Additional simulations with the Lake Greenwood model:
Impact of altered phosphorus loads from the Saluda River

Barbara Taylor, Jim Bulak, and Hank McKellar
Freshwater Fisheries Research Laboratory
South Carolina Department of Natural Resources

FINAL REPORT

11 June 2009

McKellar et al. (2008) used the Lake Greenwood model to examine the impact of altering phosphorus loads from the Reedy River only and from the Saluda and Reedy Rivers together, but not from the Saluda River only. We ran additional simulations to examine the effect of altering loads in the Saluda River only, using the loads for the Saluda River from Tab. 5 of McKellar et al. (2008). We altered sediment oxygen demand for model segments in Saluda Arm and the main channel accordingly (McKellar et al., 2008, p. 25).

In the model, input from the Saluda River has a negligible effect on the Reedy Arm. Similarly, input from the Reedy River has a negligible effect on the Saluda Arm. Results for the Saluda Arm in scenarios with loads altered in the Saluda River only are essentially the same as results for scenarios with loads altered in both rivers, as reported in McKellar et al. (2008).

Effects of the two sources combine in the main lake, below the confluence of the two arms. We use Station HW72, in the upper portion of the main lake, to illustrate these effects.

At Station HW72, the mean total phosphorus concentration shows a linear response to the annual load, regardless of the source (Figure A1). Thus, for example, a 10 metric ton reduction in load from the Saluda River would have essentially the same effect in the main lake as a 10 metric ton reduction in load from the Reedy River. The growing season mean chlorophyll a concentration also shows a linear response to the annual load (Figure A1), but the response to loads from the Reedy River is slightly stronger than the response to loads from the Saluda River

Hypoxia and tolerable habitat for striped bass also respond mainly to the combined load, regardless of source (Table A1). The responses are not quite linear, reflecting the influence of the square root function used to set sediment oxygen demand (Fig. 16, McKellar et al., 2008). The response to loads in the Reedy River is slightly stronger than the response to loads from the Saluda.

Literature cited:

McKellar, H., J. Bulak, and B. Taylor. 2008. A Dynamic Water Quality Model of Lake Greenwood, SC: Development and Application toward Issues of Phosphorus Loading, Algal Dynamics, and Oxygen Depletion. Final report. South Carolina Department of Natural Resources, Freshwater Fisheries Research Laboratory, Eastover, South Carolina 29044.

