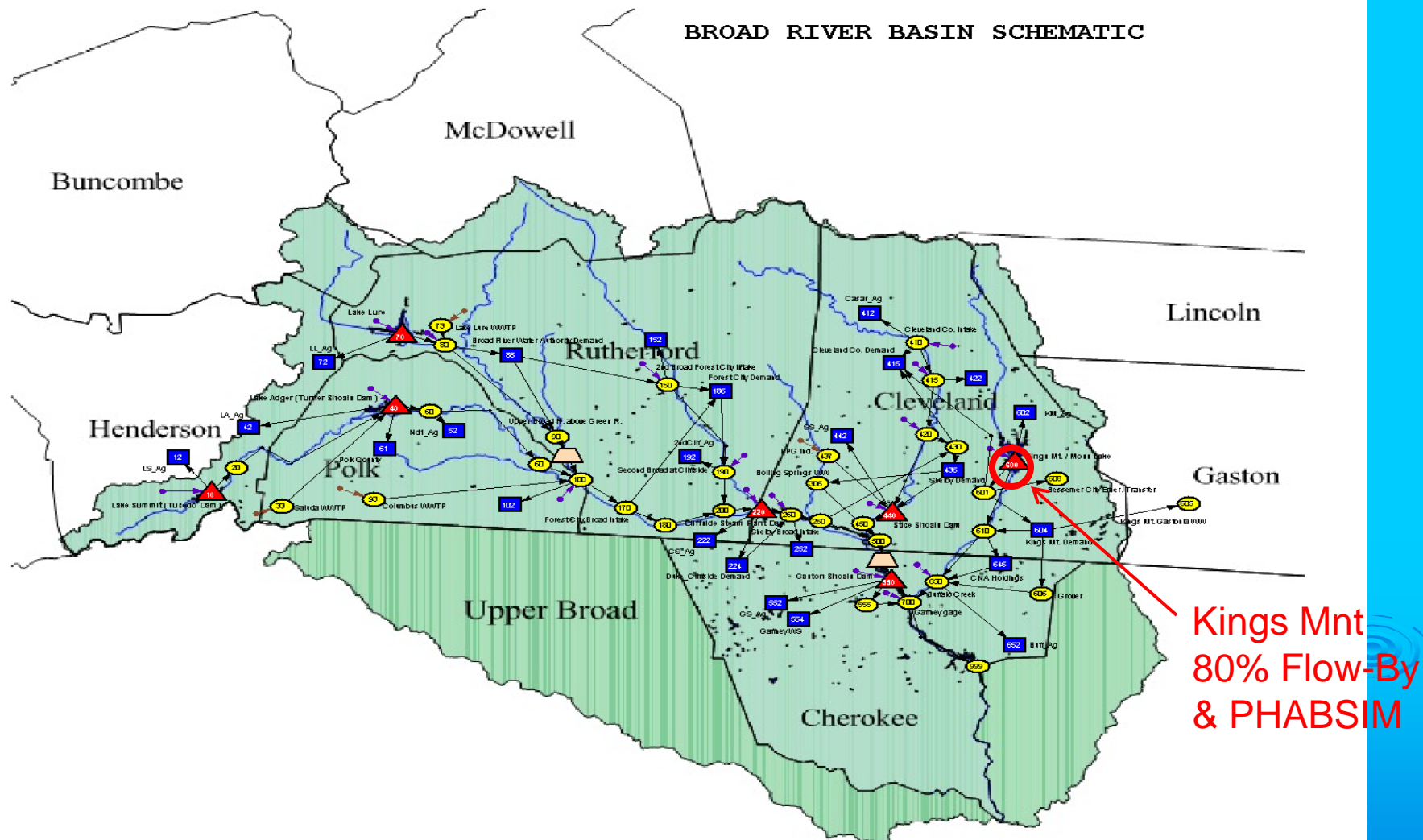# Comparison of Natural vs. Current Conditions (Simbase) PHABSIM & 80% Flow-By

June 18, 2013

Ecological Flow Science Advisory Board

Fred Tarver & Tom Fransen
Division of Water Resources
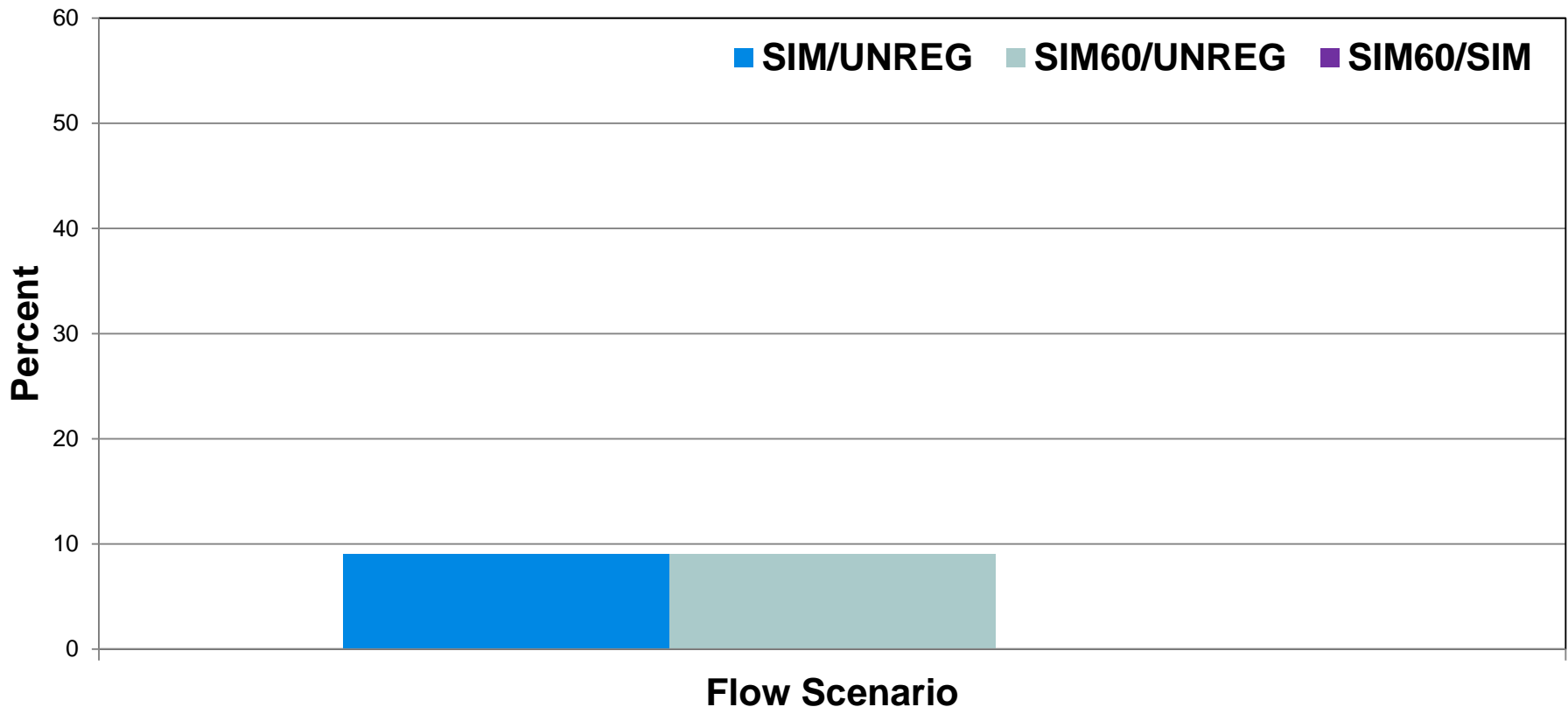**NC Department of Environment and Natural Resources**

Broad River Basin Model

BROAD RIVER BASIN SCHEMATIC

Kings Mnt
80% Flow-By
& PHABSIM

PHABSIM (Shallow)
Arc 600.100 Kings Mnt Reservoir

% of 11 Shallow or Bug (E-P-T) Guilds/Orders with Less Than 80% of Index B Values

Seasonal not shown all values are 0.

