



Durations and Frequencies of Low DO and Flow at Barton Springs during Droughts: Preliminary Considerations

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Abstract

During droughts, flow and dissolved oxygen decrease. We wanted to assess acceptable durations, frequencies of occurrence and levels of dissolved oxygen's that do not result in long term impacts to the salamander population in Barton Springs. However, this document does not address what is acceptable.

Durations and Frequencies of Low DO and Flow at Barton Springs during the period 1995 – 1997.

This is an attempt to assess the frequencies and durations for periods of low DO and flow for the salamanders. I looked at a three year period (1995-1997) which included a “drought” period of about one year with “normal” flow before and after. Our lowest measured DO occurred during this drought. Salamander counts were available for Barton Springs Pool for the entire time, and for Eliza spring for most of the time. Counts got very low, 0 at Eliza and 4 at Barton, so I’m not sure that this is what we should posit as acceptable frequencies and durations of low DO or flow. However the low counts at Eliza match the lowest flows and counts are on the increase at Eliza before the counts at Barton bottom out months after flow has started to increase.

The Tables 1 and 2 list all the periods when DO was below 5, 4.5, 4, 3.5, 3, and 2.5 mg/L from 1995-1997 and when the flow was less than 35, 30, 25, 20 and 15 cfs. Also listed are the total number of days, the number of periods, the maximum duration and the average duration of the periods. Figures 1 and 2 show the dissolved oxygen and the flow and salamander counts for 1995-1997.

Table 1. Duration and Frequency of low DO in 1995-1997

Time Frame: 1995 - 1997 which includes lowest recorded DO levels and one year of drought							
During this time salamander counts in the pool decreased from 45 to 4 and then rebounded to 44							
During this time salamander counts in Eliza decreased from 29 to 0 and then rebounded to 44							
	number of days with average DO (mg/L) less than specified level						
Period	< 5 mg/L	< 4.5 mg/L	alternate < 4.0 mg/L	< 4 mg/L	< 3.5 mg/L	< 3 mg/L	< 2.5 mg/L
1	305	135	25	25	14	5	1
2	155	101	25	23	14	1	1
3	18	62	20	18	4		
4	14	18	18	16	2		
5		2	16	16			
6		1	14	14			
7			10	10			
8			8	6			
9			3	3			
10			3	3			
11			2	2			
12			2	2			
13			1	1			
14			1	1			
15			1	1			
16			1	1			
17			1	1			
18				1			
19				1			
20				1			
21				1			
Period	< 5 mg/L	< 4.5 mg/L	alternate < 4.0 mg/L	< 4 mg/L	< 3.5 mg/L	< 3 mg/L	< 2.5 mg/L
Predicted flow (reg.)	<38 cfs	<29	<23	<23	<18	<14	<11
Total # of days	492	319	151	147	34	6	2
# of periods	4	6	17	21	4	2	2
Max. duration (days)	305	135	25	25	14	5	1
Ave. duration (days)	123	53	9	7	9	3	1

alternate < 4.0 mg/L: periods of one days adjacent to longer periods were combined into a single longer period

Datasonde DO taken in cave in strong spring flow, grab DO taken in various places nearer the pool surface

Table 2. Frequency and Duration of low flow in 1995-1997

Time Frame: 1995 - 1997 which includes low recorded flow levels and one year of drought
 During this time salamander counts in the pool decreased from 45 to 4 and then rebounded to 44
 During this time salamander counts in Eliza decreased from 29 to 0 and then rebounded to 44

		number of days with average flow (cfs) less than specified level				
Period		< 35 cfs	< 30 cfs	< 25 cfs	< 20 cfs	< 15 cfs
	1	261	122	51	19	none
	2	77	74	27	13	
	3	18	14	22	9	
	4	8	4	11	3	
	5	1		4	2	
	6			4		
	7			2		
	8			2		
	9			2		
Period		< 35 cfs	< 30 cfs	< 25 cfs	< 20 cfs	< 15 cfs
Total # of days		365	214	125	46	none
# of periods		5	4	9	5	
Max. duration (days)		261	74	51	19	
Ave. duration (days)		73	54	14	9	

