Lake Hopatcong Commission
Trout Committee
NOT FOR EXTERNAL DISTRIBUTION

RE: Preliminary Trout Habitat Data 2022

July 12, 2022

This memorandum presents the preliminary July trout habitat data collected under both the annual lake monitoring program and the complementary trout habitat study; it includes events conducted on July 5 and July 11, 2022. The data includes both the in-situ water quality tables for the two events (including highlighting viable trout habitat in blue) and figures showing the St-2 (Mid-Lake) temperature and dissolved oxygen (DO) profiles. In addition to the profiles, the figures show various habitat thresholds including the upper temperature bound (26°C) and the lower dissolved oxygen bound (5.0 mg/L) as vertical lines. It also presents two horizontal lines representing the upper and lower trout habitat bounds in the lake as determined by the intersection of the collected data and the habitat threshold bounds.

Analysis will be kept to a minimum in these continuing memoranda as we move forward, but significant events will be highlighted. As the first memorandum, some brief commentary regarding the early portion of the study will be offered. During the July 5 event all stations exceeded 25°C at the surface, but they remained slightly below the temperature threshold and thus habitat should extend all the way to the surface. The lake was well stratified, and at all stations with sufficient depth (excluding the shallow King's Cove station) the lake was anoxic in the hypolimnion. As such, low DO established a lower bound of trout habitat at all those stations. At three of four stations, that lower bound was around 5.5 m or deeper. The mid-lake St-2 station had anoxia and general oxygen depression occurring at a significantly shallower depth, at an estimated 4.25 m.

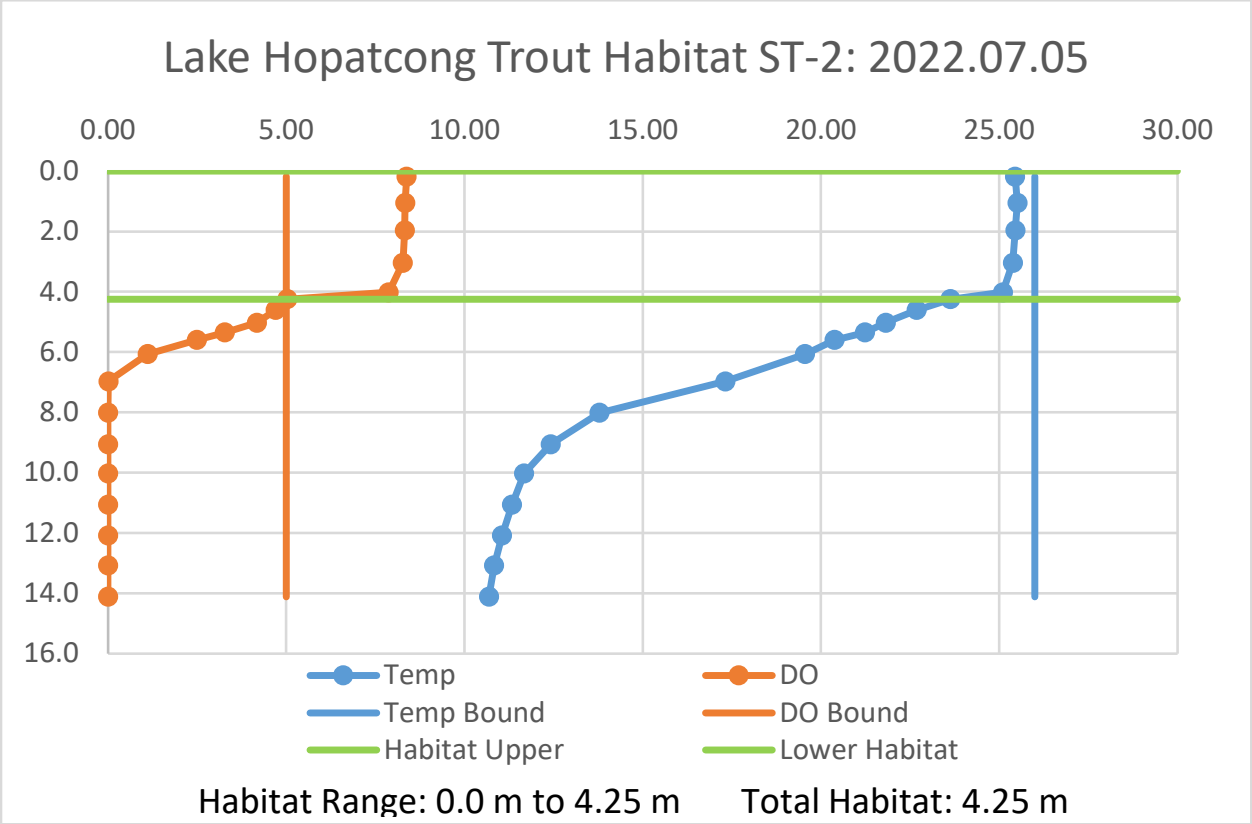
A week later (July 11), some interesting patterns were developing. Surface temperature showed a minute rise, but all stations remained below the 26°C threshold. At St-2, due to increasing temperatures the surface layer or epilimnion started to migrate down in the water column. Because oxygenation occurs within the well-mixed surface layer, the DO threshold was also pushed deeper in the water column to about 4.80 m. As a result, at this station, trout habitat thickness increased by about 0.5 m which is positive news. The flipside of continued thermal stratification is that anoxia (here a working definition of less than 1.0 mg/L is used) actually moved up in the water column to about 5.3 m versus 6.3 m one week earlier. This is a consequence of continued consumption or exhaustion of oxygen below the thermocline.