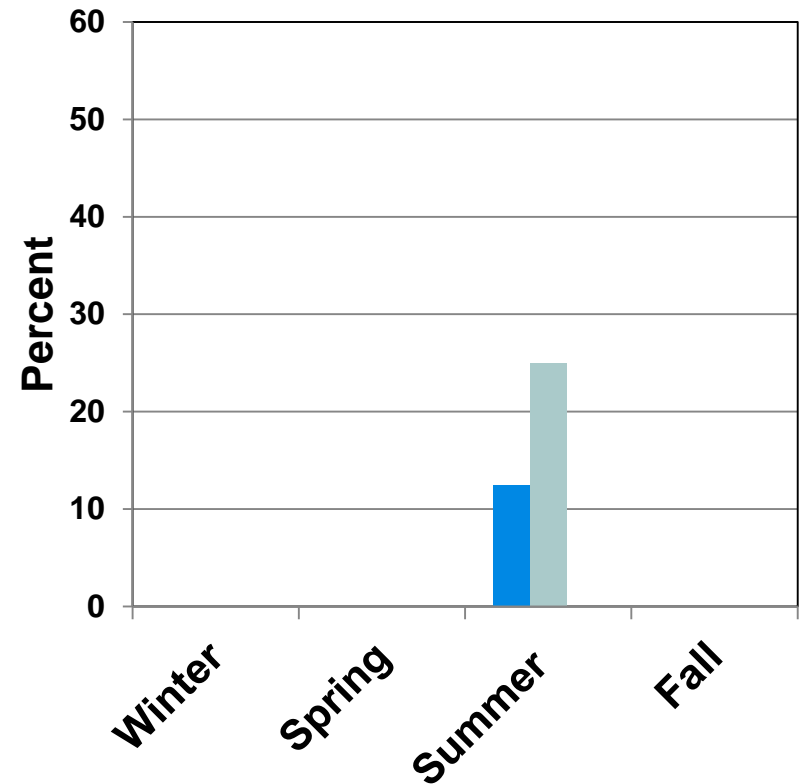# PHABSIM (Deep)
Arc 600.100 Kings Mnt Reservoir

% of 8 Deep & Golden Redhorse Guilds with Less Than 80% of Index B Values

Legend: SIM/UNREG, SIM60/UNREG, SIM60/SIM

Y-axis: Percent (0–60)

X-axis: Flow Scenario
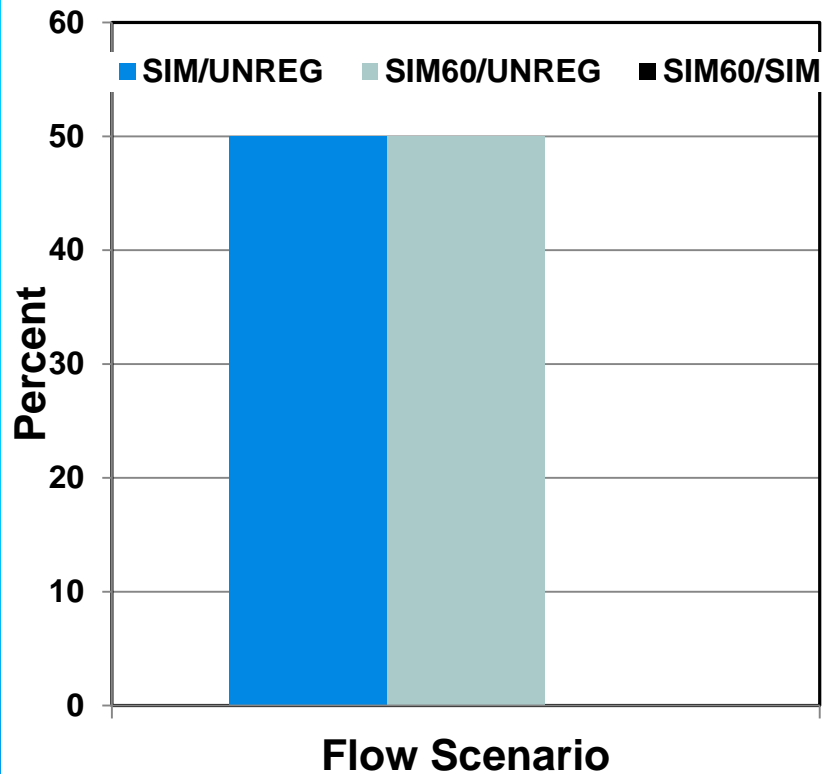
% of 8 Deep & Golden Redhorse Guilds with Less Than 80% of Index B Values By Season

Y-axis: Percent (0–60)

X-axis: Winter, Spring, Summer, Fall
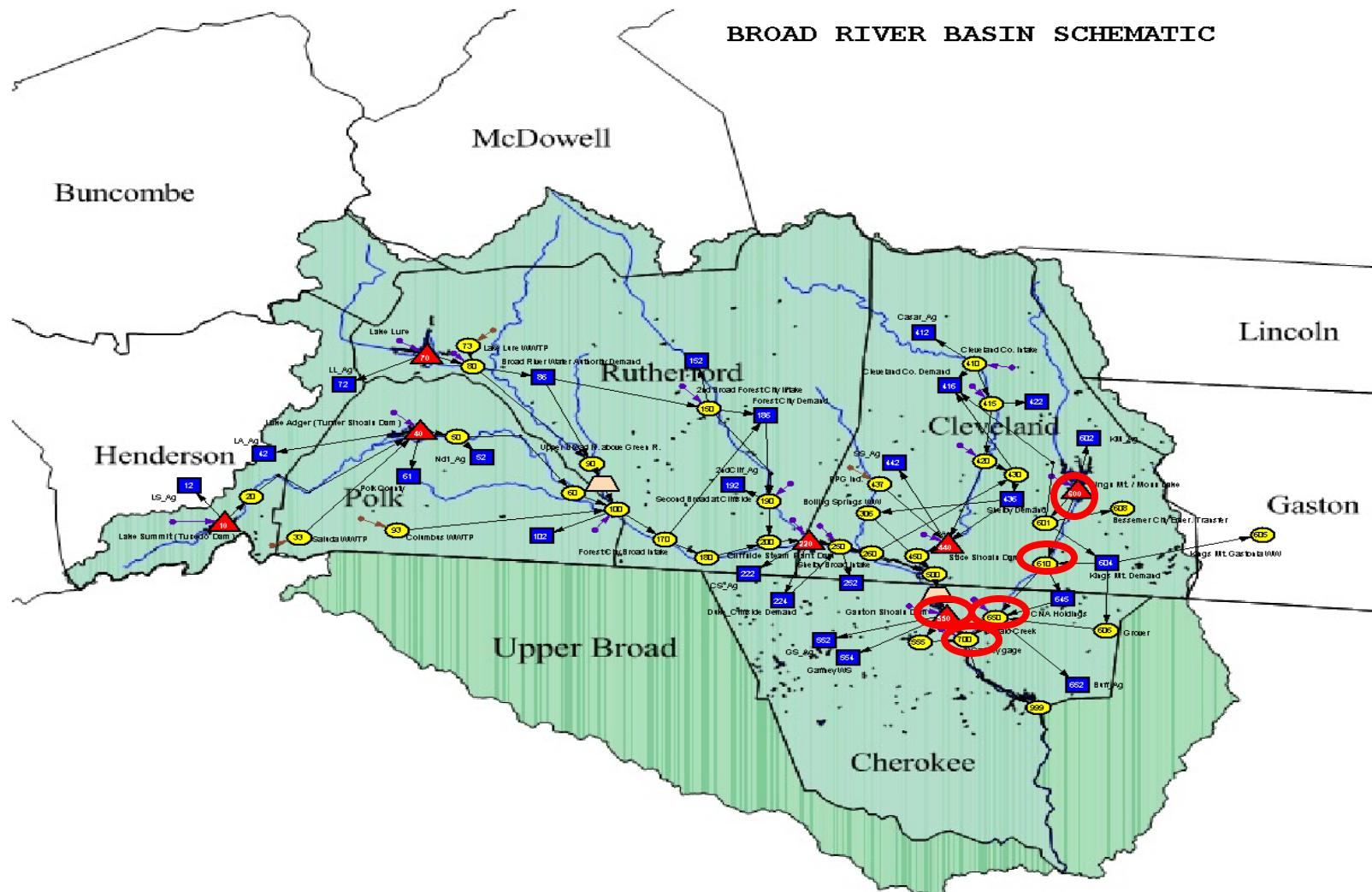
PHABSIM − Model Scenario Details

