

Technical Memorandum

Update on the data collected following the recent fish kill at Cherry Creek Reservoir

Introduction

Based on the recent fish kills at Cherry Creek Reservoir, GEI Consultants (GEI) conducted additional water column surveys on August 22 and 23, 2012 at the three routine reservoir monitoring locations. These three sites include CCR-1, CCR-2 and CCR-3, and are monitored on a monthly basis for standard water quality parameters that include temperature, conductivity, pH, dissolved oxygen and oxygen reduction potential. To better assess daily fluctuation and potential factors that contributed to the recent fish kills, GEI conducted additional water column profile surveys during the afternoon (~3pm) and immediately after sunset (~8:30 pm) on August 22nd and immediately after sunrise (~6:30 am) on August 23rd. In addition, GEI performed the routine bi-monthly sampling event on August 23rd that included nutrient, algal biomass, phytoplankton, and zooplankton analyses and retrieved data from the thermistor arrays. The phytoplankton data could elucidate potential factors contributing to the fish kill if cyanobacteria were a large component of the assemblage. These other data have been submitted for analyses.

Continuous Temperature Data

The three thermistor arrays were downloaded on August 23rd and daily average water temperatures at depth were calculated for the period between June 1, 2012 and August 23, 2012. Daily average water temperature ranged from ~19°C to ~25°C near the water surface (Figure 1). Despite the seasonally high ambient air temperatures this summer, the daily average water temperatures recorded from June 1st through August 23, 2012 have been similar to the 2011 water temperatures. In June 2012, the water temperatures were about 1.1 °C warmer than June 2011; however, in August 2012, the water temperature has actually been about 1.3 °C cooler than during August 2011.

During the initial reporting of the fish kill on August 14, 2012 the daily average temperature at 1m depth was 22.8 °C which was less than the maximum daily summer temperature of 25.0 °C that was recorded in late July (Figure 1). A majority of the fish in the recent die-off were comprised of gizzard shad (*Dorosoma cepedianum*) with some walleye (*Sander vitreus*). The temperatures mentioned above are within the tolerance ranges for both species and are below the Upper Incipient Lethal Temperature for gizzard shad (34.75 °C) and walleye (34.1 °C). The chronic (MWAT) and acute (DM) temperature thresholds for the gizzard shad are 29.73 °C and 33.67 °C, respectively, while the chronic and acute values for the walleye are 28.67 °C and 32.48 °C, respectively (CDPHE 2010).

On August 13, 2012 a weather driven mixing event occurred which is indicated by the minimal temperature difference between the surface and bottom (~7.2 m) sensors at the three locations (Figure 1). Measured wind speed at the KAPA station, Centennial Airport, averaged 10 mph with gusts to 31 mph in the afternoon of the 13th. The water temperature difference between the 1m and 6m water depth was 0.2 °C. Prior to this date, the water temperature difference between the 1m and 6m depths ranged from 0.5 to 1.5 °C.

