Dissolved Oxygen In The Upper Clark Fork River, Summer 1987

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Abstract: *Predawn DO was sampled weekly at seven stations in July and August, 1987, in the upper Clark Fork, and a diurnal DO survey was conducted at nine stations in late July. Several sites exhibited DO levels at or below the state standard several times in the summer of 1987. The lowest DO levels occurred in late July between midnight and 2 a.m. Given other stresses on the upper river fishery, the state should insure that adequate flows are available to reduce stress associated with low summer predawn DO.*

INTRODUCTION

The Upper Clark Fork River fishery suffers from a number of man-induced stresses, including heavy metal loadings and dewatering. In addition, geothermal inputs and heavy algae growths contribute to summer night time oxygen levels that are considered stressful. In dry years, the river's low flow is exacerbated by increased irrigation demands, and oxygen levels are made worse by higher temperatures, slower flows and reduced water volumes relative to the biotic community's respiration demands. Greater consumptive use of the river water can only make this situation worse.

Light snowfall and a lack of spring rains in 1973 resulted in below normal stream flows in northwestern Montana. Discharge of the Clark Fork above Missoula for July 1973 was 34% of the 1953 to 1967 average and 47% of the 1931 to 1960 median (Braico 1973). Tributaries were similarly low. Braico measured diurnal DO at several sites on the upper river on August 2 and 3 and found that DO at most sites dipped to around 70% of saturation between midnight and dawn—below the state standard of 7 ppm.

The winter and spring of 1987 were similarly low in precipitation and stream flows. The possibility of increased demands on water and of increased algae

growths warranted assessing DO levels again. The Montana Water Quality Bureau (WQB) conducted diurnal DO surveys at nine upper river stations in late July and the University of Montana (UM) sampled predawn DO weekly at seven stations in July and August.

METHODS

The WQB sampled water every two hours from 10 a.m. July 29 to 10 a.m. July 30. DO was determined by the Winkler technique using 300 ml DO bottles and phenylarsine oxide as the titrant (duplicate samples varied by 0.05 ppm). The predawn sampling by UM was carried out using 60 ml DO bottles and sodium thiosulfate as the titrant (duplicate samples varied by 0.3 ppm). Predawn sampling began around 4 a.m. at the Turah fishing access and was completed around 7 a.m. at the Warm Springs site. All samples were collected before sun up with the exception of two samples at Warm Springs that were collected soon after sunrise under heavy cloud cover.

RESULTS

To permit comparison of results, UM and WQB sampled temperature and DO at the Turah site on July 30. The results were:

	Time	Temperature (C)	DO (ppm)
UM	10:30 am	19	9.05, 9.30
WQB	10:40 am	19.0	9.10

UM's predawn sampling results are summarized in Table 1 and the WQB's diurnal sampling results (M. Kerr pers. comm.) appear in Figure 1. The latter show when the lowest DO of the day occurred while the former suggest how DO levels varied over the summer.

As in Braico's study, the WQB's results suggest that the lowest DO levels of the day occur between midnight and 2 a.m. in the upper river, rather than between 4 a.m. and 6 a.m. as in the middle river (DHES 1986). The smaller upper river may track air temperatures more closely than the middle river and cool off more toward dawn, resulting in a rise in DP levels near dawn. Hence UM's predawn samples collected from 4 to 7 a.m. are not the lowest DO levels of the day but are probably about 0.5 to 1 ppm higher.