➢ **Majority of reductions in habitat are associated with "Deep Fast" guilds where half or nearly half of months fall below 80% threshold.**

➢ **"Deep Slow" guilds have 1 or 2 month breaches of 80% threshold.**

➢ **Another Deep species (Golden Redhorse Juvenile), with nearly half of months below threshold, had habitat values <500 by month.**

➢ **The Simbase and 2060 projection include WWTP return flows, which tend to offset dam alterations.**

➢ **Seasonal calculations (Summer) tended to exclude breaches for marginal months when using Index B (mean of habitat events between 10 and 90% exceedence).**

PHABSIM - Comments

➢ **Most of the impacts occurred between Natural and Current Conditions.**

➢ **Little to no addition impacts between Current Conditions and projected 2060 scenario conditions.**

80% Flow-By Comparison

Arc Node	Broad River Basin - Simbase (Current Conditions) Scenario Baseline - Natural Flows		Broad River Basin - 2060 Scenario Baseline - Natural Flows		Broad River Basin - 2060 Scenario Baseline - Simbase (Current Conditions)	
	80% of Flow-By IndexB Approach (10% - 90%)		80% of Flow-By IndexB Approach (10% - 90%)		80% of Flow-By IndexB Approach (10% - 90%)	
	Number of days with potential adverse impacts	Percent of days	Number of days with potential adverse impacts	Percent of days	Number of days with potential adverse impacts	Percent of days
010.020	0	0.000%	0	0.000%	0	0.000%
020.040	0	0.000%	0	0.000%	0	0.000%
040.050	0	0.000%	0	0.000%	0	0.000%
050.060	0	0.000%	0	0.000%	0	0.000%
060.100	0	0.000%	0	0.000%	0	0.000%
070.080	0	0.000%	0	0.000%	0	0.000%
080.090	0	0.000%	0	0.000%	0	0.000%
090.100	0	0.000%	0	0.000%	0	0.000%
100.170	0	0.000%	0	0.000%	0	0.000%
150.190	0	0.000%	0	0.000%	0	0.000%
190.200	0	0.000%	0	0.000%	0	0.000%
170.180	0	0.000%	0	0.000%	0	0.000%
180.200	0	0.000%	0	0.000%	0	0.000%
200.220	0	0.000%	0	0.000%	0	0.000%
220.250	0	0.000%	0	0.000%	0	0.000%
250.260	0	0.000%	0	0.000%	0	0.000%
410.415 Cleveland Intake	*0*	*0.000%*	*0*	*0.000%*	*0*	*0.000%*
415.420	0	0.000%	0	0.000%	0	0.000%
420.440	0	0.000%	**0**	**0.000%**	0	0.000%
440.450	0	0.000%	0	0.000%	0	0.000%
450.500	0	0.000%	0	0.000%	0	0.000%
500.550	0	0.000%	0	0.000%	0	0.000%
550.700	35	0.148%	55	0.233%	2	0.008%
600.610 Kings Mnt Res	*8,044*	*34.118%*	*9,763*	*41.409%*	*282*	*1.241%*
610.650	4,807	20.389%	4,845	20.550%	154	0.656%
650.700	178	0.755%	192	0.814%	43	0.182%
700.999	22	0.093%	32	0.136%	0	0.000%

Nodes Potential Impact

BROAD RIVER BASIN SCHEMATIC

Broad River Basin - Simbase (Current Conditions) Scenario
Baseline - Natural Flows
Kings Mountain Reservoir (600.610)
Full Hydrograph

	Natural Flows	80% Natural Flows	Simbase
0.500%	1.97	1.58	12.00
1.000%	4.45	3.56	12.00
2.000%	8.15	6.52	12.00
5.000%	14.67	11.74	12.00
10.000%	21.36	17.09	12.00
15.000%	26.15	20.92	14.79
20.000%	30.16	24.13	20.25
25.000%	34.07	27.26	25.03
30.000%	37.96	30.37	29.26
35.000%	41.30	33.04	33.70
40.000%	45.49	36.40	38.26
45.000%	49.67	39.74	42.85
50.000%	54.57	43.66	48.26
55.000%	59.47	47.58	53.81
60.000%	64.62	51.70	60.19
65.000%	71.17	56.94	67.07
70.000%	77.99	62.39	74.76
75.000%	86.16	68.92	83.96
80.000%	96.69	77.36	96.45
85.000%	113.17	90.54	115.94
90.000%	141.36	113.09	148.30
95.000%	217.60	174.08	234.08
98.000%	419.13	335.30	461.28
99.000%	657.43	525.94	710.88
99.500%	966.98	773.59	1,035.70
99.997%	4,242.06	3,393.65	4,448.70

Broad River Basin - Simbase (Current Conditions) Scenario
Baseline - Natural Flows
Kings Mountain Reservoir (600.610)
IndexB Approach (10% - 90%)

Month/Period	Number of Days Flows < 80%	% of Days Flows < 80%	Average Deficit, cfs	Average Deficit, % Diff
1	96	4.647%	0.26	0.804%
2	109	5.867%	0.24	0.754%
3	106	5.389%	0.34	0.813%
4	506	23.947%	0.77	1.836%
5	1,015	45.011%	1.58	4.646%
6	1,176	58.247%	2.49	7.148%
7	1,189	61.992%	3.31	9.986%
8	1,184	66.071%	3.48	10.699%
9	1,121	67.612%	2.73	9.119%
10	948	52.872%	1.69	5.905%
11	472	23.529%	0.87	2.638%
12	122	5.722%	0.37	1.013%
Spring (4-6)	2,697	42.226%	1.60	4.507%
Summer (7-9)	3,494	65.089%	3.19	9.956%
Fall (10-11)	1,420	37.378%	1.26	4.180%
Winter (12-3)	433	5.397%	0.33	0.902%
P-O-R	8,044	34.118%	1.46	4.450%

80% Flow-By - Comments

➢ **Most of the impacts occurred between Natural and Current Conditions.**

➢ **Measures small addition impacts between Current Conditions and projected 2060 scenario conditions.**

➢ **IndexB approach 85% (22 out of 27) no potential impact.**

Questions

Disclaimer

- ➢ **DWR is not assuming that the "80% Flow-By" approach will be the SAB's final recommendation.**

- ➢ **Goal of analysis is to test a potential ecologic integrity planning criteria.**

- ➢ **The purpose of this presentation is to provide an example of "one" approach that could be used to implement a Flow-By approach.**

How is 20% 7Q10 used?