In the coming weeks water quality patterns will continue to shift. It is expected that water temperatures will continue to creep upwards. Eventually, this will result in the upper bound of usable trout habitat being pushed deeper and no longer extending to the surface. If the thermocline continues to migrate down in the water column as a result of warming, the lower habitat bound should follow it to some extent, yet the total amount of available DO below the top of the thermocline is nearly entirely exhausted. Weather patterns will dictate what this looks like moving ahead as both temperature as well as cloud cover, precipitation, and wind are all controls on the thermal stratification and mixing.

Lake Hopatcong *In-Situ* Monitoring Data 2022.07.05

Station	Depth (m)			Temp.	SpC	DO		pH
	Total	Secchi	Sample	°C	µg/L	Conc. (mg/L)	Sat. (%)	s.u.
Byram Bay	10.4	1.9	0.2	25.02	435.83	8.04	100.2	7.54
			1.1	25.02	436.07	8.05	100.3	7.50
			2.1	24.97	435.77	8.00	99.8	7.45
			3.0	24.92	435.45	7.98	99.2	7.34
			4.0	24.85	435.18	7.92	98.3	7.16
			5.0	24.04	430.78	6.49	79.4	6.91
			5.3	22.70	427.86	5.26	62.8	6.81
			5.6	21.49	427.97	3.96	46.2	6.64
			6.0	20.38	425.42	2.38	27.1	6.55
			7.1	18.33	420.12	0.19	2.0	6.44
			8.0	15.64	421.62	0.00	0.0	6.40
			9.0	13.51	427.39	0.00	0.0	6.46
			10.0	12.01	432.04	0.00	0.0	6.57
Halsey Island	10.4	1.9	0.3	25.41	435.73	8.21	103.1	7.57
			1.0	25.36	436.34	8.22	103.1	7.60
			2.0	25.30	436.41	8.19	102.6	7.54
			3.0	25.25	436.51	8.16	102.1	7.48
			4.0	25.23	436.71	8.09	101.2	7.31
			5.1	25.19	436.75	7.94	99.3	7.17
			5.3	23.97	438.93	6.33	77.3	6.84
			5.6	23.08	430.25	5.70	68.6	6.79
			6.0	19.98	426.46	1.05	12.7	6.57
			7.0	17.44	422.30	0.09	1.0	6.44
			7.9	15.72	424.43	0.00	0.0	6.41
			10.1	12.10	423.47	0.00	0.0	6.51
Mid-Lake	14.3	1.8	0.2	25.44	436.38	8.38	105.3	7.75
			1.1	25.51	436.48	8.33	104.8	7.75
			2.0	25.45	436.32	8.32	104.5	7.70
			3.0	25.38	436.27	8.27	103.7	7.60
			4.0	25.10	435.91	7.88	98.3	7.35
			4.2	23.63	435.97	5.03	61.1	6.83
			4.6	22.69	431.30	4.70	56.1	6.79
			5.0	21.81	427.34	4.18	49.0	6.72
			5.3	21.23	427.45	3.28	38.1	6.64
			5.6	20.38	426.62	2.49	28.4	6.51
			6.1	19.56	424.94	1.11	11.7	6.47
			7.0	17.32	420.24	0.01	0.1	6.39
			8.0	13.79	418.11	0.00	0.0	6.38
			9.1	12.42	420.65	0.00	0.0	6.44
			10.0	11.68	419.57	0.00	0.0	6.51
			11.1	11.34	426.47	0.00	0.0	6.58
			12.1	11.05	431.68	0.00	0.0	6.70
			13.1	10.83	439.16	0.00	0.0	6.87
			14.1	10.68	444.68	0.00	0.0	7.02
Great Cove	7.1	1.9	0.2	25.62	436.17	8.48	106.9	7.80
			0.9	25.59	436.19	8.44	106.4	7.83
			2.0	25.56	436.40	8.43	106.1	7.80
			3.0	25.49	436.16	8.42	105.9	7.71
			4.0	25.45	436.41	8.36	105.0	7.57
			4.3	25.41	436.42	8.29	104.2	7.45
			4.5	25.40	436.62	8.29	104.1	7.38
			5.0	25.40	437.43	7.87	98.8	7.27
			5.3	25.37	436.92	7.88	98.9	7.25
			5.6	22.73	434.66	3.92	46.7	6.89
			6.0	19.97	422.90	0.67	7.6	6.67
			7.0	17.77	426.07	0.03	0.3	6.47
King's Cove	2.5	1.3	0.2	25.94	443.01	7.65	97.0	7.41
			1.1	25.92	442.65	7.67	97.3	7.40
			2.0	25.50	440.60	7.32	91.5	7.29