LE 1. PREDAWN DISSOLVED OXYGEN IN THE UPPER CLARK FORK, SUMMER 1987

DATE	SITE/TIME		TEMP (C)	DO (ppm)	SAT	FLOW (cfs)	ELEVATION (ft)
7/7/87	TURAH	4:30	14.0	7.9	85	663	3200
	BONITA	5:00	15.7	7.1	81		3600
	DRUMMOND	5:40	14.0	7.3	81		4000
	GOLD CR.	6:05	14.5	7.4	84	172	4400
	ABV LBF	6:25	13.7	7.3	81		4600
	DEER L.	6:55	14.0	7.2	81	78	4800
	WARM SP.	7:25	16.0	7.1	86		5000
7/16/87	TURAH	3:46	14.5	6.8	73	708	
	BONITA	4:20	15.0	6.4	71		
	DRUMMOND	5:00	13.0	6.8	73		
	GOLD CR.	5:30	13.0	6.7	73	227	
	ABV LBF	5:50	12.0	6.7	71		
	DEER L.	6:15	13.0	6.3	69	101	
	WARM SP.	6:45	14.0	6.6	75		
7/24/87	TURAH	3:50	11.5	7.8	78	1080	
	BONITA	4:25	18.0	7.6	93		
	DRUMMOND	5:05	15.2	7.6	86		
	GOLD CR.	5:30	16.5	7.6	91	396	
	ABV LBF	5:45	16.0	7.3	87		
	DEER L.	6:05	16.0	7.3	87	227	
	WARM SP.	6:30	17.0	7.6	95		
7/30/87	TURAH	4:30	19.2	7.0	87	740	
	ABV R.CR.	5:00	19.7	6.8	87		
	DRUMMOND	5:00	17.1	7.3	88		
	GOLD CR.	5:00	17.6	7.2	89	227	
	ABV LBF	6:00	16.2	7.3	87		
	DEER L.	5:00	16.3	6.9	84	117	
	WARM SP.	6:00	17.9	6.9	89		
8/7/87	TURAH	4:00	16.0	7.5	85	470	
	BONITA	4:30	18.0	7.3	89		
	DRUMMOND	5:25	14.5	7.7	86		
	GOLD CR.	5:57	14.0	7.9	88	154	
	ABV LBF	6:15	13.5	7.8	86		
	DEER L.	6:33	12.5	7.6	83	74	
	WARM SP.	7:00	15.0	7.5	88		
8/14/87	TURAH	4:10	14.0	8.2	87	409	
	BONITA	4:55	15.0	7.9	88		
	DRUMMOND	5:40	13.5	7.9	86		
	GOLD CR.	6:00	13.5	8.2	90	148	
	ABV LBF	6:40	13.0	8.1	88		
	DEER L.	7:00	13.0	7.8	86	85	
	WARM SP.	7:25	14.2	7.8	90		
8/21/87	TURAH	4:15	14.0	8.1	86	448	
	BONITA	4:45	15.0	7.6	85		
	DRUMMOND	5:15	13.0	7.9	84		
	GOLD CR.	5:45	13.0	7.8	84	169	
	ABV LBF	6:15	12.0	7.9	84		
	DEER L.	6:30	12.0	7.5	81	81	
	WARM SP.	7:00	13.5	7.7	86		
8/28/87	TURAH	4:15	14.0	8.2	88	541	
	BONITA	4:45	15.0	7.8	87		
	DRUMMOND	5:20	12.0	8.2	86		
	GOLD CR.	5:50	13.0	8.4	91	219	
	ABV LBF	6:15	12.0	8.2	87		
	DEER L.	6:35	12.0	8.0	86	121	
	WARM SP.	7:00	13.5	8.3	93		

