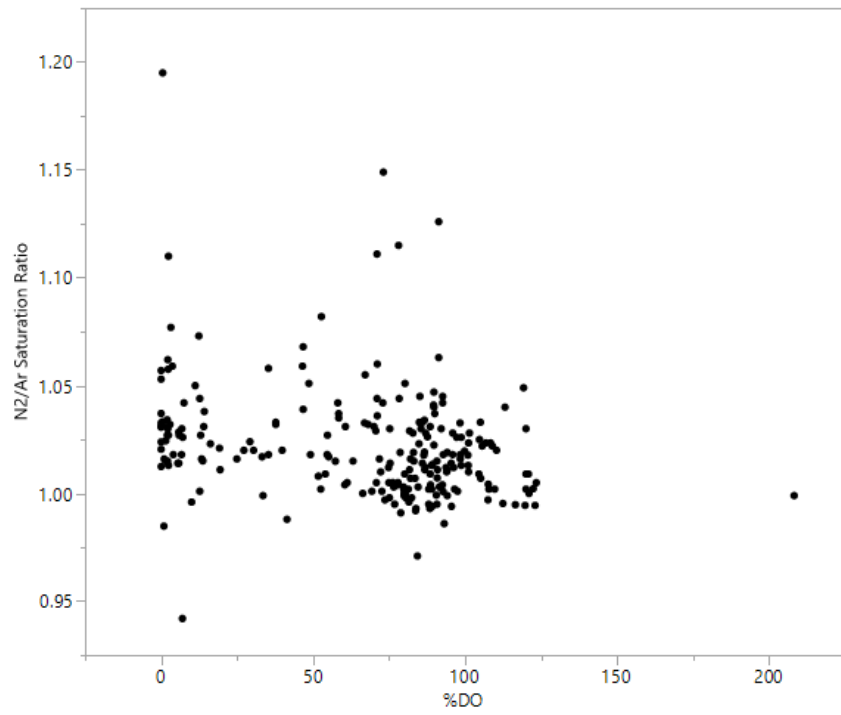


Supplemental Table S1: List of lakes sampled with characteristics: County, overall trophic state, chlorophyll concentration, water clarity, maximum depth, lake area, littoral area, and perimeter information was obtained from Lake Finder on the Minnesota Department of Natural Resources (DNR) website for lakes in Minnesota. The information obtained from LakeFinder is the 10-year summer average. The Minnesota DNR does not sample each lake every year, so the 10-year average is based on the samples taken over a 10-year period. Similar information for lakes in Iowa was obtained from the Iowa Lakes Information System. The Iowa Lake Information System contained data collected by the Iowa DNR in summer 2016.

Lake Name	County	Number of times sampled	Trophic Name	Chlorophyll (ppb)	Water Clarity (m)	Watershed use	Max depth (m)	Lake Area (km ²)	Percent Littoral	Perimeter (km)
Buchanan	Ottertail	1	Mesotrophic	7.85	2.90	Agriculture	12.8	3.90	86.70	12.96
Itasca	Clearwater	4	Mesotrophic-Eutrophic	13	1.65	Forest	12.2	4.31	42.15	22.95
Ozawindib	Clearwater	4	Oligotrophic-Mesotrophic	4.33	3.51	Forest	24.4	0.64	39.62	6.53
Elk	Clearwater	4	Mesotrophic	4	2.44	Forest	28.3	1.23	24.09	6.24
Trout	Cook	1	Oligotrophic-Mesotrophic	1	5.43	Forest	23.5	1.05	22.77	5.20
Josephine	Hubbard	3	-	1.3	0.80	Forest	9.4	0.04	-	-
Arco	Hubbard	4	-	5.1	0	Forest	9.4	0.02	-	-
Long	Hubbard	4	Mesotrophic	6	3.05	Forest	41.1	7.79	24.29	30.43
Deming	Hubbard	3	-	10.9	0.10	Forest	17.4	0.06	-	-
Boot	Hubbard	4	-	-	-	Forest	18	1.43	-	-
Mary	Hubbard	4	-	1.5	0.10	Forest	12.5	0.22	34.55	2.19
Beckman	Anoka	1	-	28.3	0.70	Developed	-	0.04	-	-
Cedar Bog	Anoka	1	-	57.2	1.50	Developed	-	0.01	100	-
Fish	Anoka	1	-	9.6	0.20	Developed	3.1	1.35	100	5.42
Pickereel	Freeborn	2	Eutrophic	187	0.17	Agriculture	1.2	2.01	100	9.12