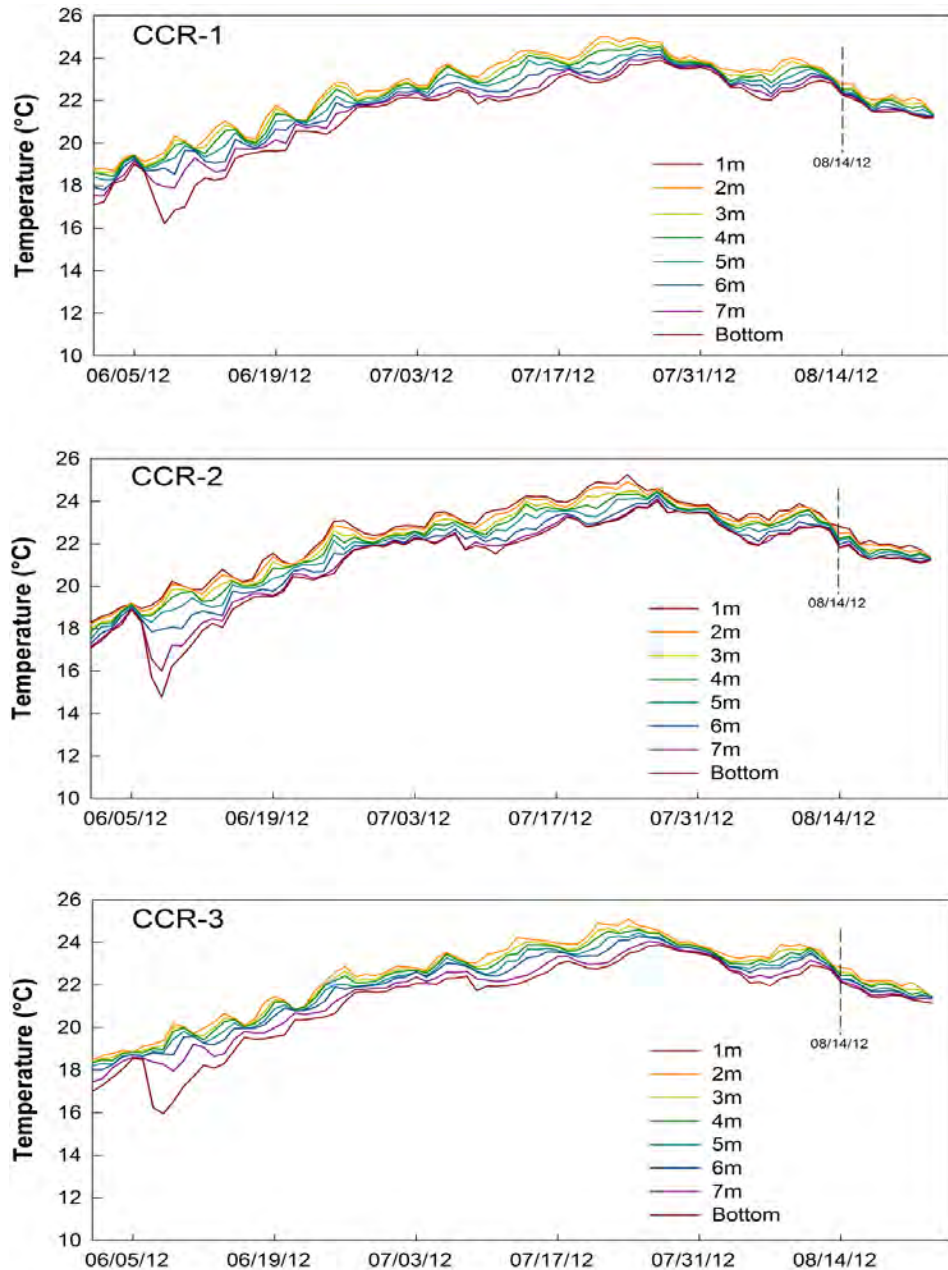


Figure 1: Temperature data collected from June 1, 2012 through August 23, 2012 at three monitoring sites on Cherry Creek Reservoir. The dashed line represents August 14, 2012 and marks the initial fish kill reports at Cherry Creek Reservoir.

Dissolved Oxygen, Oxygen Reduction Potential and pH

Dissolved oxygen levels recorded during the diurnal survey period (August 22nd and 23rd) were within normal ranges for the reservoir during the summer and were not low enough to produce anoxic conditions throughout the water column (Figure 2). The warm water dissolved oxygen standard is 5 mg/L, although most fish can tolerate dissolved oxygen conditions down to ~ 3 mg/L (Chapman 1986) or seek more suitable habitat provided temperature is not constraining movement either. Also, no substantial changes in dissolved oxygen were recorded during the sampling event prior to the fish kill (August 7, 2012) and levels were very similar to the data presented below. Based on personal communication with Paul Winkle (August 20th, Colorado Parks and Wildlife, Aquatic Biologist), the 531 dead gizzard shad and 17 dead walleye that were collected on August 21st, after the initial fish kill, showed no signs of prolonged dissolved oxygen stress such as flared gills. The dissolved oxygen data Paul collected was also not indicative of low oxygen stress conditions. Our dissolved oxygen data corroborates the CPW data.