Trout Habitat Highlighted in Pale Blue

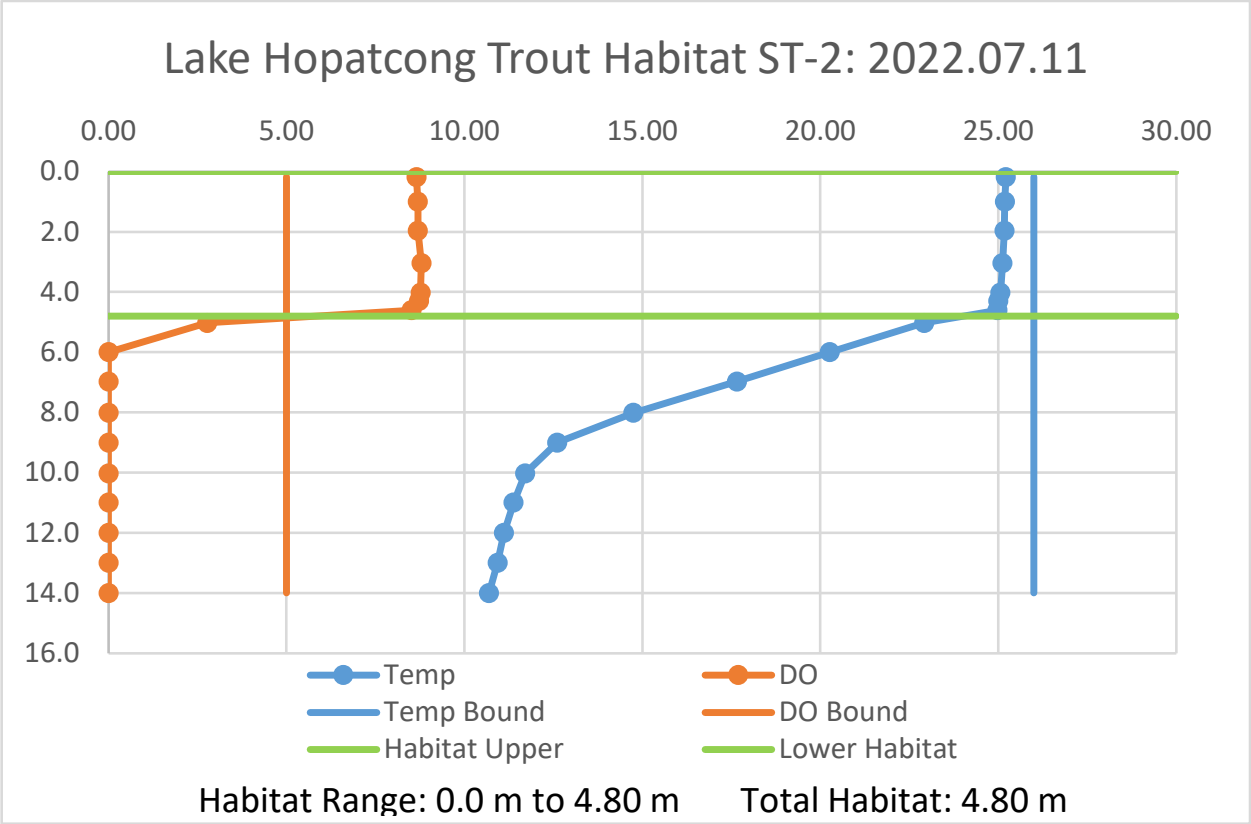


Habitat Range: 0.0 m to 4.25 m Total Habitat: 4.25 m

Lake Hopatcong *In-Situ* Monitoring Data 2022.07.11

Station	Depth (m)			Temp.	SpC	DO		pH
	Total	Secchi	Sample	°C	µg/L	Conc. (mg/L)	Sat. (%)	s.u.
Byram Bay	10.3	1.7	0.2	25.83	442.10	8.71	110.5	7.81
			1.0	25.74	442.20	8.73	110.6	7.82
			2.0	25.58	441.70	8.71	109.9	7.80
			3.0	25.43	441.90	8.67	109.2	7.78
			4.0	35.31	442.30	8.49	106.8	7.73
			5.0	25.24	442.30	8.18	102.7	7.67
			5.3	23.43	436.70	2.90	35.5	7.21
			6.0	21.78	431.90	0.00	0.0	6.95
			7.0	18.50	429.30	0.00	0.0	6.85
			8.0	14.89	432.90	0.00	0.0	6.85
			9.0	12.91	434.50	0.00	0.0	6.89
			10.0	12.14	437.60	0.00	0.0	6.93
Halsey Island	10.2	1.6	0.3	25.56	444.70	8.71	110.0	7.86
			1.0	25.53	444.50	8.73	109.9	7.87
			2.0	25.53	444.30	8.73	110.0	7.87
			3.0	25.48	444.40	8.71	110.8	7.86
			4.0	25.45	444.40	8.70	109.7	7.84
			5.0	25.41	444.40	8.63	108.7	7.81
			5.3	25.39	444.30	8.54	107.5	7.79
			5.6	25.31	444.40	8.32	105.3	7.72
			6.0	23.65	439.90	3.99	48.6	7.31
			6.3	19.60	419.60	0.00	0.0	6.96
			7.0	17.69	424.70	0.00	0.0	6.87
			8.0	15.10	429.90	0.00	0.0	6.84
			9.0	13.95	430.60	0.00	0.0	6.85
			10.0	12.79	430.30	0.00	0.0	6.88