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Lake Name	County	Number of times sampled	Trophic Name	Chlorophyll (ppb)	Water Clarity (m)	Watershed use	Max depth (m)	Lake Area (km ²)	Percent Littoral	Perimeter (km)
Minnesota	Faribault	2	Eutrophic	35	0.34	Agriculture	1.5	7.75	100	-
Island	St. Louis	1	Mesotrophic	-	1.40	Forest	28.7	32.38	40.74	186.8
Boulder	St. Louis	1	Mesotrophic	9	1.77	Forest	5.5	13.19	98.37	56.46
West Okoboji	Dickinson	2	Mesotrophic	5	4.82	Agriculture	40.8	15.57	59.5	31.87
East Okoboji	Dickinson	2	Eutrophic	23	1.80	Agriculture	6.7	7.43	30.7	27.04
Lower Gar	Dickinson	2	Eutrophic	16	0.91	Agriculture	1.7	0.98	100	6.28
Minnewashta	Dickinson	2	-	-	-	Agriculture	-	-	40.1	-
Upper Gar	Dickinson	2	Eutrophic	32	1.52	Agriculture	1.5	0.15	100	1.93
Lake of the Isles	Hennepin	1	Eutrophic	24	1.83	Urban	9.4	0.44	80.90	5.46
Cedar Lake	Hennepin	1	Eutrophic	9	1.86	Urban	15.5	0.66	38.46	4.86
Madison	Blue Earth	1	Eutrophic	57	0.64	Agriculture	21.0	5.85	49.92	19.96
St James	Watonwan	1	Eutrophic	26	0.70	Agriculture	4.7	0.82	100	6.02
Whiteface	St. Louis	1	Eutrophic	7	1.25	Forest	10.7	18.48	98.08	149.49
Namakan	St. Louis	1	Mesotrophic	2	3.26	Forest	45.7	97.39	20.88	514.88
Sandpoint	St. Louis	1	Mesotrophic	2	2.41	Forest	56.1	34.51	33.38	238.22
Entrance	Clearwater	1	-	-	1.50	Forest	-	-	-	-
East Twin	Clearwater	1	-	-	2.10	Forest	-	-	-	-
Geneva	Freeborn	1	Eutrophic	34	-	Agriculture	1.1	7.63	99.99	20.76
Fish	Hennepin	1	Eutrophic	61	1.58	Urban	14.9	0.96	45.17	8.21



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30 *Supplemental Figure S1: Relationship of dissolved oxygen and N₂/Ar Saturation ratio.*

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Supplemental Table S2: Information collected at each lake visit. Percent maximum depth refers to the area in the water column the sample was collected in relation to the maximum depth with values closer to 100 indicating samples taken from deeper in the water column. Dissolved oxygen saturation (%DO), specific conductivity, temperature, and pH were recorded the day of sampling using a Hydrolab water quality sonde.

Lake Name	Temperature (°C)	Month	N ₂ /Ar Saturation Ratio	Depth (m)	Percent Maximum depth	%DO	Specific Conductivity (µS)	pH
Arco	4.51	February	1.100	2	21.17			
Arco	4.51	February	1.020	4	42.33	39.8	96	6.8
Arco	4.61	February	1.062	9	95.25	2.2	174	6.68
Arco	20.54	July	1.014	2	21.17	78.6	100	8.21
Arco	10.97	July	1.004	5	52.92	88.6	102	8.76
Arco	7.01	July	1.037	7	74.08	58.4	115	6.69
Arco	5.61	July	1.042	9	95.25	7.5	218	6.54
Arco	7.97	October	1.027	7	74.08	54.7	122	6.37
Arco	5.44	October	0.996	9	95.25	10	246	5.88
Arco	11.31	October	1.004	2	21.17	72.9	95	6.88
Arco	11.28	October	1.001	5	52.92	69.3	96	6.88
Arco	21	September	1.025	2	21.17	87.6	103	7.68
Arco	16.7	September	1.003	5	52.92	122.4	105	7.57
Arco	8.6	September	1.058	7	74.08	2.3	112	6.9
Arco	7	September	1.025	9	89.96	1.5	246	6.51
Beckman	13	May	1.007	0	0	105.1	56	6.57
Beckman	15.5	May	1.009	0.5	100	98.7	57	6.44
Boot	2.89	February	1.014	2	11.12	95.4	310	8
Boot	3.26	February	1.011	4	22.24	90.9	306	8
Boot	3.3	February	1.013	6	33.36	89	306	8
Boot	19.84	July	1.005	2	11.12	75	318	8.36
Boot	19.06	July	1.005	5	27.8	74.9	320	8.31
Boot	8.99	July	1.020	9	50.05	83	331	8.25
Boot	7.2	July	1.018	15	83.41	49.1	337	7.13