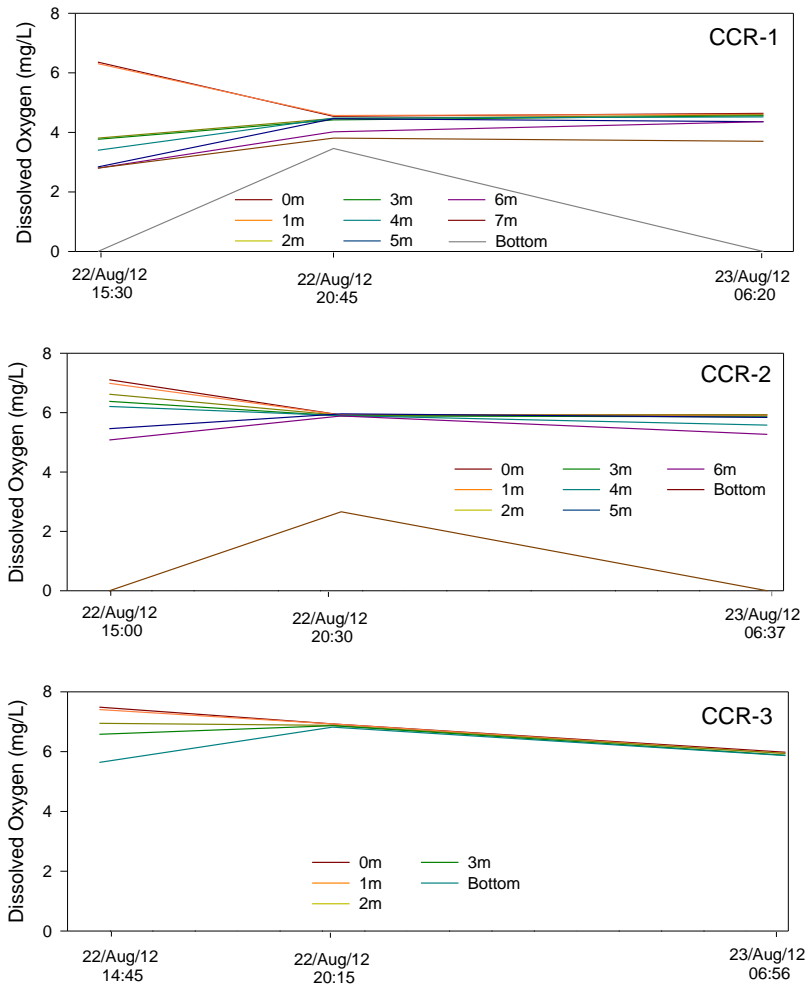


Figure 2: Dissolved oxygen data collected from diurnal surveys at three monitoring sites on Cherry Creek Reservoir.

On August 23, 2012, early afternoon, the dissolved oxygen transect profiles (D1-D10) revealed dissolved oxygen conditions were generally greater than 4.5 mg/L at the 6 meter depth, and showed the typical decrease in oxygen concentration at depths closer to the sediment interface. At the sediment interface, anoxic conditions (<1 mg/L) were present at sites D1 through D5 (Figure 5).

Over the two day period, GEI collected 23 dissolved oxygen profiles and calculated the 303(d) assessment value for each profile. Two profile assessment values for Site CCR-1 were slightly less than the 5.0 mg/L standard. The profile collected at 8:45 pm on August 22nd and the 6:20 am profile on August 23rd were 4.52 mg/L and 4.60 mg/L, respectively. All other profiles collected throughout the reservoir ranged from 5.06 mg/L to 7.39 mg/L during these two days. While these two CCR-1 values are less than the warm water standard, they are certainly not low enough to cause immediate fish mortality.