Mid-Lake	14.4	1.8	0.2	25.21	446.20	8.65	108.7	7.91
			1.0	25.18	444.40	8.69	108.9	7.92
			2.0	25.17	444.90	8.69	108.9	7.93
			3.0	25.12	444.80	8.79	110.1	7.95
			4.0	25.06	444.90	8.77	109.8	7.97
			4.3	25.00	445.40	8.72	109.1	7.89
			4.6	24.98	448.10	8.51	106.0	7.87
			5.0	22.92	438.10	2.78	33.5	7.15
			6.0	20.26	431.10	0.00	0.0	6.91
			7.0	17.66	428.50	0.00	0.0	6.88
			8.0	14.75	429.00	0.00	0.0	6.93
			9.0	12.61	427.00	0.00	0.0	6.97
			10.0	11.71	428.20	0.00	0.0	6.98
			11.0	11.38	431.90	0.00	0.0	6.99
			12.0	11.11	434.80	0.00	0.0	7.60
			13.0	10.93	440.90	0.00	0.0	7.00
			14.0	10.69	446.60	0.00	0.0	7.02
Great Cove	8.2	1.8	0.2	25.77	443.80	9.06	114.9	8.15
			1.0	25.71	443.70	9.08	114.9	8.14
			2.0	25.56	443.50	8.94	112.5	8.06
			3.0	25.46	443.80	8.76	110.2	8.00
			4.0	25.40	444.10	8.37	105.4	7.83
			4.3	25.37	444.50	8.21	103.2	7.78
			4.6	25.35	444.70	8.21	103.1	7.74
			5.0	25.32	444.90	8.04	101.8	7.68
			5.3	25.28	445.10	7.80	97.8	7.62
			5.6	24.11	442.10	4.70	58.7	7.41
			6.0	21.12	431.20	0.00	0.0	7.07
			7.0	17.64	428.60	0.00	0.0	6.94
			8.0	16.70	431.50	0.00	0.0	6.87
King's Cove	2.7	1.0	0.2	25.36	446.80	7.48	94.1	7.38
			1.0	25.34	447.00	7.46	93.5	7.37
			2.0	25.35	446.90	7.44	93.5	7.36
			2.5	25.31	447.10	7.35	92.4	7.33