Boot	6.09	July	1.023	20	90	16.2	343	6.78
Boot	5.56	July	1.027	25	100	2	350	6.67
Boot	12.18	October	1.060	2	11.12	91.3	300	7.75
Boot	12.18	October	0.994	5	27.8	95.5	301	7.7
Boot	12.18	October	1.028	10	55.61	101.4	300	7.7
Boot	8.14	October	1.030	15	83.41	46.7	331	6.78
Boot	7.1	October	1.045	18	100.09	35.3	328	6.7
Boot	20.33	September	1.024	2	11.12	106.8	294	8.44
Boot	18.6	September	1.023	7	38.93	108.3	319	8.3
Boot	8.5	September	1.032	12	66.73	66.9	350	7.62
Boot	6.98	September	1.034	17	94.53	0	350	7.22
Boot	6.05	September	1.037	22	100	0	353	7.13
Boulder	25	May	0.999	0.5	9.11	94.1	58	7.29
Boulder	15	May	0.998	1.5	27.34	75.1	58	6.82
Buchanan	22.72	August	1.048	2	15.62	92.6	388	8.79
Buchanan	22.6	August	1.042	4	31.25	92.6	388	8.79
Buchanan	22.58	August	1.166	5	39.06	91.3	389	8.76
Buchanan	22.39	August	1.115	7	54.68	78.1	390	8.71
Buchanan	22.17	August	1.111	9	70.3	71	393	8.61
Buchanan	21.74	August	1.059	10.5	82.02	46.5	401	8.28
Buchanan	19.74	August	1.050	11.5	89.83	11.2	428	7.57
Cedar Bog	10.14	May	1.012	0	0	96.2	57	6.67
Cedar Bog	10.14	May	1.012	1	100	74.8	336	6.8
Cedar Lake	21.68	June	1.025	2	12.87	104.7	664	8.05
Cedar Lake	12.71	June	1.016	5	32.17	82	719	6.79
Cedar Lake	9.45	June	1.021	7	45.03	51.7	730	6.66
Cedar Lake	7.33	June	1.013	9	57.9	24.9	762	6.41
Deming	8.19	July	1.014	2	11.51	71.8	135	8.19
Deming	6.94	July	1.005	4	23.02	61.2	136	6.94
Deming	5.18	July	1.027	6	34.54	5.9	164	6.59
Deming	4.68	July	1.060	9	51.8	3.2	209	6.34
Deming	5.07	July	1.127	14	80.58	2.4	597	5.99
Deming	4.92	October	1.001	10	57.56	12.7	299	5.93
Deming	5.02	October	0.924	12	69.07	7	502	5.02