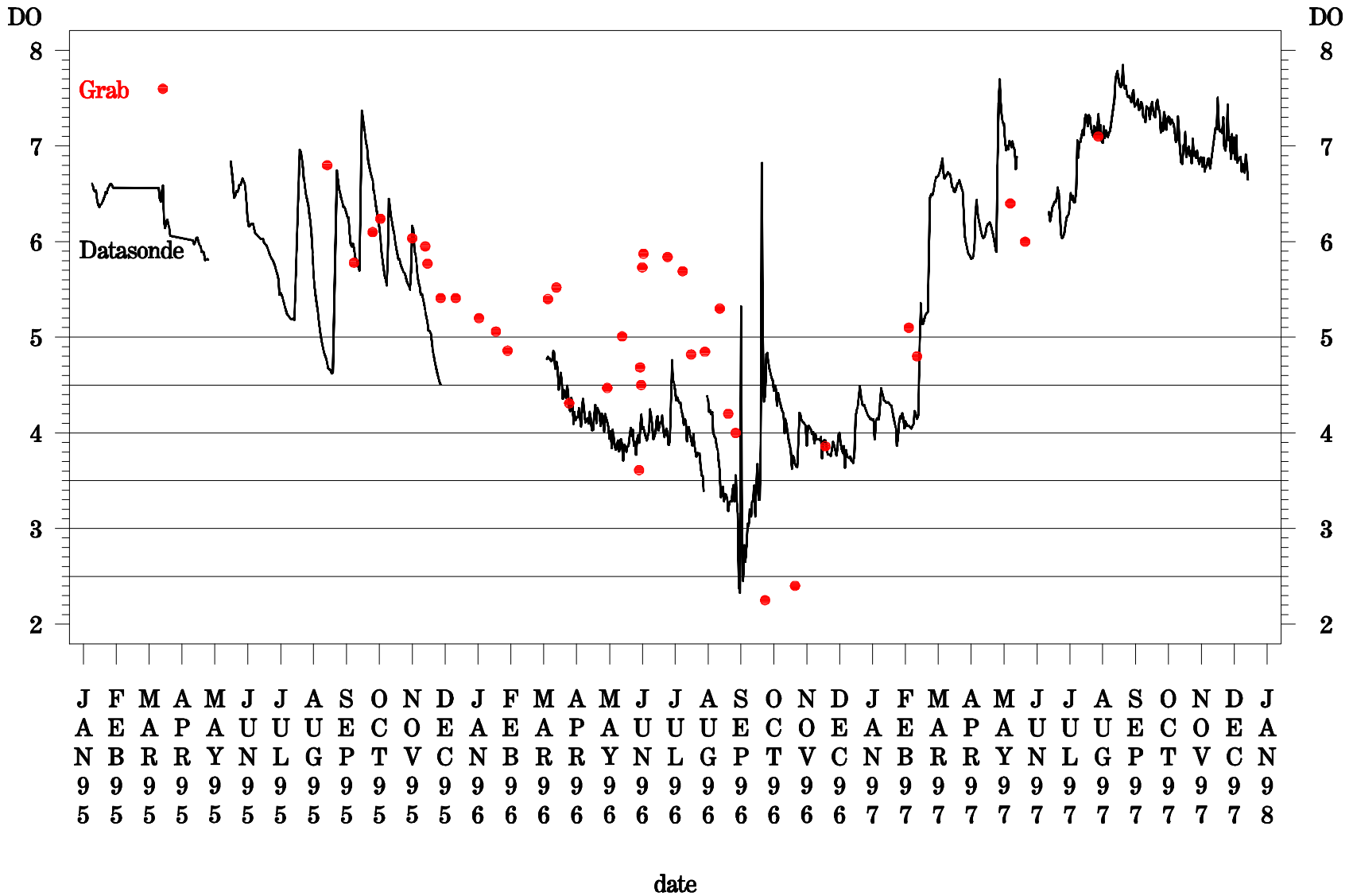


Figure 1. Dissolved oxygen in mg/L at Barton Springs during the 1996 drought

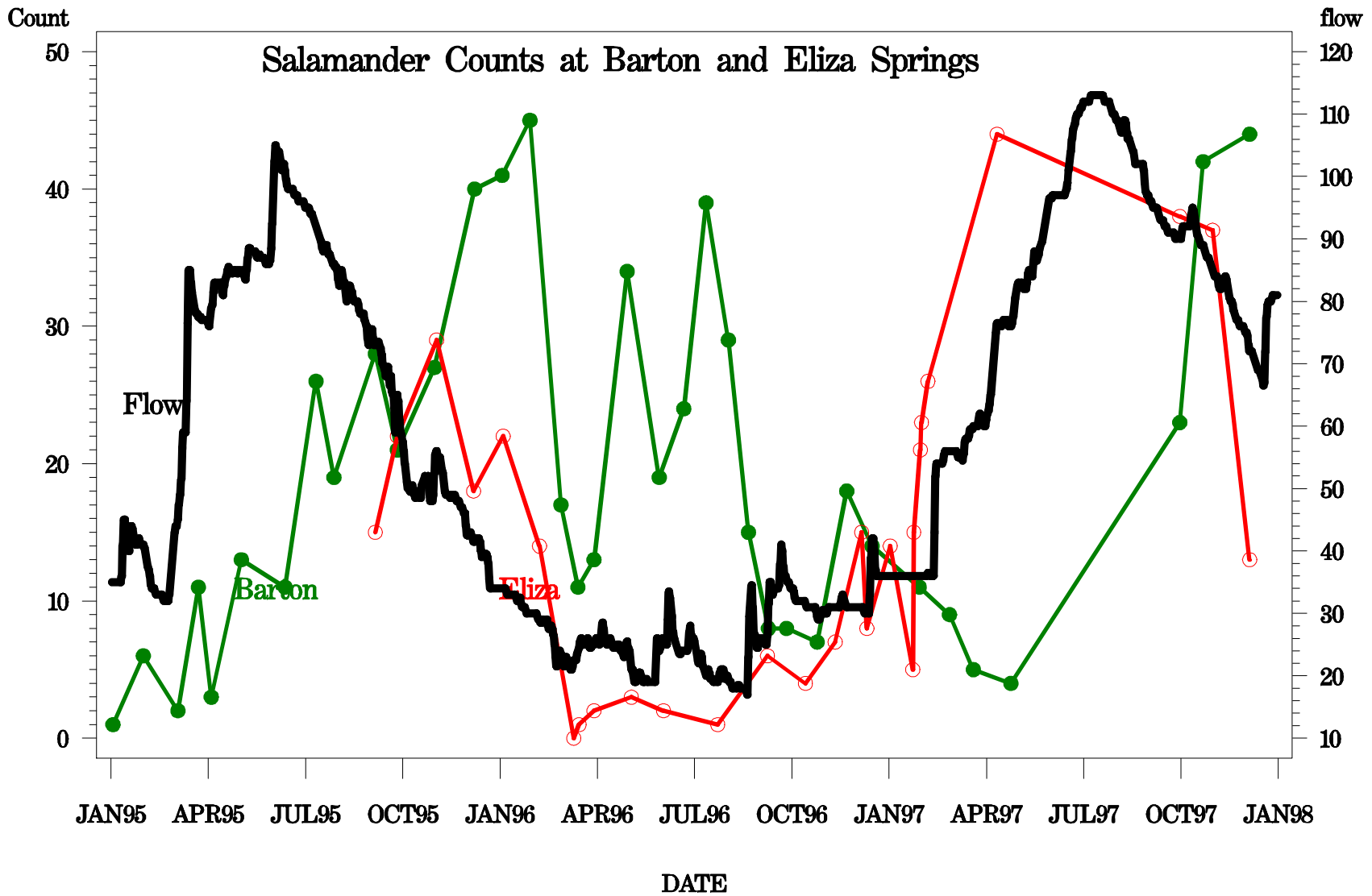


Figure 2. Total salamander counts at Barton and Eliza Springs with flow from the main Barton Spring for the drought of 1996

Durations and Frequencies of Low DO and Flow at Barton Springs during the period 1999 – 2001.

I looked at a three year period (1999-2001) which included a “drought” period of about one year with “normal” flow before and after. Salamander counts were available for Barton Springs Pool, Eliza, Old Mill, and Upper Barton Spring during this time. Counts dropped very low like they did during the 1995-1997 period: 0 at Eliza and 3 at Barton, but then increased when flows returned to normal.

The Tables 3 and 4 list all the periods when DO was below 5, 4.5, and 4 mg/L from 1999-2001 and when the flow was less than 35, 30, 25, 20 and 15 cfs. Also listed are the total number of days, the number of periods, the maximum duration and the average duration of the periods. Figures 3 and 4 show the dissolved oxygen and the flow and salamander counts for 1999-2000.