Trout Habitat Highlighted in Pale Blue


Lake Hopatcong Trout Habitat ST-2: 2022.07.11
0.00
5.00
10.00
15.00
20.00
25.00
30.00
0.0
2.0
4.0
6.0
8.0
10.0
12.0
14.0
16.0
Temp
DO
Temp Bound
DO Bound
Habitat Upper
Lower Habitat
Habitat Range: 0.0 m to 4.80 m
Total Habitat: 4.80 m

Lake Hopatcong Commission
Trout Committee
NOT FOR EXTERNAL DISTRIBUTION

RE: Preliminary Trout Habitat Data July 18, 2022

July 20, 2022

This memorandum presents the preliminary trout habitat data collected on July 18, 2022. The data includes both the in-situ water quality table for the event (including highlighting viable trout habitat in blue) and figures showing the ST-2 (Mid-Lake) temperature and dissolved oxygen (DO) profiles. In addition to the profiles, the figures show various habitat thresholds including the upper temperature bound (26°C) and the lower dissolved oxygen bound (5.0 mg/L) as vertical lines. It also presents two horizontal lines representing the upper and lower trout habitat bounds in the lake as determined by the intersection of the collected data and the habitat threshold bounds.

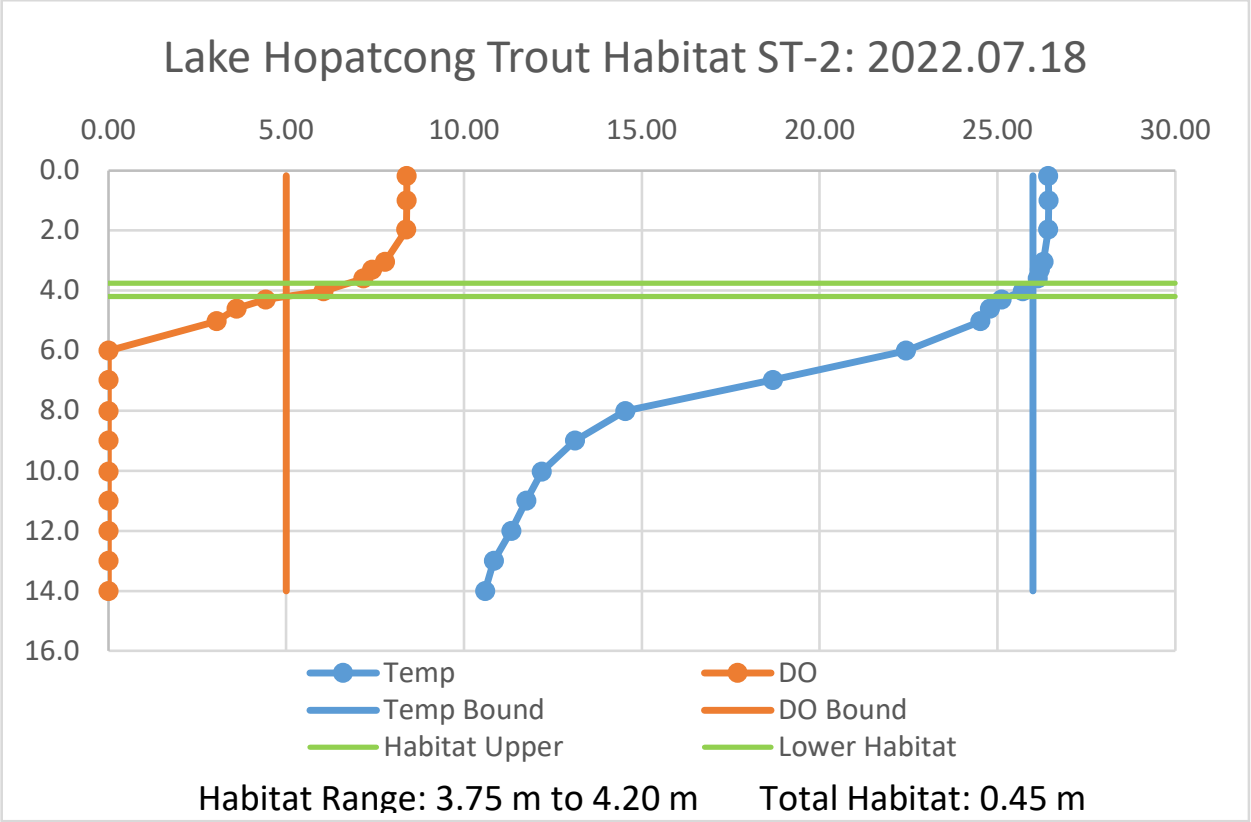
This event showed a marked change in available trout habitat. During the preceding event the approximate bounds extended from the surface to a depth of about 5.5 m dependent on location in the lake. During the last event it shrank significantly. At all five of the primary sampling stations surface temperatures exceeded the 26.0°C threshold. As such, the upper bound was pushed down to 2.7 m to 4.4 m reflecting significant warming of the epilimnion. The thermocline, sometimes better thought of as a zone covering some depth termed the metalimnion rather than a sharp boundary, was not quite as sharply defined as before. As a result, DO concentrations did not plunge to anoxia quite as quickly as before, but this is a very subtle distinction. Despite this difference, there was still rapid oxygen depression and the lower bound defined by a DO concentration of 5.0 mg/L actually came up slightly in the water column. As a result, trout habitat thickness was significantly reduced. At the mid-lake ST-2 station, trout habitat thickness was just 0.45 m covering the depths from roughly 3.75 m to 4.20 m. During the previous event ST-2 exhibited the lowest trout habitat thickness, while during this event it was the highest with the other stations ranging from 0.20 m to 0.35 m.