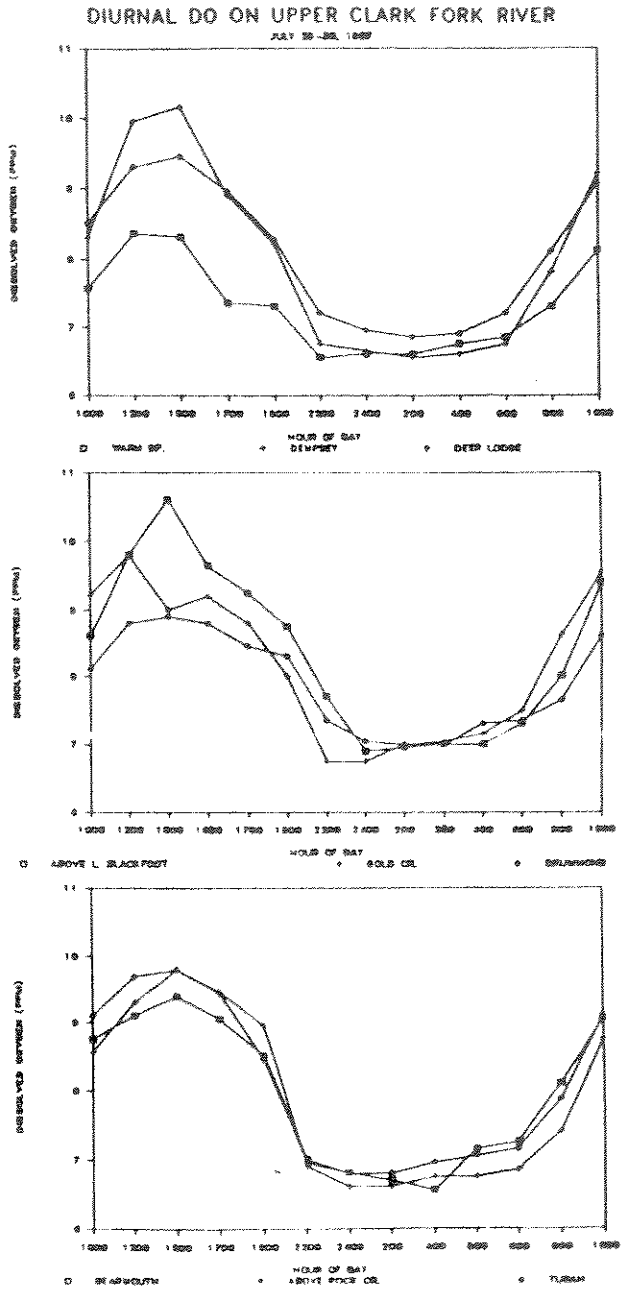
The predawn sampling results suggest that the WQB's diurnal survey occurred during one of the periods of lowest DO levels that summer. Early in July, predawn DO levels were approaching the state standard and were around 80 to 85% of saturation. By mid-July (7-16), very low flows, warm water temperature and heavy algae growths brought the entire upper and middle river down to 70 to 75% of saturation (below the state standard). However, the following week (7-24), record rainfalls swelled river flows to uncommonly high levels for late July, and despite higher temperatures, DO levels rose to 85-95% of saturation. The following week (the week of WQB's diurnal survey), flows returned to levels observed July 16th and water temperatures were higher. Predawn DO levels (4 to 6 a.m.) were not as low as those observed July 16, but the lowest DO levels of the night were as low. Rain and falling night time temperatures in August raised river flows and lowered temperature. Hence predawn DO levels progressively increased from this point.

CONCLUSIONS

Despite low winter and spring precipitation, record rainfall in July, 1987, averted the very low DO levels expected to develop that summer. Hence, 1987 did not provide an assessment of extremely low flow summer DO conditions on the river. Without the unseasonal July rains, it is likely that the river would have exhibited predawn DO levels below the state standard from early July to mid August. Despite the July rains, 1987 was a summer of below average flows. Based on the USGS flow station at St Regis and the years 1961-1980, June flows were 25% of normal, July 32% of normal and August 56% (Mel White pers, comm.). While 1987 flows represent lower percents of "normal" than did flows reported by Braico (1973), the 1973 flows were lower than 1987 flows (apparently, Braico's reference years were drier than 1961-1980). River flow at the ASGS site above Missoula on the day of the 1987 diurnal survey (July 30) was 1300 cfs while it was 905 cfs when Braico conducted his study on August 2, 1973.

Based on the 1987 DO data and that of Braico, the lowest DO levels of the day occur between midnight and 2 a.m. and are usually around 80% of saturation but have been as low as 70%.

Assuming that predawn DO levels of 80-85% of saturation are typical of summer low flow conditions (<1000 cfs at Turah and <200 cfs at Deer Lodge), the upper Clark Fork is at high risk for DO levels below the state standard (7 ppm) when nighttime temperatures rise above 16 to 18 °C at Turah (elevation 3320 ft) and above 14 to 16 °C at Warm Springs (elevation 4810 feet). With flows as low as 700 cfs at Turah and 100 cfs at Deer Lodge, DO levels have approached 70% of saturation and



may be below the state standard at temperatures as low as 12 °C or lower, depending on elevation.

Adequate flows are very important in providing sufficient aeration and volume to meet the oxygen demands of river algae. Even though temperatures increased from July 16 to July 24, DO levels increased thanks to increased river flows. Given the number of stresses on the upper fishery, sound management dictates that the state strive to provide adequate flows to reduce stress associated with low summer predawn DO.

ACKNOWLEDGEMENTS

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