

After consideration of the two proposals on revision of the pH standard, I offer a third alternative for consideration by the NCSAC group members. The intent is to incorporate a vertical spatial averaging to better match the availability of suitable habitat to protect aquatic life.

Proposal:

- Maintain existing pH range of 6.0 to 9.0
- Implement as water column average at a monitoring location
- Utilize 90th percentile of data for assessment of impairment
- Analysis could be done with all data OR limited to the portion of the water column with adequate dissolved oxygen

Background:

1. Laboratory testing of pH sensitivity of fish and invertebrate species is typically based on chronic exposure of a test organism to a particular pH value over days to weeks. Given the chronic exposure evaluated in the laboratory tests, time or spatial averaging of pH conditions in a waterbody would be appropriate when considering the pH thresholds reported in the literature.
2. There are limited test results for pH sensitivity of species to high pH (much more work on low pH range). Many of the tests were conducted decades ago.
3. Impacts of pH on a fishery occur as a “gradual deterioration as the pH values are further removed from the normal range” (Alabaster and Lloyd, 1980). Although the transferability of summary statements from the literature provided to NCSAC members is uncertain relative to the fish species present in High Rock Lake, the generalizations provided in the summary papers do give context to the current discussions. The authors conclude the literature supports pH values above 10 were harmful to all species studied, while salmonids and some other species were harmed at pH values above 9.
4. For cases where elevated pH is caused by high aquatic plant photosynthesis, other factors, such as water temperature and gas supersaturation, Robertson-Bryan (2004) indicated a difficulty in correlating field mortality with laboratory results.
5. Given the mobility of fish and the linkage of high pH in High Rock Lake to photosynthesis, the overall field context for protection of aquatic life from elevated pH values is more appropriately done within the context of available suitable habitat.
6. Monitoring of field parameters in reservoirs by NCDEQ as part of the ambient monitoring program is typically done on a monthly basis during the growing season – for one year in five. Measurements generally include a profile for field parameters at monitoring locations.

Evaluation of Concept:

- Monitoring data for all stations in High Rock Lake for monitoring conducted during 1981-2016 provided to NCSAC members in the past were used to evaluate the proposed concept.
- For each profile in the monitoring record, an average pH value was computed for the station and date. Average pH values were computed for all available data and for measured points where dissolved oxygen concentration was above a desired threshold. The table below is for DO concentrations greater than or equal to 4.0 mg/L, as the instantaneous minimum value. Modification to a different DO threshold can be done quickly with the macro written to support this analysis.

- The plot provided below is the average pH for all locations by date based on only measurement points with a DO \geq 4.0 mg/L or no DO value listed in the Excel file I have. The summary tables synthesize data for different stations across the 1981-2016 period.
- Observation = the 90th percentile at all locations is less than 9.0 when all data are used but YAD152C is above 9.0 when only data for DO \geq 4.0 mg/L are used.

Summary Statistics for Water Column Average pH values by Station 1981-2016

Station	50%	75%	90%	Maximum	Samples
HRLO51	7.88	8.41	8.82	9.50	79
HRLO52	7.98	8.45	8.74	9.18	69
YAD139	6.10				1
YAD1391A	8.14	8.53	8.72	8.95	36
YAD139C	8.64				2
YAD146A	8.73				2
YAD152	8.29	8.69	8.80	9.20	58
YAD152A	7.53	8.10	8.44	9.07	105
YAD152Aa	7.50	7.50		7.67	5
YAD152Ab	7.31	7.52		7.58	5
YAD152C	7.78	8.71	9.18	9.86	114
YAD1561A	8.13	8.75	8.96	9.17	58
YAD156A	8.08	8.59	8.73	9.18	62
YAD169A	7.42	7.63	7.89	8.23	105
YAD169B	7.92	8.53	8.76	9.06	111
YAD169E	7.66	7.96	8.58	8.98	106
YAD169F	8.27	8.68	8.98	9.38	107

Note - pH values when DO is below 4 mg/L are excluded from calculation.

Summary Statistics for Water Column Average pH values by Station 1981-2016

Station	50%	75%	90%	Maximum	Samples
HRLO51	7.35	7.70	8.16	8.53	79
HRLO52	7.61	7.99	8.17	8.49	69
YAD139	6.10				1
YAD1391A	7.19	7.50	7.57	7.80	36
YAD139C	6.39				2
YAD146A	6.53				2
YAD152	7.69	8.19	8.43	8.86	58
YAD152A	7.74	8.28	8.66	9.40	105
YAD152Aa	7.92	7.98		8.93	5
YAD152Ab	7.87	8.20		8.29	5
YAD152C	7.81	8.19	8.43	9.50	114
YAD1561A	7.66	8.02	8.31	8.65	58
YAD156A	7.76	8.19	8.30	8.87	62
YAD169A	7.57	7.83	8.08	9.00	105
YAD169B	7.65	8.00	8.16	9.30	111
YAD169E	7.54	7.81	8.02	8.57	106
YAD169F	7.40	7.72	8.01	8.52	107

Note - all pH measurements used