Table 3. Duration and Frequency of low DO in 1999-2001

Time Frame: 1999 - 2001 which includes lowest recorded DO levels and one year of drought							
During this time salamander counts in the pool decreased from to 4 and then rebounded to							
During this time salamander counts in Eliza decreased from to 0 and then rebounded to 44 and salamander counts in Old Mill decreased from to 0 and then increased to							
number of days with average DO (mg/L) less than specified level							
Period	< 5 mg/L	Alternate < 5 mg/L	< 4.5 mg/L	< 4 mg/L	< 3.5 mg/L	< 3 mg/L	< 2.5 mg/L
1	92	94	36	6	none	none	none
2	44	55	31	1			
3	36	36	11				
4	13	19					
5	10	10					
6	10	8					
7	5	4					
8	4						
9	4						
10	3						
11	2						
Period	< 5 mg/L	Alternate < 5 mg/L	< 4.5 mg/L	< 4 mg/L	< 3.5 mg/L	< 3 mg/L	< 2.5 mg/L
Total # of days	223	226	78	7			
# of periods	11	7	3	2			
Max. duration (days)	92	94	36	6			
Ave. duration (days)	20	32	26	3			

alternate < 5.0 mg/L: adjacent periods with one day between were combined into a single longer period
 Datasonde DO taken in cave in strong spring flow

Table 4. Frequency and Duration of low flow in 1999-2001

Time Frame: 1999 - 2001 which includes low recorded flow levels and one year of drought

		number of days with average flow (cfs) less than specified level				
Period		< 35 cfs	< 30 cfs	< 25 cfs	< 20 cfs	< 15 cfs
	1	207	78	27	6	none
	2	94	64	19	4	
	3	4	32	15	3	
	4	1	27	11	2	
	5		22	8	1	
	6		15	4	1	
	7		4	2	1	
	8		2	2		
	9		1	1		
Period		< 35 cfs	< 30 cfs	< 25 cfs	< 20 cfs	< 15 cfs
Total # of days		306	245	89	18	none
# of periods		4	9	9	7	
Max. duration (days)		207	78	27	6	
Ave. duration (days)		76	27	10	3	