Deming	5.11	October	1.014	14	80.58	5.8	550	5.62
Deming	10.26	October	0.992	2	11.51	83.7	124	7.05
Deming	9.39	October	0.991	5	28.78	78.8	138	6.87
Deming	20.8	September	1.011	2	11.51	94.1	136	8.04
Deming	10.4	September	1.028	5	28.78	5.8	156	7.06
Deming	5.7	September	1.032	8	46.05	1.9	197	6.57
Deming	5.4	September	0.986	12	69.07	0.9	475	6.14
East Okoboji	22.94	August	1.041	2	29.83	89.6	418	8.14
East Okoboji	22.74	August	1.068	4	59.65	46.7	417	7.96
East Okoboji	22.49	August	1.034	6	89.48	58.4	424	7.31
East Okoboji	16.81	May	1.001	2	29.83	97.5	352	8.41
East Okoboji	16.48	May	1.001	4	59.65	92.7	353	8.48
East Okoboji	16.36	May	0.999	6	89.48	90.5	357	8.41
Elk	2.34	February	0.986	2	7.06	93.1	300	6.63
Elk	2.57	February	1.028	5	17.64	84.9	295	7.03
Elk	2.8	February	0.999	10	35.28	72.2	303	7.09
Elk	20.07	July	1.007	2	7.06	83.5	305	8.46
Elk	18.67	July	1.007	5	17.64	82	307	8.36
Elk	7.7	July	1.017	9	31.75	33.2	332	6.96
Elk	6.45	July	1.016	15	52.92	13.3	331	6.77
Elk	5.49	July	1.013	20	70.56	2.4	337	6.68
Elk	5.32	July	1.013	25	88.19	1	347	6.74
Elk	11.39	October	1.049	10	35.28	80.2	301	7.5
Elk	7.12	October	1.084	14	49.39	12.4	330	6.76
Elk	6.04	October	1.014	18	63.5	5.5	335	6.68
Elk	11.98	October	0.995	2	7.06	88	295	7.67
Elk	11.9	October	0.993	5	17.64	83.8	295	7.67
Elk	20.42	September	1.021	2	7.06	105.6	293	8.35
Elk	15.34	September	0.999	7	24.69	80.5	339	7.81
Elk	8.46	September	1.015	10	35.28	13.7	342	7.29
Elk	6.79	September	1.012	15	52.92	0	343	7.1
Elk	5.52	September	1.016	22	77.61	1.5	359	7.05
Fish	13	May	1.002	0.5	16.4	109.7	91	7.77
Fish	12.5	May	1.002	1	32.81	107.8	91	7.91
Fish Lake	17.63	July	1.057	6	40.17	0	469	7.13

Fish Lake	25.46	July	1.060	4	26.78	71.1	453	7.63
Fish Lake	22.43	July	1.053	5	33.48	0	461	7.24
Fish Lake	25.96	July	1.040	3	20.09	89.7	454	7.78
Fish Lake	26.39	July	1.040	2	13.39	113.1	450	8.06
Geneva	21.21	August	1.015	0.5	41.01	98.4	351	8.32
Geneva	21.43	August	1.045	0.5	41.01	98.4	351	8.32
Island	11.5	May	1.014	2	6.98	85.9	54	6.56
Island	10.5	May	1.009	6	20.94	80.1	54	6.62
Island	10.5	May	1.005	8	27.92	77.9	55	6.79
Island	10	May	1.003	12	41.88	76.5	55	7.05
Itasca	1.26	February	0.988	2	16.4	84.3	329	7.78
Itasca	2.19	February	1.002	5	41.01	52.5	338	7.58
Itasca	2.68	February	0.988	7	57.41	41.4	354	7.56
Itasca	20.66	July	0.999	1	8.2	79.9	339	8.7
Itasca	20.65	July	1.000	1.5	12.3	80	339	8.71
Itasca	20.65	July	1.000	2	16.4	80.1	339	8.71
Itasca	20.6	July	1.001	2.5	20.51	80.2	339	8.71
Itasca	20.56	July	1.000	3	24.61	80.3	338	8.71
Itasca	20.53	July	1.002	3.5	28.71	80	338	8.7
Itasca	20.47	July	1.002	4	32.81	79.8	337	8.7
Itasca	20.38	July	1.003	4.5	36.91	79.7	337	8.64
Itasca	20.4	July	1.004	5	41.01	77.8	340	8.58
Itasca	19.52	July	1.031	5.5	45.11	71	343	8.54
Itasca	19.32	July	1.032	6	49.21	68.1	343	8.42
Itasca	18.4	July	1.031	6.5	53.31	60.6	350	8.07
Itasca	15.97	July	1.032	7	57.41	37.7	361	7.77
Itasca	15.97	July	1.033	7.5	61.52	37.7	361	7.77
Itasca	14.56	July	1.031	8	65.62	14	367	7.68
Itasca	13.68	July	1.026	8.5	69.72	7.1	366	7.65
Itasca	11.98	July	1.059	9	73.82	3.7	369	7.65
Itasca	10.86	July	1.049	9.5	77.92	2.9	372	7.63
Itasca	10.15	July	1.027	10	82.02	2.4	376	7.61
Itasca	9.55	July	1.030	10.5	86.12	2.2	385	7.57
Itasca	11.46	October	1.029	8	65.62	70.6	313	7.23
Itasca	11.46	October	1.031	10	82.02	70	314	7.08