- ➤ **20% 7Q10 is a SEPA minimum criteria for additional study.**
  - • **If the maximum instantaneous with is less than 20% 7Q10 then no additional analysis is needed.**
- ➤ **20% 7Q10 has frequency been misapplied as the safe yield.**

Implementation Problem With 20% 7Q10

➤ **Best application is a single isolated run-of-river withdrawal.**

➤ **Does not work for withdrawals from reservoirs.**

➤ **How to apply to multiple near by withdrawals?**

➤ **Does not provide a metric to assess the accumulative upstream impacts.**

  ● **Only applies to run-of-river nodes with a withdrawal.**

Trial Implementation of 80% Flow-By

➢ **Need an approach that will work for single, multiple near-by, and reservoir withdrawals.**

➢ **Needs to be able to assess the accumulative upstream impacts at all flow nodes, work at nodes with or without withdrawals.**

Starting Point

➢ **SL 2010-143 Definitions**

- "**Ecological integrity**" means the ability of an aquatic system to support and maintain a balanced, integrated, adaptive community of organisms having a species composition, diversity, and functional organization **comparable to prevailing ecological conditions** and, when subject to disruption, to recover and continue to provide the natural goods and services that normally accrue from the system.

- "**Prevailing ecological conditions**" means the ecological conditions determined by reference to the applicable period of record of the United States Geological Survey stream gauge data, **including data reflecting the ecological conditions that exist after the construction and operation of existing flow modification devices, such as dams**, but excluding data collected when stream flow is temporarily affected by in-stream construction activity.

➢ **Analysis Assumption**

- Assume the **SIMBASE** modeling scenario represents "Prevailing ecological conditions". SIMBASE is the model scenario that represents current conditions, withdrawals, discharges, reservoir operations, drought plans, etc.

80% Flow-By Analysis Approach

> **Create an 80% BASELINE using SIMBASE and compare scenarios to the baseline. When a scenario flow is below the BASELINE, that represents a potential adverse ecological impact.**

> **Analysis steps:**

1. For each day (29,493 days)
   BASELINE = 80% * SIMBASE (outflow from the arc)

2. Compare each day (29,493 days)
   IF scenario < BASELINE then that days is a potential adverse ecological impact day.

3. Looking for guidance on how to assess if a node is adversely impacted based on number of days, time of year, etc.

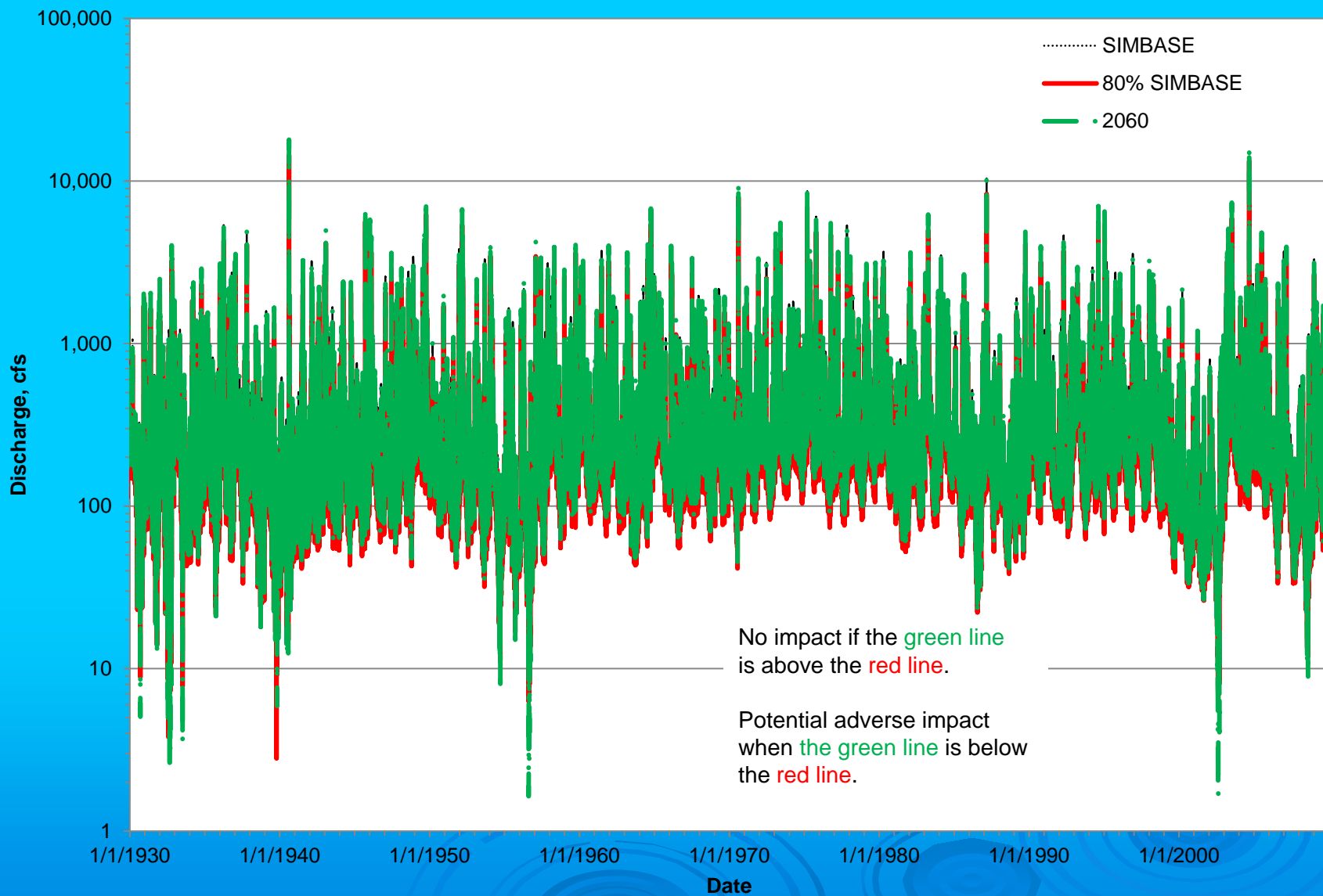# 80% Flow-By Example

Cleveland County Intake
2060 Scenario
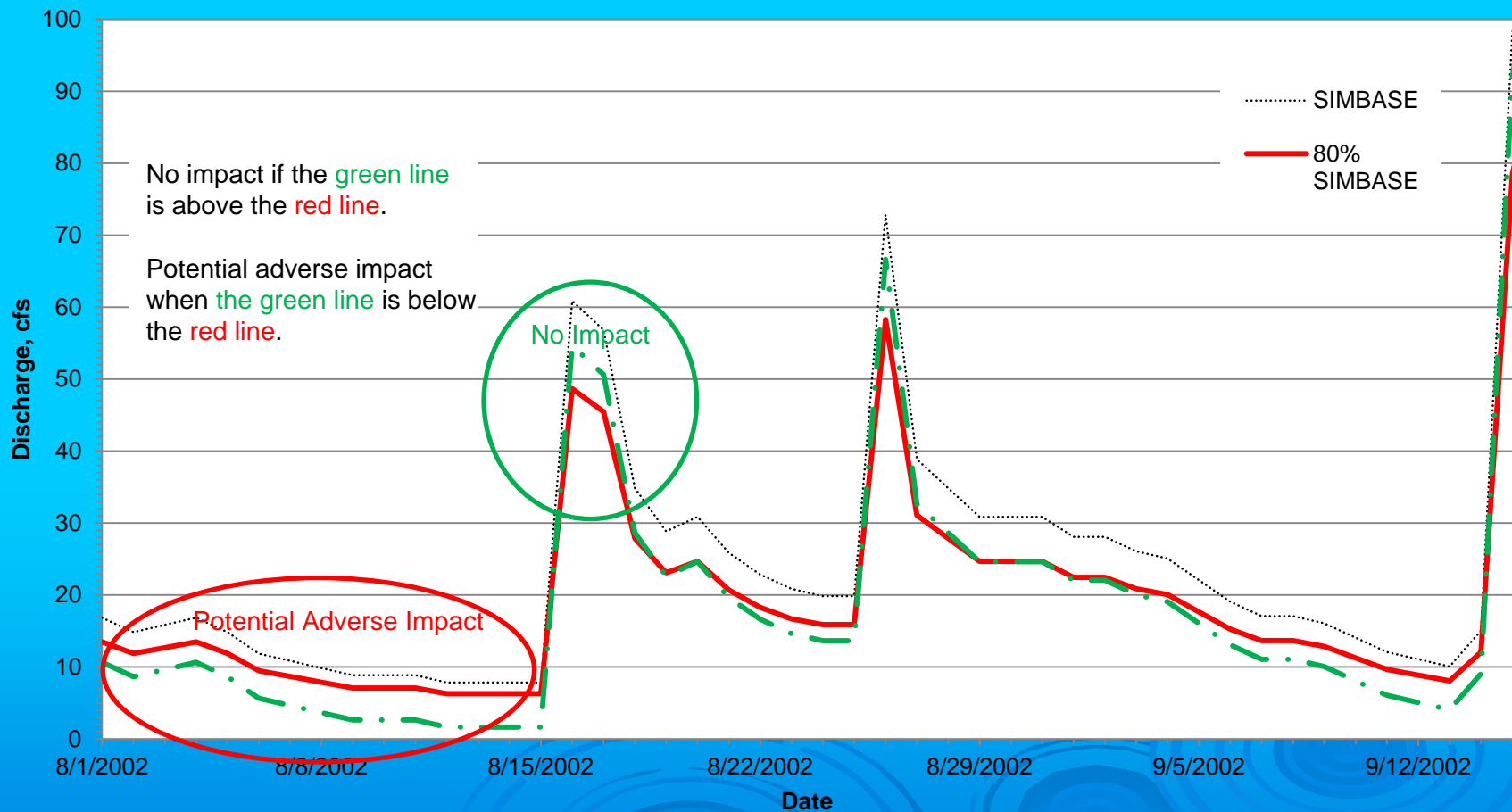
Trial Balloon