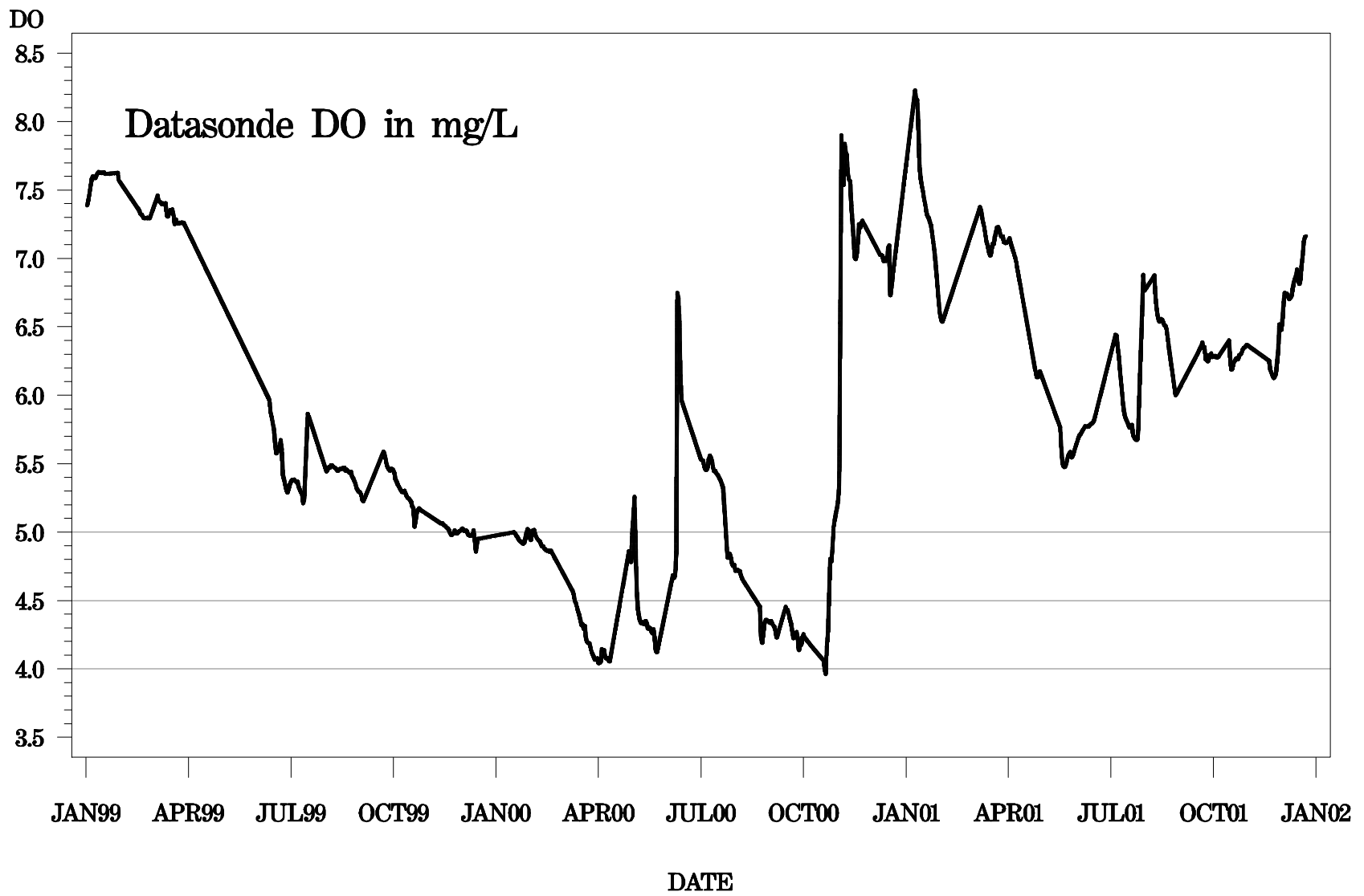


Figure 3. Dissolved oxygen at Barton Springs during the 2000 drought

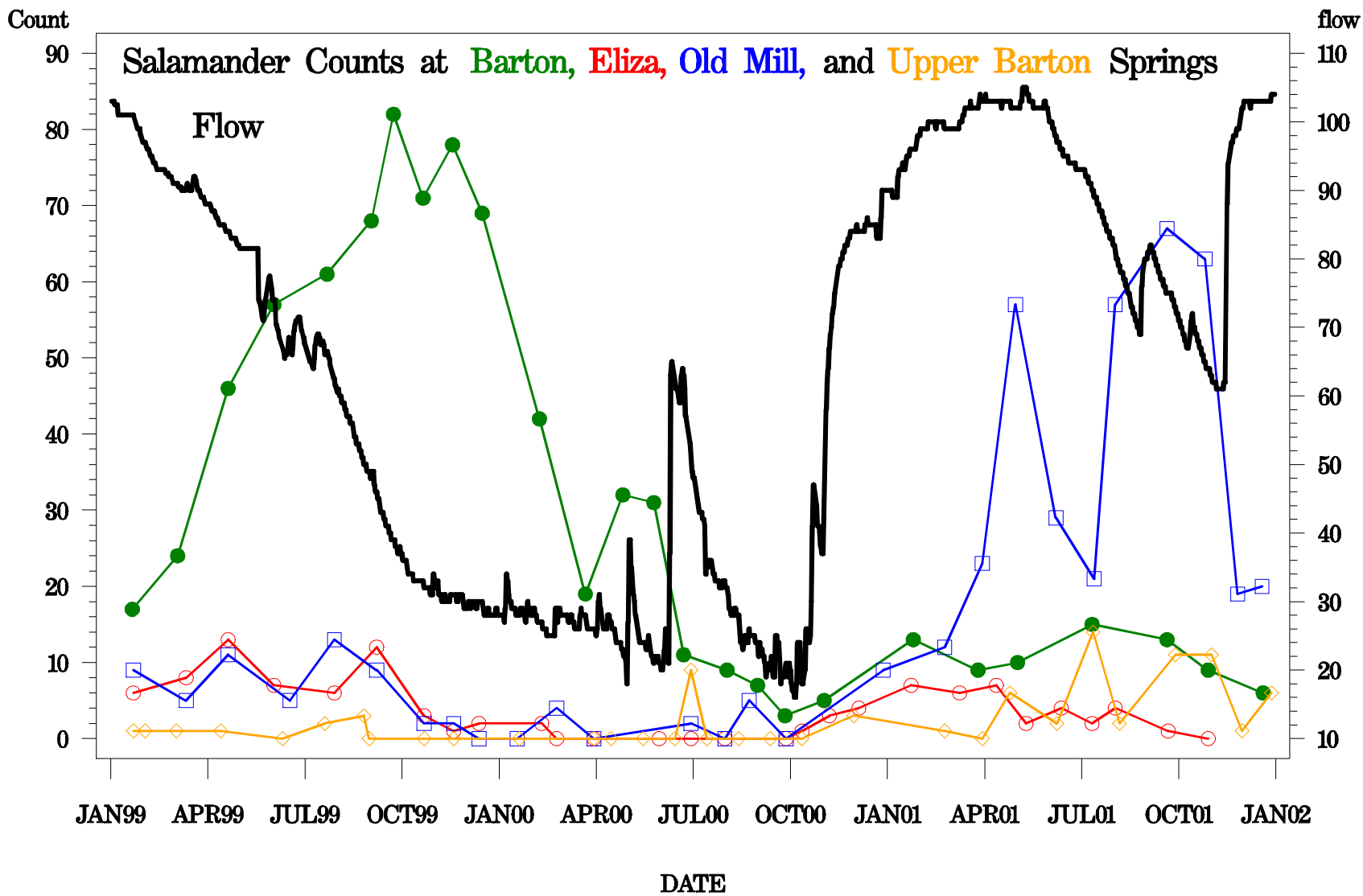


Figure 4. Total salamander counts at four springs with flow from the main Barton Spring for the drought of 2000

Durations and Frequencies of Low DO and Flow at Barton Springs during the period 2008 - 2009.

I looked at a two year period (2008-2009) which included a “drought” period of about 1 and 1/3 years with “normal” flow before and after. Salamander counts were available for Barton Springs Pool, Eliza, Old Mill, and Upper Barton Spring during this time. The salamander counts in the pool decreased from 447 to 5 and then rebounded to 37. The salamander counts in Eliza decreased from 1234 to 35 and then rebounded to 405

The Tables 5 and 6 list all the periods when DO was below 5, 4.5, and 4 mg/L from 2008 - 2009 and when the flow was less than 35, 30, 25, 20 and 15 cfs. Also listed are the total number of days, the number of periods, the maximum duration and the average duration of the periods. Figures 5 and 6 show the dissolved oxygen and the flow and salamander counts for 2008-2009.

Table 5. Frequency and Duration of low flow in 2008-2009

Time Frame: 2008-2009 which includes low recorded DO levels and one year + of drought						
During this time salamander counts in the pool decreased from 447 to 5 and then rebounded to 37						
During this time salamander counts in Eliza decreased from 1234 to 35 and then rebounded to 405						