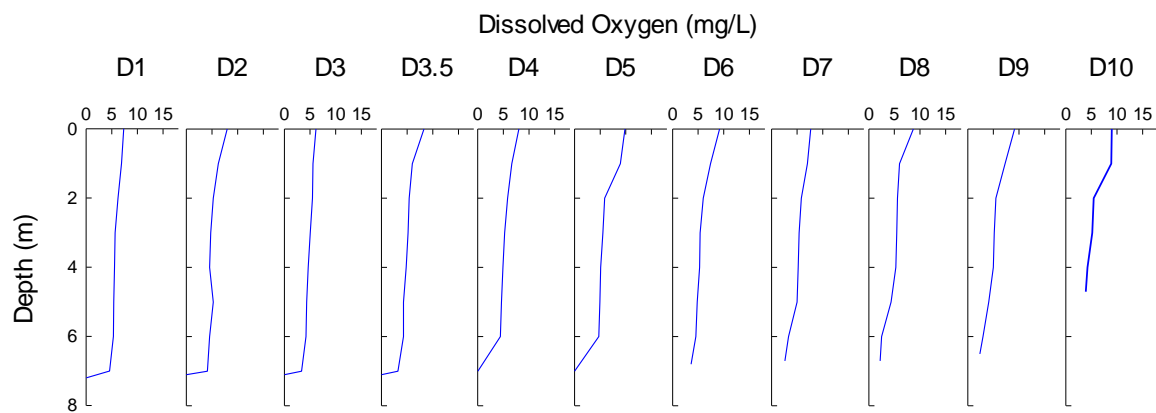


Figure 3: Dissolved oxygen profiles along the transect perpendicular to the middle of the dam face in Cherry Creek Reservoir, August 23, 2012.

Additionally, pH levels were within typical ranges for the reservoir at all three sampling sites during the diurnal surveys (Figure 4). No substantial changes in pH were recorded during the sampling event following to the fish kill event and values ranged from 7.43 to 8.28 among sites and depths. On August 7, prior to the fish kill event, the pH ranged from 7.1 to 8.26 among sites and depths.