➢ **Broad River Basin**

- **Only certified model**

- **One of the smaller and simpler basins.**

- **Has a mix of withdrawals both run-of-river and reservoir.**

- **Analyzed 27 river nodes, this include the reservoir release nodes with a modeling record of 1/1/1930 to 12/31/2009.**
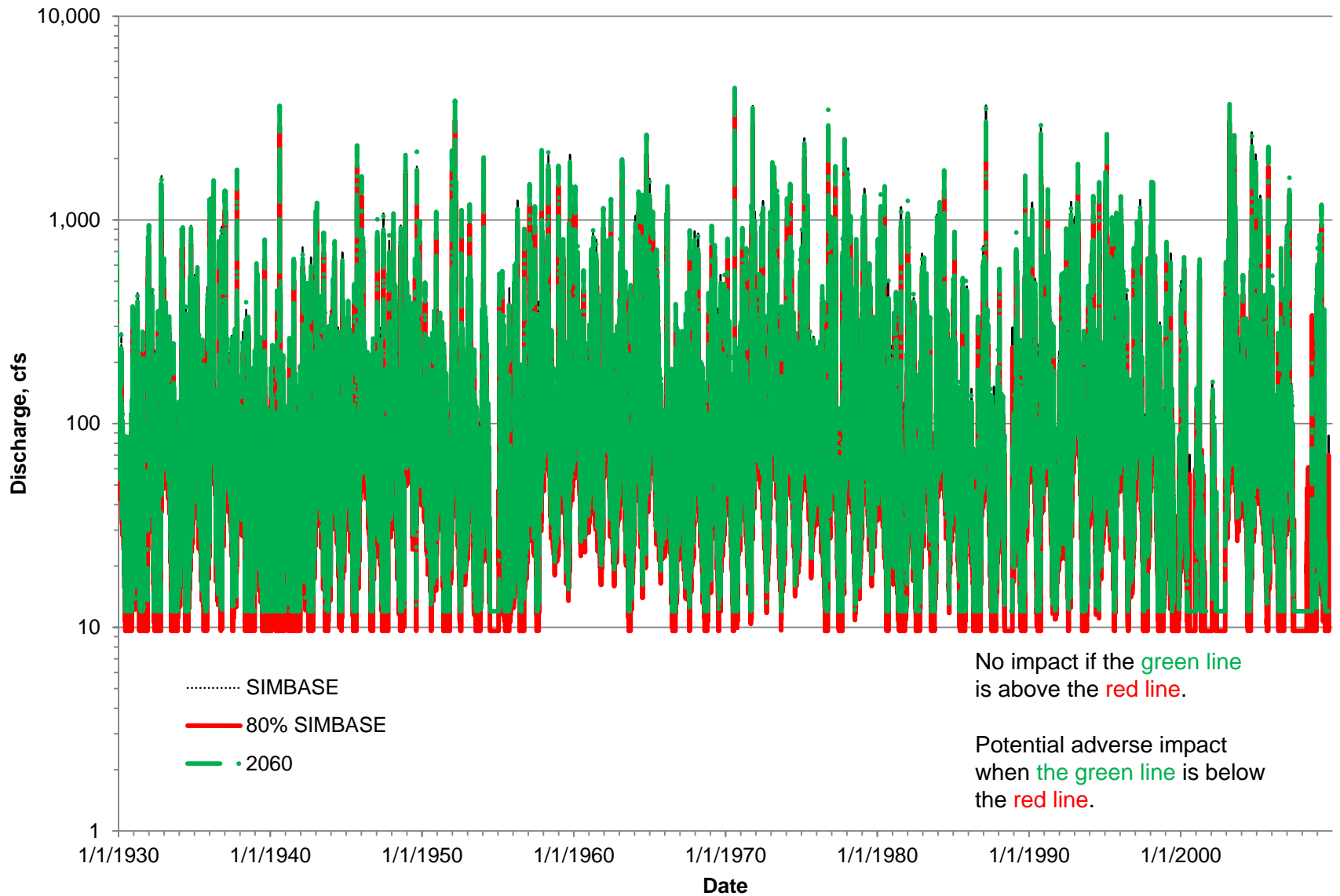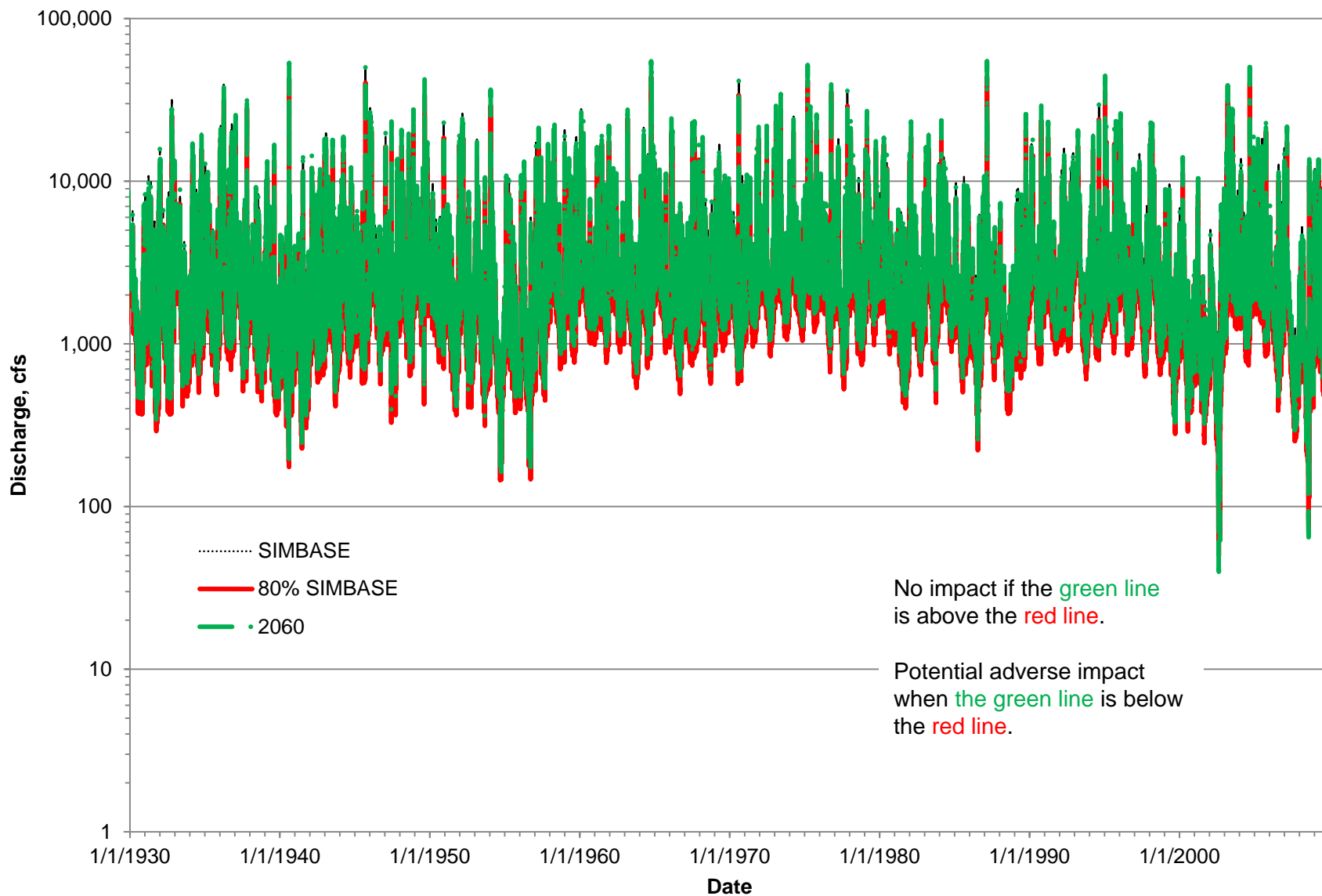
Broad River Basin Model
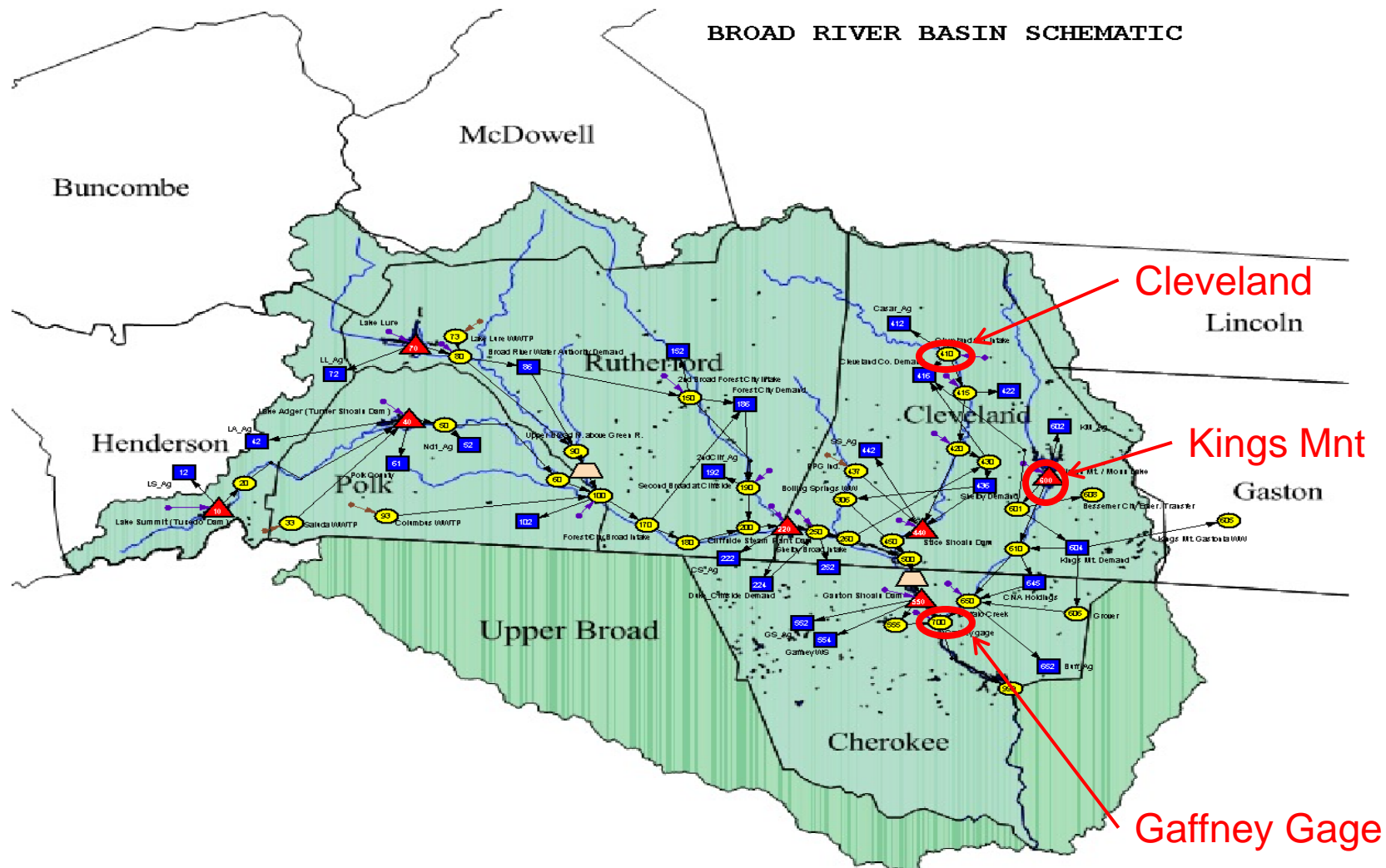
Cleveland County Intake
2060 Scenario