number of days with average DO (mg/L) less than specified level						
Period	< 5 mg/L	< 4.5 mg/L	< 4 mg/L	< 3.5 mg/L	< 3 mg/L	< 2.5 mg/L
1	207	88	none			
2	202	53				
3	3	13				
4		5				
5		3				
6		3				
7		2				
8		1				
9		1				
10		1				
Period	< 5 mg/L	< 4.5 mg/L	< 4 mg/L	< 3.5 mg/L	< 3 mg/L	< 2.5 mg/L
Total # of days	412	170				
# of periods	3	10				
Max. duration (days)	207(409)*	88				
Ave. duration (days)	137	17				

Datasonde DO taken in cave in strong spring flow, grab DO taken in various places nearer the pool surface

* hit five mg/L on one day in the middle

Table 6. Frequency and Duration of low flow in 2008-2009

Time Frame: 2008-2009 which includes low recorded DO levels and one year + of drought					
During this time salamander counts in the pool decreased from 447 to 5 and then rebounded to 37					
During this time salamander counts in Eliza decreased from 1234 to 35 and then rebounded to 405					
number of days with average flow (cfs) less than specified level					
Period	< 35 cfs	< 30 cfs	< 25 cfs	< 20 cfs	< 15 cfs
1	465	304	176	70	7
2	6	145	145	25	5
3		1	20	14	3
4		1	20	14	3
5		1	10	13	1
6			5	13	1
7			1	9	1
8				8	
9				6	
10				6	
11				6	
12				5	
13				5	
14				5	
15				3	
16				3	
17				2	
18				2	
19				1	
20				1	
21				1	
22				1	
Period	< 35 cfs	< 30 cfs	< 25 cfs	< 20 cfs	< 15 cfs
Total # of days	471	452	377	213	21
# of periods	2	5	7	22	7
Max. duration (days)	465	304	176	70	7
Ave. duration (days)	233	90	54	10	3