This obviously marks a critical time for trout in the lake. While there is no suggestion that contravening these bounds causes immediate death, they do represent acute stressors to the fish. The observed data very much reflected the predictions discussed in the last memorandum, namely that increasing temperatures would cause the upper bound to move down in the water column. While the thermocline broadened somewhat and was not as well defined, its upper bound did not show considerable movement and the lower habitat bound defined by DO concentration rose up slightly. Unless there is a significant change in the weather, perhaps punctuated by a storm event, considerable expansion of usable habitat is unlikely in the near term. It is possible that the thermocline may start showing some more substantial downward movement hopefully leading to somewhat improved DO concentrations at greater depths.

Lake Hopatcong *In-Situ* Monitoring Data 2022.07.18

Station	Depth (m)			Temp.	SpC	DO		pH
	Total	Secchi	Sample	°C	µg/L	Conc. (mg/L)	Sat. (%)	s.u.
Byram Bay	10.3	1.4	0.2	26.43	446.40	8.16	104.9	7.27
			1.0	26.49	446.20	8.14	104.7	7.39
			2.0	26.50	446.00	8.12	104.4	7.45
			3.0	26.44	446.20	8.07	103.8	7.46
			3.3	26.46	446.60	8.06	103.5	7.46
			3.6	26.42	446.70	8.02	102.9	7.47
			4.0	26.40	446.60	7.97	102.1	7.48
			4.3	26.19	445.60	7.39	94.3	7.42
			4.6	25.27	442.80	5.20	65.6	7.12
			5.0	24.54	440.90	2.91	36.2	6.96
			6.0	22.14	433.20	0.00	0.0	6.77
			7.0	19.11	432.70	0.00	0.0	6.65
			8.0	15.00	430.90	0.00	0.0	6.54
			9.0	13.79	432.70	0.00	0.0	6.52
			10.0	12.52	436.40	0.00	0.0	6.54
Halsey Island	11.5	1.3	0.3	26.40	447.80	8.21	105.4	7.67
			1.0	26.46	447.00	8.20	105.9	7.72
			2.0	26.48	447.00	8.19	104.8	7.75
			3.0	26.46	447.00	8.14	104.7	7.71
			3.3	26.45	446.80	8.06	102.7	7.66
			3.6	26.32	446.40	7.68	98.2	7.63
			4.0	25.60	444.50	5.25	66.2	7.28
			4.3	24.96	443.30	3.58	44.9	7.08
			5.0	23.97	439.80	1.45	17.6	6.89
			6.0	22.11	434.20	0.00	0.0	6.67
			7.0	18.24	430.00	0.00	0.0	6.51
			8.0	15.70	425.70	0.00	0.0	6.46
			9.0	13.11	429.70	0.00	0.0	6.47
			10.0	12.17	429.30	0.00	0.0	6.48
			11.0	11.56	431.10	0.00	0.0	6.49
Mid-Lake	14.4	1.5	0.2	26.43	463.90	8.39	107.8	7.88
			1.0	26.44	459.80	8.39	107.8	7.92
			2.0	26.43	447.90	8.38	107.6	7.88
			3.0	26.29	448.70	7.78	99.5	7.61
			3.3	26.19	448.70	7.41	94.7	7.45
			3.6	26.13	448.00	7.17	91.5	7.32
			4.0	25.71	445.90	6.05	76.3	7.09
			4.3	25.12	444.30	4.42	54.8	6.87
			4.6	24.79	443.60	3.60	44.8	6.71
			5.0	24.52	443.50	3.04	35.8	6.64
			6.0	22.43	443.40	0.00	0.0	6.47
			7.0	18.69	429.40	0.00	0.0	6.40
			8.0	14.53	429.70	0.00	0.0	6.39
			9.0	13.12	429.40	0.00	0.0	6.43
			10.0	12.19	429.30	0.00	0.0	6.51
			11.0	11.75	432.00	0.00	0.0	6.56
			12.0	11.33	437.00	0.00	0.0	6.65
			13.0	10.84	447.90	0.00	0.0	6.79
			14.0	10.59	455.20	0.00	0.0	6.94
Great Cove	8.5	1.4	0.2	26.52	447.50	8.50	109.3	8.03
			1.0	26.54	447.50	8.48	109.3	8.02
			2.0	26.54	447.50	8.44	108.9	8.02
			2.3	26.44	448.10	8.43	108.3	7.89
			2.6	26.33	447.70	7.62	97.9	7.73
			3.0	25.76	445.20	5.70	72.2	7.45
			3.3	25.18	443.80	4.32	54.2	7.28
			3.6	24.88	443.40	3.69	46.0	7.12
			4.0	24.60	443.10	3.14	38.9	7.03
			5.0	24.10	439.90	1.81	22.3	6.90
			6.0	22.36	433.80	0.00	0.0	6.56
			7.0	18.33	430.60	0.00	0.0	6.45
			8.0	15.89	431.40	0.00	0.0	6.47
King's Cove	2.7	1.1	0.2	26.47	448.10	7.02	90.2	7.36
			1.0	26.48	448.20	7.05	90.6	7.42
			2.0	26.47	448.20	6.94	89.1	7.42
			2.5	26.02	448.60	5.35	68.6	7.32
			2.9	25.47	447.10	3.49	43.4	7.16