**Kings Mnt Reservoir Release
2060 Scenario**

No impact if the green line is above the red line.

Potential adverse impact when the green line is below the red line.

Legend:
- SIMBASE
- 80% SIMBASE
- 2060

Gaffney Gage
2060 Scenario

SIMBASE

80% SIMBASE

2060

No impact if the green line
is above the red line.

Potential adverse impact
when the green line is below
the red line.

Broad River Basin - 2060 Scenario Node Summary

| Arc Node	Description of the Node	80% of Flow-By	
		Number of days with potential adverse impacts	Percent of days
010.020	Lake Summit Release	0	0.00%
020.040	Green River to Lake Adger	0	0.00%
040.050	Lake Adger Release	168	0.57%
050.060	Green River to Ken Miller	168	0.57%
060.100	Green River to Broad Confluence	168	0.57%
070.080	Lake Lure Release	0	0.00%
080.090	Upper Broad	30	0.10%
090.100	Upper Broad to Broad Confluence	24	0.08%
100.170	Broad River to Forest City Intake	4	0.01%
150.190	2nd Broad	18	0.06%
190.200	2nd Broad Cliffside	0	0.00%
170.180	Forest City Intake (2nd Broad)	4	0.01%
180.200	Upper Cliffside	4	0.01%
200.220	2nd Broad Confluence	0	0.00%
220.250	Cliffside Dam Release	25	0.08%
250.260	Boiling Spring Gage	4	0.01%
410.415	Cleveland Intake	159	0.54%
415.420	Lawndale Gage	116	0.39%
420.440	Shelby Intake (1st Broad)	131	0.44%
440.450	Gaston Shoals Dam Release	0	0.00%
450.500	First Broad Confluence	0	0.00%
500.550	Lower Broad	4	0.01%
550.700	Gaston Shoals Dam Release	104	0.35%
600.610	Kings Mountain Reservoir Release	290	0.98%
610.650	Kings Mountain WTP Discharge	163	0.55%
650.700	Buffalo Creek Confluence	50	0.17%
700.999	Gaffney Gage	26	0.09%