Itasca	11.49	October	0.997	2	16.4	76.2	313	7.37
Itasca	11.47	October	0.997	4	32.81	73.6	314	7.35
Itasca	11.47	October	1.001	6	49.21	72.6	314	7.31
Itasca	20.61	September	1.019	2	16.4	86.6	326	8.1
Itasca	19.5	September	1.019	7	57.41	86.4	339	7.95
Itasca	15.88	September	1.006	9	73.82	90.8	391	7.44
Itasca	10.43	September	1.034	11	90.22	98.3	448	7.24
Josephine	20.77	July	1.014	2	21.17	75.3	69	8.13
Josephine	18.49	July	0.995	4	42.33	76.8	69	8.08
Josephine	9.1	July	1.016	7	74.08	35.3	73	6.75
Josephine	7.26	July	1.018	9	95.25	6.7	82	6.44
Josephine	11.57	October	1.023	7	74.08	82.8	64	6.94
Josephine	10.52	October	1.030	9.5	100	75.2	92	6.59
Josephine	11.64	October	0.996	2	21.17	90.7	64	6.95
Josephine	11.63	October	0.995	5	52.92	84.5	64	6.95
Josephine	21.2	September	1.014	2	21.17	89.3	71	7.53
Josephine	20.9	September	1.012	5	52.92	86.9	71	7.45
Josephine	11.1	September	1.035	9	95.25	2	65	5.98
Josephine	8.7	September	1.034	10.5	100	0.5	186	6.2
Lake of the Isles	23.01	June	1.016	2	21.17	83.1	609	8.75
Lake of the Isles	23.01	June	1.016	2	21.17	83.1	609	8.75
Long	2.77	February	1.020	2	4.86	110.3	333	7.98
Long	3.23	February	1.019	5	12.15	94.1	331	8.03
Long	3.84	February	1.018	18	43.74	71.1	342	7.96
Long	19.33	July	1.009	2	4.86	120	339	
Long	18.99	July	1.003	4	9.72	120	339	
Long	17.91	July	1.002	6	14.58	120	339	
Long	11.83	July	1.030	9	21.87	120	352	
Long	9.04	July	1.033	11	26.73	105	350	
Long	6.97	July	1.028	14	34.02	87	351	
Long	12.55	October	1.025	2	4.86	89.7	324	7.98
Long	12.53	October	0.994	5	12.15	89.1	324	7.96
Long	12.51	October	1.026	10	24.3	88.5	324	7.95

Long	7.56	October	1.011	15	36.45	19.4	360	6.95
Long	6.87	October	1.026	18	43.74	14.2	365	6.86
Long	8.21	September	1.022	2	4.86	109	335	8.21
Long	8.27	September	1.022	7	17.01	108.9	336	8.27
Long	11.16	September	1.024	11	26.73	89.7	369	7.63
Long	7.17	September	1.032	15	36.45	0	377	7.18
Long	6.17	September	1.037	22	53.47	0	389	6.99
Lower Gar	22.68	August	1.026	0.5	27.34	98.9	382	
Lower Gar	22.67	August	1.026	1	54.68	98.7	381	
Lower Gar	19.05	May	0.994	0.5	27.34	119.7	361	8.77
Lower Gar	18.73	May	0.994	1	54.68	123	356	9.02
Madison	23.08	June	1.019	2	9.51			
Madison	22.89	June	1.018	5	23.77			
Madison	17.81	June	1.016	7	33.28			
Madison	15.07	June	1.012	8.5	40.42			
Mary	1.63	February	1.002	2	16	96.5	278	8.03
Mary	3.45	February	0.995	7	56.01	66.3	295	7.54
Mary	2.85	February	0.998	5	40.01	82.4	287	7.63
Mary	20.34	July	1.011	2	16	81.7	300	8.29
Mary	16.37	July	1.005	4	32.01	70.8	312	7.54
Mary	9.63	July	1.017	6	48.01	29.2	314	6.91
Mary	8.22	July	1.015	8	64.02	4	317	6.73
Mary	7.96	July	1.015	9	72.02	2.1	320	6.71
Mary	12.03	October	1.003	2	16	81.5	283	7.58
Mary	12.01	October	1.023	4	32.01	84.8	283	7.52
Mary	12	October	1.045	5	40.01	85.1	283	7.52
Mary	11.94	October	1.026	7	56.01	85.9	283	7.51
Mary	11.8	October	1.034	9	72.02	86.6	284	7.45
Mary	20.93	September	1.020	2	16	99.8	286	8.21
Mary	19.13	September	1.015	5	40.01	57.3	319	7.5
Mary	15.65	September	1.024	6	48.01	0	318	7.22
Mary	12.01	September	1.021	7	56.01	0	328	7.18
Minnesota 1	14.5	May	1.001	0.2	13.12	121	424	8.27
Minnesota 1	14.5	May	0.999	0.5	32.81	123.4	423	8.25
Minnesota 2	14.5	May	0.999	0	0	208.2	426	8.2