Trout Habitat Highlighted in Pale Blue



Habitat Range: 3.75 m to 4.20 m Total Habitat: 0.45 m

Lake Hopatcong Commission
Trout Committee
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RE: Preliminary Trout Habitat Data August 2, 2022

August 5, 2022

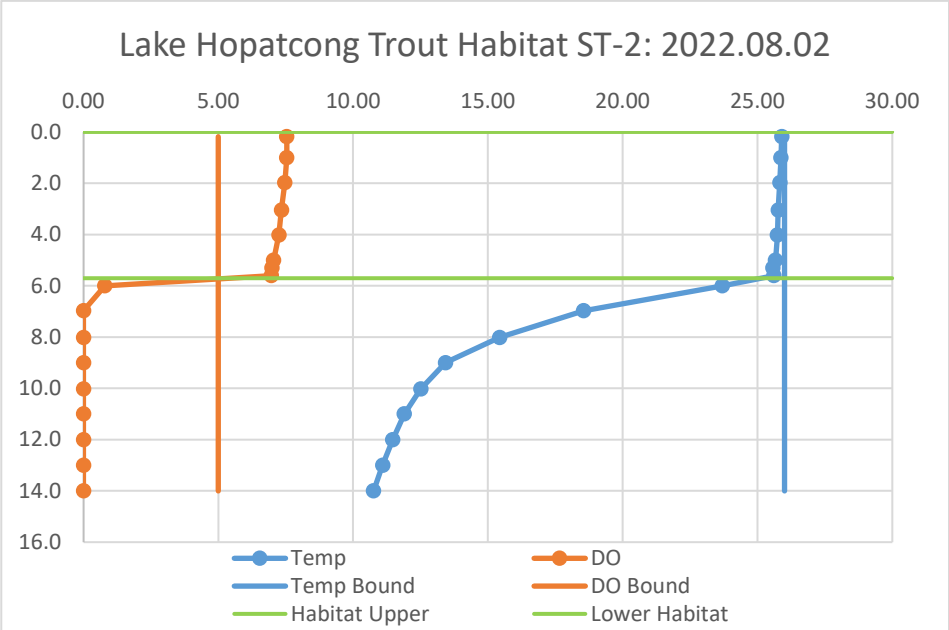
This memorandum presents the preliminary trout habitat data collected on August 2, 2022. The data includes both the in-situ water quality table for the event and figures showing the ST-2 (Mid-Lake) temperature and dissolved oxygen (DO) profiles. In addition to the profiles, the figures show various habitat thresholds including the upper temperature bound (26°C) and the lower dissolved oxygen bound (5.0 mg/L) as vertical lines. It also presents two horizontal lines representing the upper and lower trout habitat depth bounds in the lake as determined by the intersection of the collected data and the habitat threshold bounds.