74% of the nodes (20 out 27) with 1 or more days with potential impacts.
Potential impacts occur less than 1% of the time.
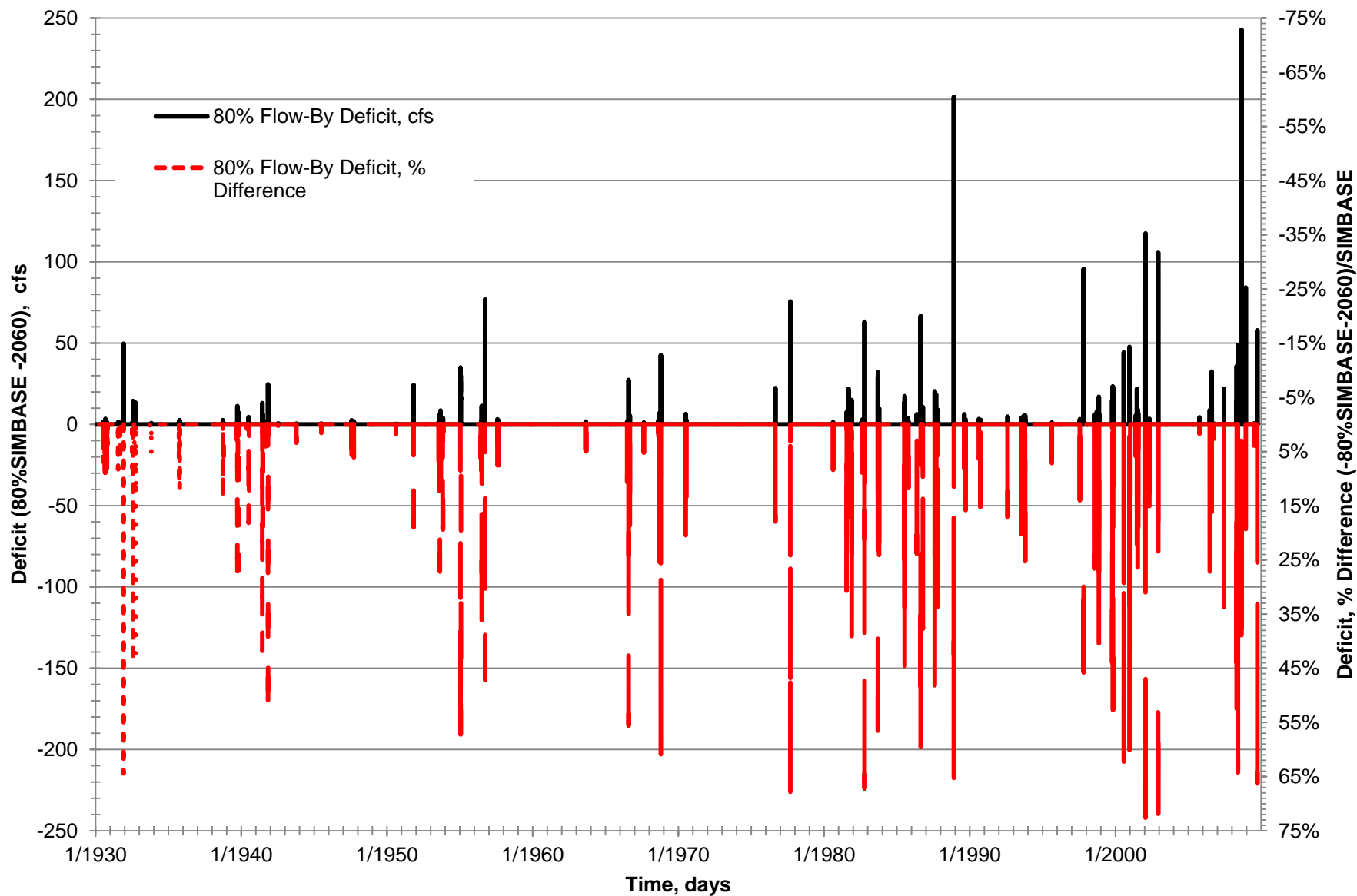
Broad River Basin - 2060 Scenario
80% of Flow-By Summary

| Arc Node	Description of the Node	Days Potential Impact		Difference (2060-80%SIMBASE), cfs			
		Number of days	Percent of days	Minimum	Average	Median	Maximum
410.415	Cleveland Intake	159	0.54%	0.00	0.01	0.00	4.64
600.610	Kings Mountain Reservoir Release	290	0.98%	0	0.11	0	242.83
700.999	Gaffney Gage	26	0.09%	0.00	0.01	0.00	32.61
	Average of the 27 Nodes	61	0.21%				
				Difference (2060-80%SIMBASE), cfs			
				Minimum	Average	Median	Maximum
410.415	Cleveland Intake			0.00%	0.08%	0.00%	80.00%
600.610	Kings Mountain Reservoir Release			0.00%	0.20%	0.00%	72.59%
700.999	Gaffney Gage			0.00%	0.01%	0.00%	16.46%

Cleveland County Intake- 2060
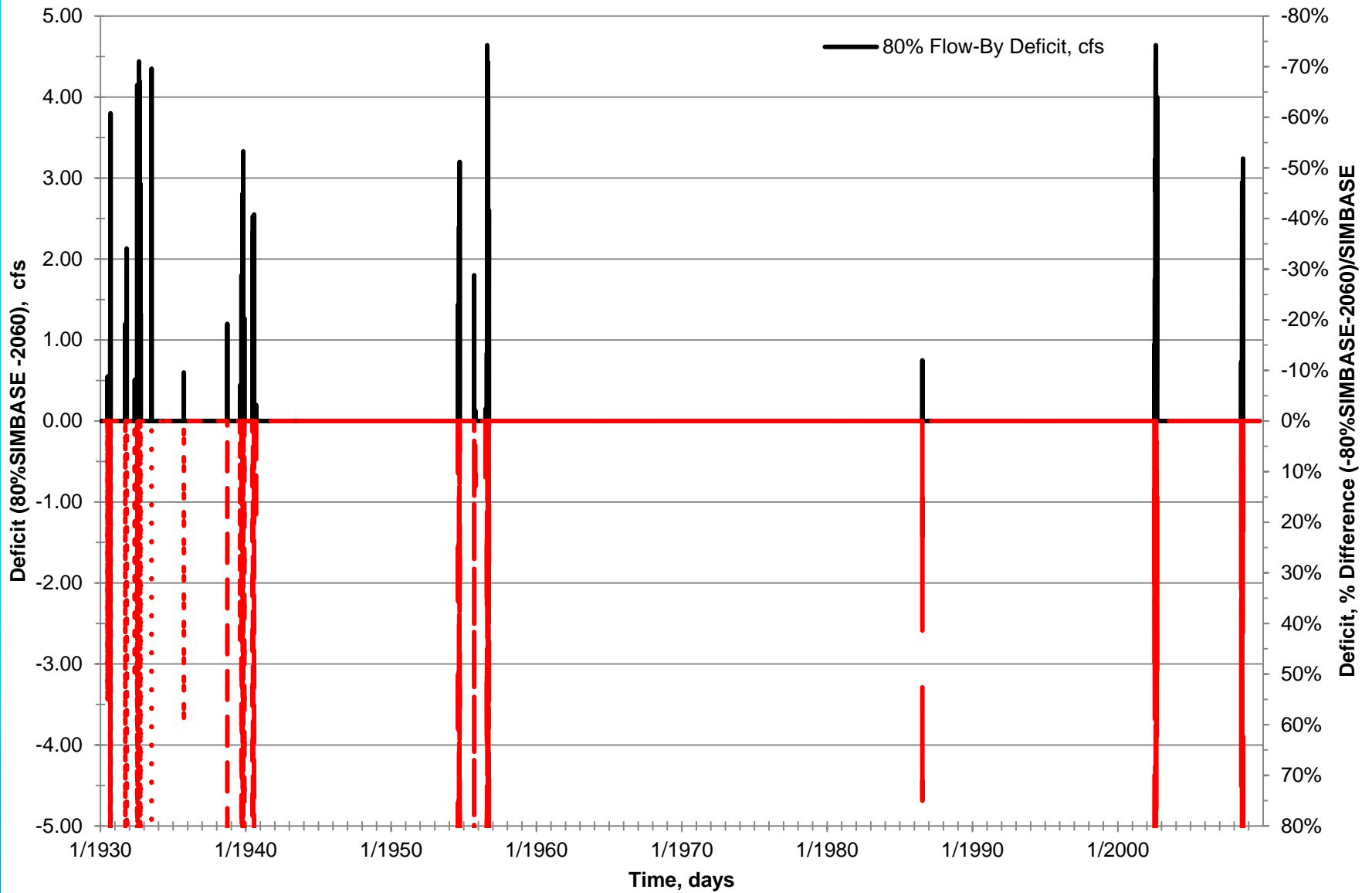
Kings Mnt Reservoir Release - 2060