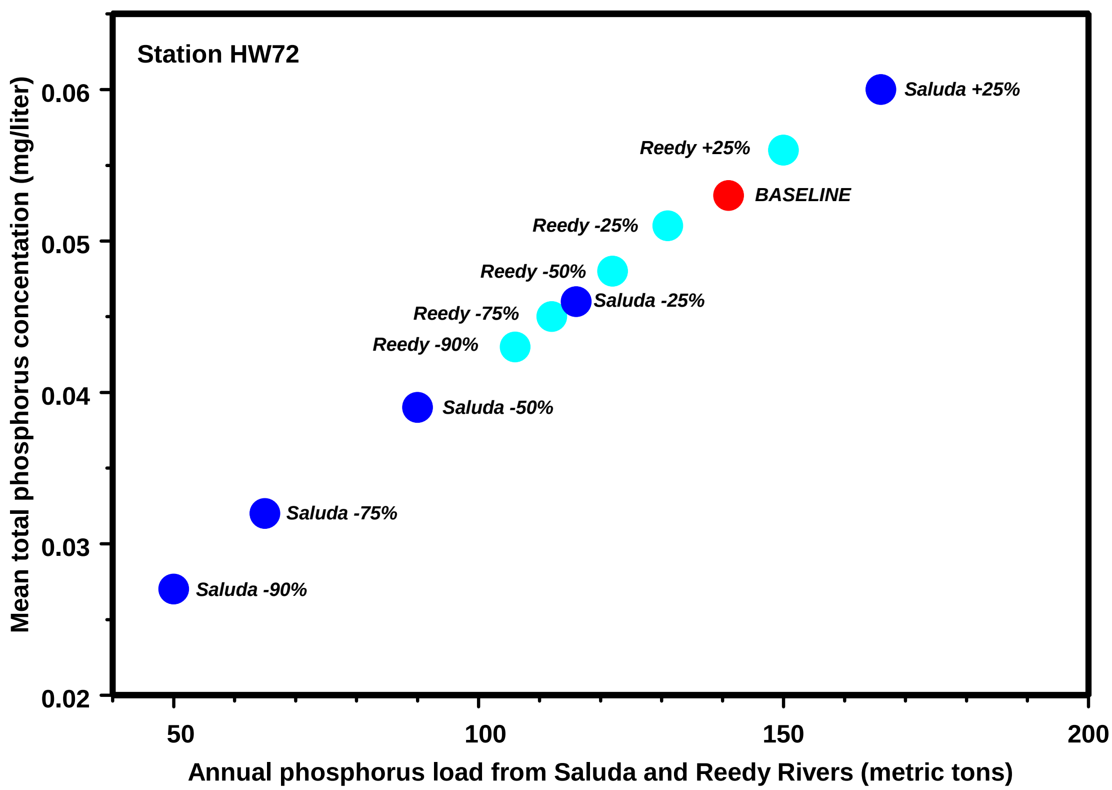

Figure A1. Responses of mean total phosphorus concentration to altered phosphorus loads from the Saluda and Reedy Rivers. Results are shown from the baseline scenario and from scenarios with altered loads in the Saluda River only or the Reedy River only (labeled as Saluda or Reedy, followed by %). Results for baseline and Reedy River load alterations were taken from Tab. 6 of McKellar et al. (2008).