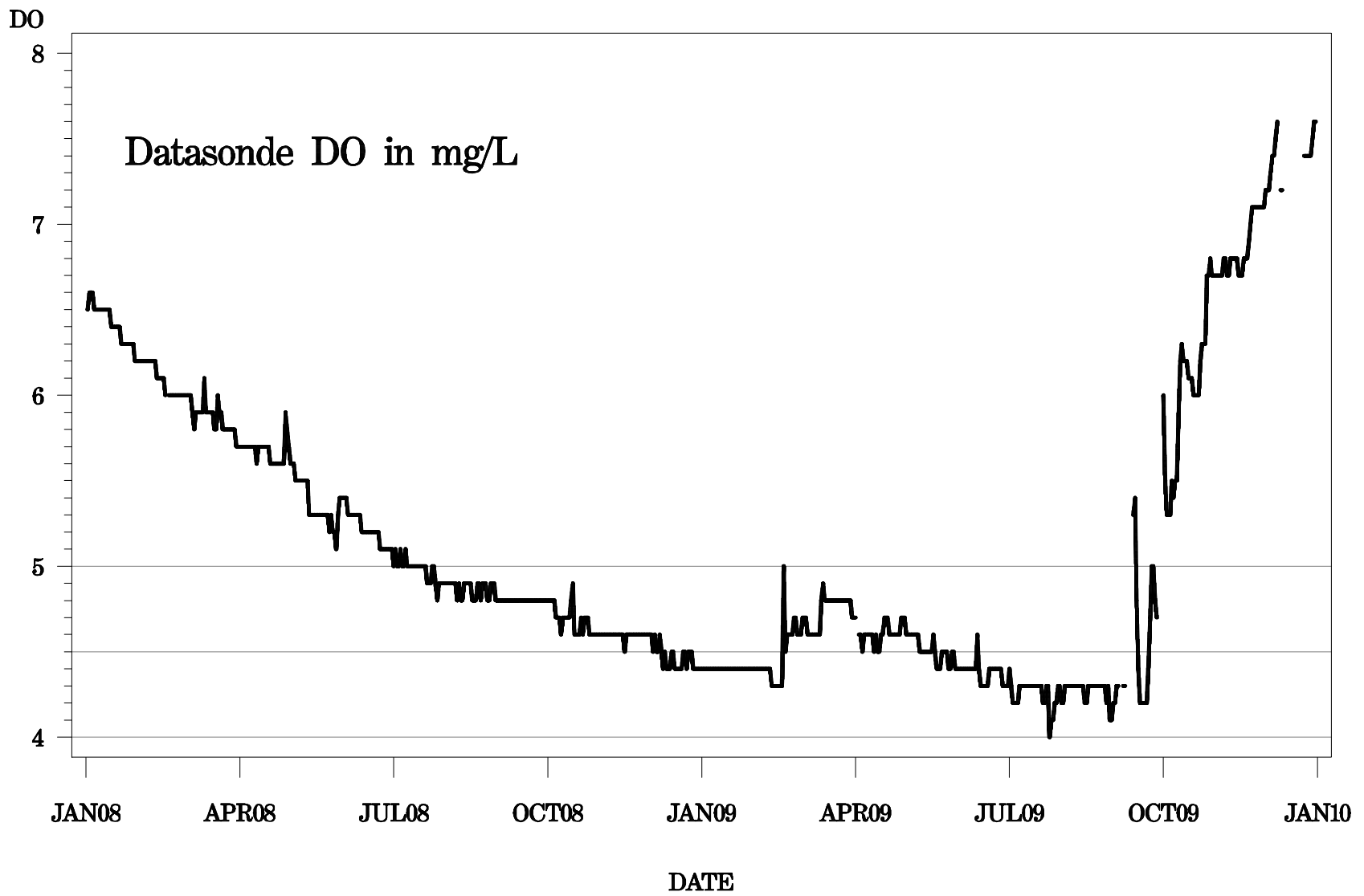


Figure 5. Dissolved oxygen at Barton Springs during the 2008-2009 drought