Gaffney Gage - 2060
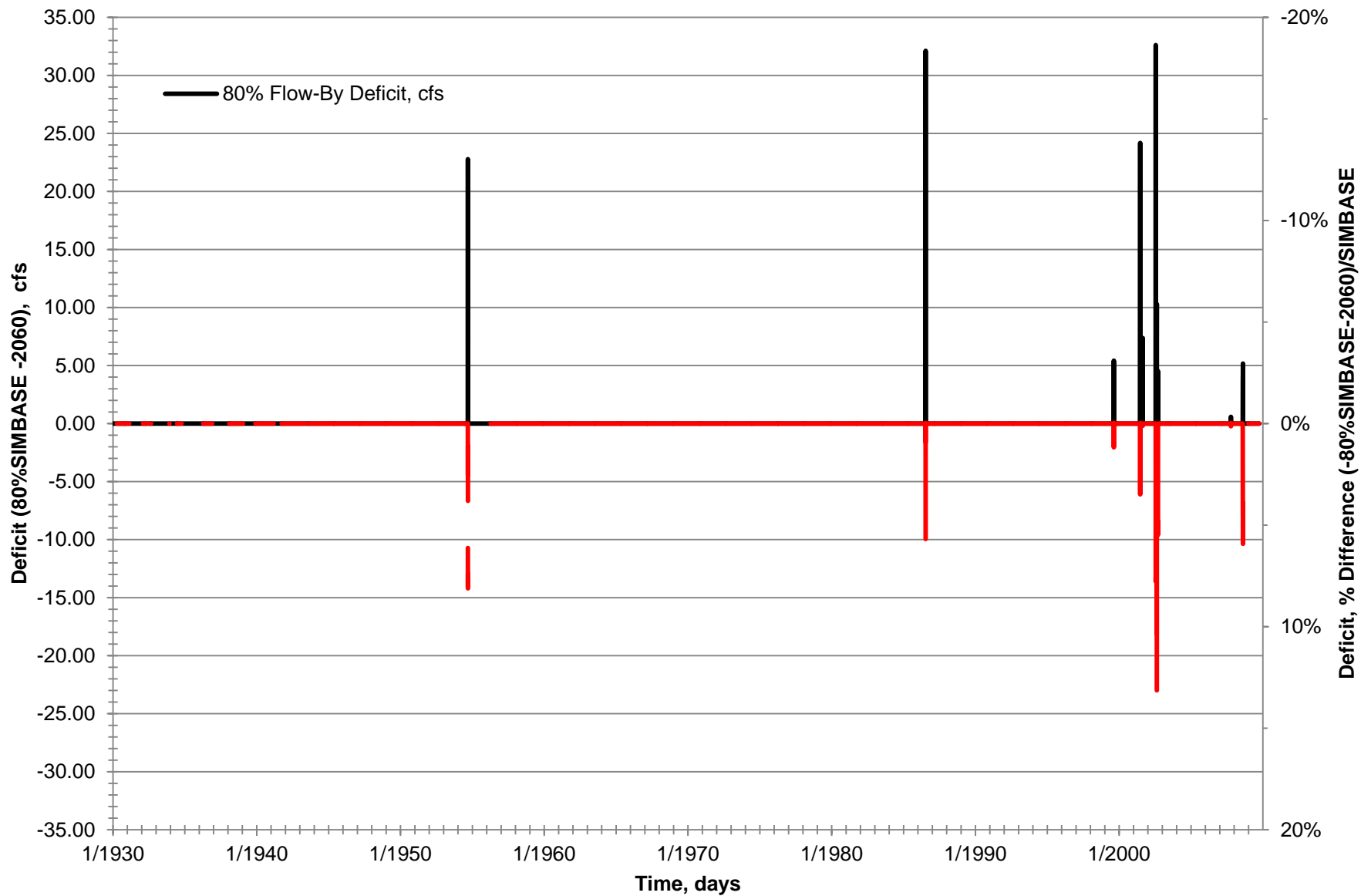
Broad River Basin - 2060 Scenario - 80% of Flow-By Frequency Analysis

Non-Exceedence	Cleveland Intake cfs		Kings Mountain Reservoir Release cfs		Gaffney Gage cfs	
Percent	80%SIMBASE	2060	80%SIMBASE	2060	80%SIMBASE	2060
0.003%	2.81	0.00	9.60	12.00	50.05	39.76
0.500%	23.80	23.44	9.60	12.00	278.08	323.90
1.000%	30.46	32.06	9.60	12.00	364.80	442.81
2.000%	38.46	42.13	9.60	12.00	396.62	485.32
5.000%	50.28	56.89	9.60	12.00	561.44	682.26
10.000%	66.46	77.13	9.60	12.00	720.60	876.10
15.000%	78.07	91.89	11.84	12.14	831.03	1,015.71
20.000%	87.00	102.98	16.20	18.27	933.17	1,144.17
25.000%	94.86	112.89	20.02	23.12	1,025.51	1,259.31
30.000%	103.01	123.14	23.41	27.49	1,115.89	1,373.37
35.000%	112.13	134.44	26.96	32.15	1,207.28	1,487.16
40.000%	121.40	146.09	30.60	36.56	1,292.03	1,593.01
45.000%	130.48	157.30	34.28	41.23	1,385.76	1,709.70
50.000%	140.08	169.34	38.61	46.72	1,487.14	1,837.53
55.000%	150.48	182.30	43.05	52.22	1,598.96	1,977.31
60.000%	162.19	197.09	48.16	58.59	1,719.80	2,128.53
65.000%	174.99	213.09	53.65	65.52	1,843.28	2,283.46
70.000%	190.48	232.28	59.81	73.28	1,996.54	2,474.56
75.000%	209.73	256.98	67.17	82.35	2,183.80	2,707.04
80.000%	235.79	289.23	77.16	94.89	2,432.98	3,019.67
85.000%	272.83	335.27	92.75	114.22	2,790.52	3,466.91
90.000%	334.48	412.28	118.64	146.41	3,393.62	4,220.36
95.000%	497.03	615.52	187.26	231.59	4,886.97	6,088.46
98.000%	868.27	1,080.09	369.03	458.72	7,920.52	9,881.02
99.000%	1,339.84	1,669.31	568.70	709.43	11,190.51	13,968.40
99.500%	1,938.71	2,417.33	828.56	1,034.32	14,958.05	18,676.93
99.997%	14,402.30	17,996.62	3,558.96	4,446.98	43,746.91	54,661.96

Red cells are 2060 flows a potential adverse impact.

We Need Help With -

➢ **How do we implement your recommendation?**

- **If a flow-by approach is used, is the analysis on the right path?**

- **Is SIMBASE the correct starting point?**

- **Do all flows need to be ≥ 80% of SIMBASE?**

- **Are certain times of the year or specific flow ranges of more importance?**

- **?**

Questions

80% flow-by is a trial balloon DWR is open willing to consider all recommendations from the SAB, including variations on the 80% theme.

Contact Information

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