Minnesota 2	14.5	May	0.997	0.5	32.81	107.5	425	8.2
Minnewashta	23.08	August	1.030	2	39.77	92.1	389	8.05
Minnewashta	22.59	August	1.030	4	79.54	85.5	386	7.92
Minnewashta	18.03	May	0.995	2	39.77	112.4	360	8.69
Minnewashta	17.19	May	0.995	4	79.54	116.5	363	8.46
Namaken	7.16	August	1.010	2	4.37	101.1	48	7.18
Namaken	7.05	August	1.015	5	10.94	95.9	48	7.06
Namaken	7.01	August	1.010	7	15.31	93.9	48	7.01
Namaken	6.8	August	1.011	10	21.87	86.7	48	6.8
Ozawindib	1.87	February	1.006	5	20.51	92.5	163	7.76
Ozawindib	3.05	February	1.002	10	41.01	81.3	167	7.59
Ozawindib	3.47	February	0.998	20	82.02	33.5	192	7.27
Ozawindib	1.87	February	1.012	2	8.2	97.2	165	7.76
Ozawindib	3.19	February	1.004	15	61.52	60.4	177	7.39
Ozawindib	20.1	July	1.044	2	8.2	78.3	181	8.24
Ozawindib	13.9	July	1.029	5	20.51	81.7	178	7.81
Ozawindib	7.11	July	1.017	9	36.91	55.1	180	6.89
Ozawindib	6.16	July	1.020	15	61.52	30.4	183	6.62
Ozawindib	6.1	July	1.020	19	77.92	27.2	185	6.57
Ozawindib	7.39	October	1.016	10	41.01	63.1	173	6.85
Ozawindib	6.53	October	1.017	12	49.21	19.2	177	6.43
Ozawindib	6.34	October	1.025	15	61.52	13	178	6.29
Ozawindib	11.55	October	1.003	2	8.2	91.5	167	7.66
Ozawindib	11.45	October	0.993	5	20.51	88.4	167	7.5
Ozawindib	20.1	September	1.024	2	8.2	101.1	179	8.07
Ozawindib	20.1	September	1.017	5	20.51	100.9	179	8.01
Ozawindib	8.91	September	1.019	9	36.91	54.6	183	7.15
Ozawindib	6.34	September	1.031	12.5	51.26	0	186	6.81
Pickerel 1	13.5	May	1.013	0	0	101	431	7.87
Pickerel 1	13.5	May	1.015	1	82.02	90.7	435	7.83
Pickerel 2	13.5	May	1.009	0	0	120.8	426	7.93
Pickerel 2	13	May	1.009	1	82.02	104.5	426	7.87
Sandpoint	12	August	1.050	10	17.83	48.6	66	6.33
Sandpoint	9	August	1.040	12.5	22.29	58.1	65	6.31
Sandpoint	22.09	August	1.010	2	3.57	93.7	72	7.07

Sandpoint	18.63	August	1.009	7	12.48	54	69	6.54
St. James	23.3	June	1.034	0.5	10.65			
St. James	23.29	June	1.032	2	42.61			
Trout	16.11	June	1.031	5	21.3	90	33	7.58
Trout	16.11	June	1.007	7	29.83	88.5	33	7.29
Trout	16.11	June	1.002	8	34.09	89	33	6.91
Trout	16.11	June	1.002	9	38.35	88	33	6.78
Trout	16.11	June	1.028	2	8.52	95.9	34	7.71
Trout	16.11	June	1.018	3	12.78	92.8	34	7.45
Upper Gar	8.13	August	1.049	0.5	32.81	119.2	408	8.52
Upper Gar	7.81	August	1.030	2	100	6.8	647	6.91
Upper Gar	18.32	May	1.004	1	65.62	107.6	350	9.48
Whiteface	18.56	August	1.149	2	18.75	73.1	61	7.09
Whiteface	18.56	August	1.055	4	37.5	67.1	61	6.91
Whiteface	18.56	August	1.082	6	56.24	52.7	62	6.77
Whiteface	18.56	August	1.044	8	74.99	12.7	64	6.52
Whiteface	18.56	August	1.195	9	84.36	0.5	66	6.49

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