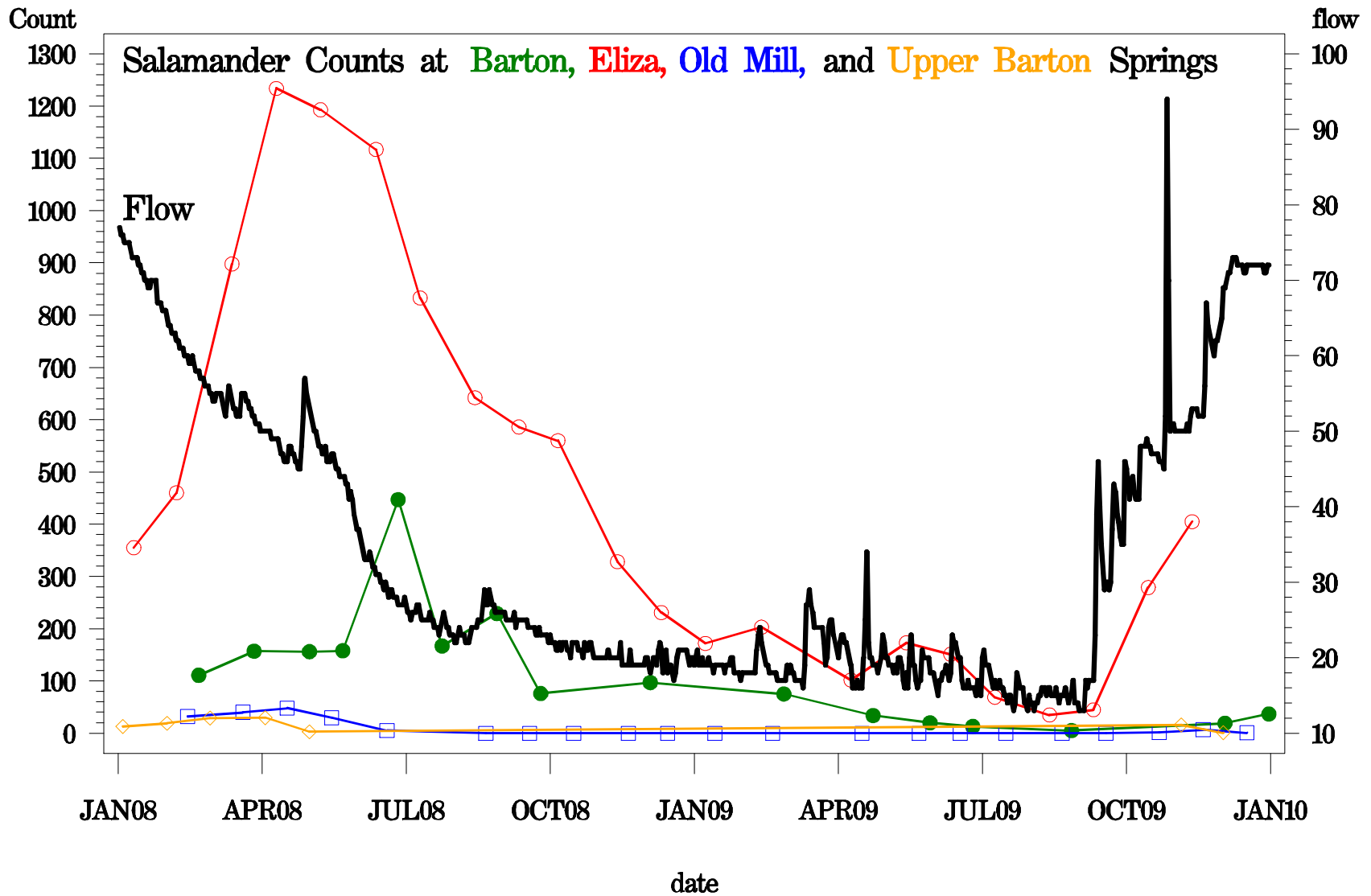


Figure 6. Total salamander counts at four springs with flow from the main Barton Spring for the drought of 2008-2009