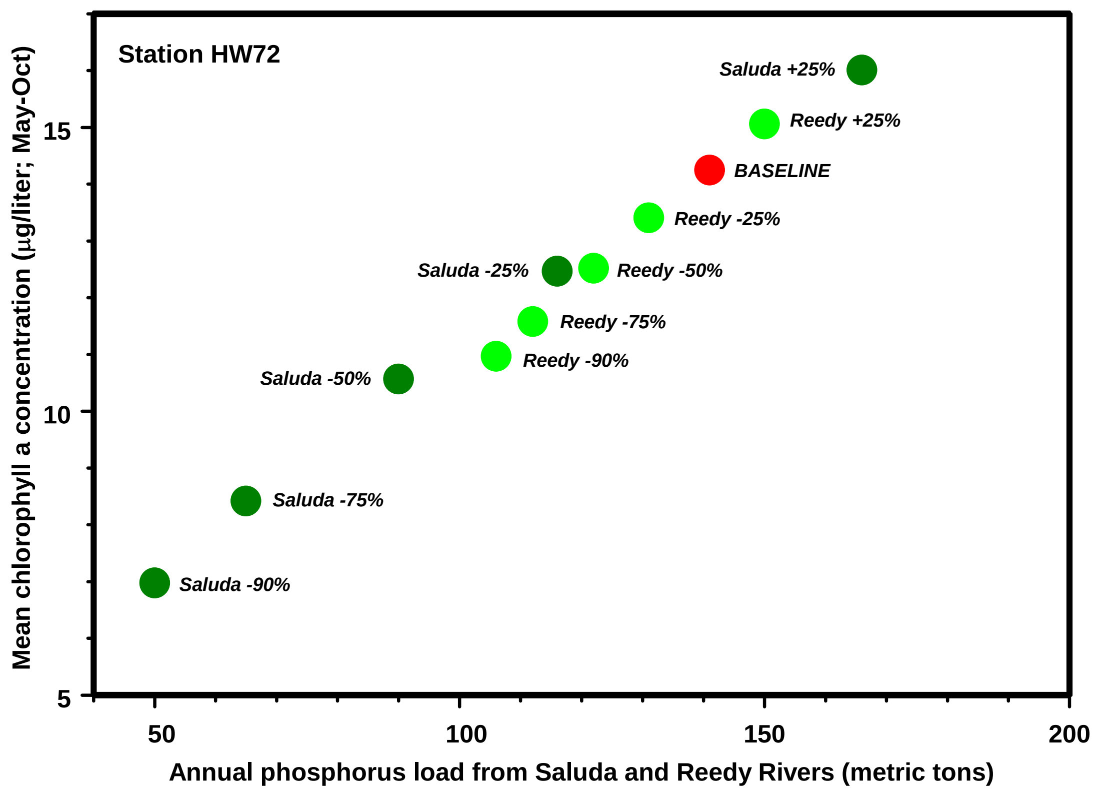

Figure A2. Responses of mean growing season chlorophyll a concentration to altered phosphorus loads from the Saluda and Reedy Rivers. Results are shown from the baseline scenario and from scenarios with altered loads in the Saluda River only or the Reedy River only (labeled as Saluda or Reedy, followed by %). Growing season was defined as May through October. Results for baseline and Reedy River load alterations were taken from Tab. 7 of McKellar et al. (2008).

Table A1. Extent of extreme hypoxia and tolerable habitat for striped bass as a function of phosphorus loading in Lake Greenwood. "Total Vol-Day" values indicate the integrated volume and duration of these conditions. The "One-Day Max or Min" values indicate the volume and % of the total lake volume of hypoxic water and habitat during extreme conditions of oxygen depletion. Results for baseline, Reedy loading, and Saluda and Reedy loading scenarios were taken from Tab. 8 of McKellar et al. (2008).

	EXTREME HYPOXIA (DO < 1 mg/liter)				STRIPED BASS HABITAT (May-June) (Temp < 28 C and DO > 2 mg/liter)			
SCENARIO DESCRIPTION	Total Vol-day/yr (10^9 m^3 da)	Total Vol-day/Yr (% tot)	One-day Max vol (10^9 m^3)	One-day Max vol (% tot)	Total Vol-day (10^9 m^3 da)	Total Vol-day (% tot)	One-day Min vol (10^9 m^3)	One-day Min vol (% tot)
BASELINE CALIBRATION	7.7	8.9	85.6	33.6	25.3	55.1	1.4	0.6
REEDY LOADING								
25% increase	8.0	9.2	87.9	34.5	25.1	54.5	1.4	0.6
25% decrease	7.4	8.5	83.1	32.6	25.7	55.8	1.4	0.6
50% decrease	7.0	8.1	78.5	30.6	26.1	56.6	1.4	0.6
75% decrease	6.6	7.6	76.2	29.9	26.5	57.5	1.4	0.6
90% decrease	6.4	7.3	73.5	28.8	26.8	58.3	1.5	0.6
SALUDA AND REEDY LOADING								
25% increase	8.7	10.0	93.3	36.6	24.5	53.3	1.0	0.4
25% decrease	6.6	7.6	75.5	29.6	26.4	57.4	1.5	0.6
50% decrease	5.3	6.1	60.8	24.3	27.8	60.4	1.6	0.6
75% decrease	3.4	3.9	44.4	17.5	29.9	65.1	7.2	2.9
90% decrease	1.7	1.9	29.6	11.8	32.1	69.7	17.0	6.8
SALUDA LOADING			-					
25% increase	8.4	9.7	92.1	36.1	24.7	53.7	1.0	0.4
25% decrease	6.9	7.9	77.8	30.6	26.1	56.7	1.5	0.6
50% decrease	5.9	6.8	67.5	26.8	27.1	58.8	1.6	0.7
75% decrease	4.5	5.2	58.0	23.1	28.5	61.9	2.8	1.1
90% decrease	3.2	3.7	46.4	18.5	29.8	64.8	5.4	2.1

Computed as the sum of the total integrated volume-days for the entire 2-yr simulation divided by 2 to yield the average vol-days/yr
Computed as the sum of the total integrated volume-days for the entire 2-yr simulation divided by 2 to yield the average vol-days for the season (May-Oct)