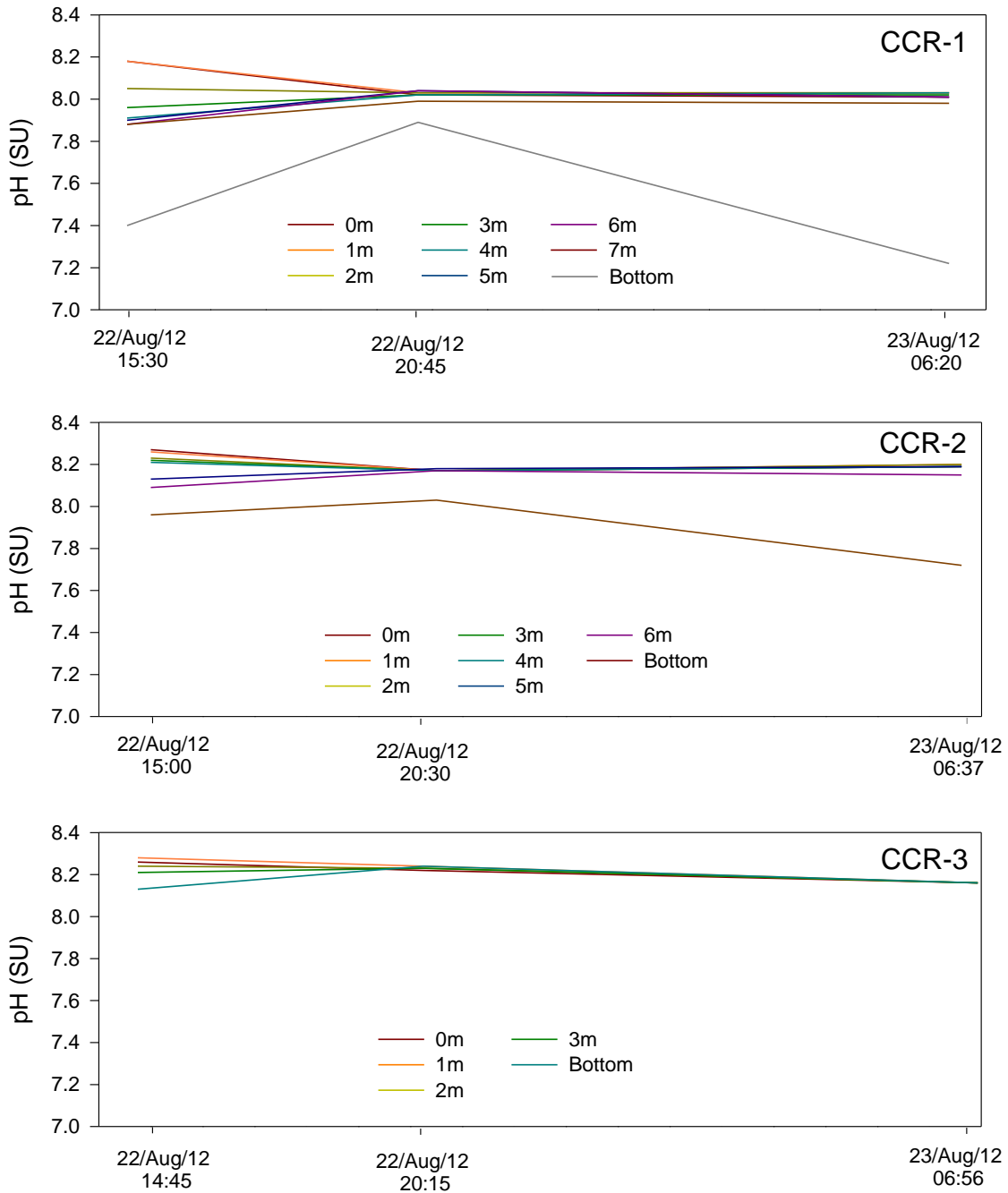


Figure 4: pH data collected from diurnal surveys at three monitoring sites on Cherry Creek Reservoir.

Algae and Zooplankton

Currently, algae and zooplankton samples are being identified to species from samples collected on August 7, 2012 and August 23, 2012. This data will be used to assess the possible presence of harmful algae species and for zooplankton composition.

Algal biomass (chlorophyll *a*) was measured on August 23rd at sites CCR-1, CCR-2, and CCR-3 with levels being 30.4 µg/L, 34.5 µg/L, and 38.1 µg/L, respectively. Secchi disk readings for the same sites were 0.75m, 0.67m, 0.58m respectively. The chlorophyll *a* measurements were greater than what was observed on August 7th. Chlorophyll *a* levels during the previous sampling date were 27.3 µg/L, 23.9 µg/L, and 21.7 µg/L for sites CCR-1, CCR-2 and CCR-3, respectively. Thus, there was an algal bloom between the two sampling dates, and a key piece of the information will be what species contributed to the bloom. This may provide some added information on additional stressors to these fish during this time.

Fish

While the CPW collected numerous dead gizzard shad in the open water and some walleye along the dam face on August 21st (presumably wind driven to the dam face), they did not submit any of the specimens to their laboratory for necropsy to help identify a reason for the fish kill. There is still some uncertainty as to why other species such as the black crappie, channel catfish, white sucker or largemouth bass did not show up in the fish kill too. CPW will be setting gill nets the week of August 27th for their annual reservoir fish survey (not prompted by the fish kill) and will be electrofishing the week of September 3rd to sample littoral zone fish habitat. GEI requested that CPW collect multiple species and submit specimens for necropsy to evaluate the overall health of the fish.

Summary

Presently, the fish kill appears to be related to a weather driven mixing event on August 13th resulting in uniform water column temperatures that may have been exacerbated by low/anoxic dissolved oxygen from the bottom water layer that likely was mixed throughout the reservoir. While the destratification system has been shown to be effective at mixing the upper water column, that bottom 1 m layer still becomes anoxic during the summer. A weather driven mixing event can turn-over the entire reservoir, including the 1 m anoxic zone and areas that are less like to mix such as the Marina and Tower Loop areas. A sudden change in reservoir conditions that mixes anoxic water into the water column with a combination of other stressors likely resulted in the fish kill. However, there are key components such as the physical condition of the fish, along with the phytoplankton and zooplankton data that will provide insightful information into other potential factors that may have exacerbated the stressful conditions for the gizzard shad and walleye. This information will be forth coming.

References

Chapman, G., 1986. Ambient aquatic life criteria for dissolved oxygen. US Environmental Protection Agency, Washington, DC, EPA-440/5-86-003.

Colorado Division of Public Health and Environment. 2010. Water Quality Control Division Prehearing Statement, Regulation #31 Rulemaking Hearing: June 7, 2010.