As during the July 18 event, this early August event exhibited a marked change in available trout habitat in the lake, but this recent event showed a considerable expansion. First, there was a slight cooling at all stations near the surface, and two of the stations, including Mid-Lake and King's Cove, fell back under the 26°C threshold thereby extending the habitat to the surface at those locations. The cooling however was not consistent through the epilimnion, and in fact, as a result of warming near the top of the thermocline and within the upper metalimnion, the epilimnion expanded and the thermocline migrated down through the water column. This was a predicted result consistent with water quality patterns recorded over time and a good illustration of metalimnetic erosion, the slow downward migration of the thermocline. Expansion of the epilimnion means that deeper portions of the water column are starting to mix and become oxygenated. During the July event the lower habitat bound, which is defined by oxygen, averaged 4.04 m (excluding the shallow King's Cove station), while in the most recent event it averaged 6.00 m, opening up considerable trout habitat. As a result of both factors, but primarily the downward migration of the thermocline, average trout habitat at the four deeper stations jumped from just 0.35 m on July 18 to 3.48 m, a ten-fold expansion. At the mid-lake ST-2 station, which has been used as the benchmark for understanding these data, habitat thickness increased to 5.70 m, from the surface (0.00 m) to 5.70 m depth.

Overall, this is positive news, although the results should be tempered somewhat because temperatures in the epilimnion remain very high and small increases could substantially affect the assessed habitat. Moving ahead 90°F+ days can be counted on in August, and are likely to occur in September and potentially later. Yet, the expansion of the epilimnion and the downward movement of the thermocline is unlikely to reverse until the lake fully mixes establishing additional refuge at depth even if the surface temperatures should rise again. Conditions are still stressful to the fish, but can no longer be described as critical.

Lake Hopatcong *In-Situ* Monitoring Data 2022.08.02

Station	Depth (m)			Temp.	SpC	DO		pH
	Total	Secchi	Sample	°C	µg/L	Conc. (mg/L)	Sat. (%)	s.u.
Byram Bay	10.3	1.7	0.2	26.29	452.40	7.43	95.4	7.31
			1.0	26.23	452.60	7.34	94.7	7.39
			2.0	26.04	452.60	7.14	91.4	7.39
			3.0	26.00	452.80	7.00	89.5	7.35
			4.0	25.91	452.90	6.93	88.5	7.34
			5.0	25.83	453.10	6.88	87.7	7.34
			5.3	25.63	454.20	6.64	84.5	7.11
			5.6	25.63	453.70	6.61	83.9	7.11
			6.0	24.77	443.80	2.60	34.0	6.99
			7.0	19.26	443.70	0.00	0.0	6.91
			8.0	15.34	437.80	0.00	0.0	6.80
			9.0	12.44	440.50	0.00	0.0	6.67
			10.0	11.65	442.20	0.00	0.0	6.67
Halsey Island	10.2	1.7	0.3	26.31	454.90	7.75	99.6	7.57
			1.0	26.27	454.20	7.75	99.5	7.54
			2.0	26.16	454.30	7.74	99.1	7.58
			3.0	26.11	454.30	7.65	97.8	7.60
			4.0	26.01	454.40	7.41	95.1	7.55
			5.0	25.99	454.40	7.33	93.8	7.52
			6.0	25.65	455.60	6.03	79.1	7.15
			6.3	22.89	439.00	0.00	0.0	6.82
			7.0	17.84	444.80	0.00	0.0	6.83
			8.0	15.59	437.50	0.00	0.0	6.57
			9.0	14.14	439.00	0.00	0.0	6.55
			10.0	12.99	436.40	0.00	0.0	6.59
Mid-Lake	14.5	1.8	0.2	25.90	458.80	7.54	96.3	7.59
			1.0	25.87	455.00	7.54	96.3	7.59
			2.0	25.83	454.90	7.47	95.4	7.59
			3.0	25.77	454.70	7.34	93.4	7.56
			4.0	25.74	454.60	7.25	92.2	7.51
			5.0	25.67	454.70	7.05	89.6	7.49
			5.3	25.57	455.40	6.99	88.7	7.33
			5.6	25.61	455.20	6.97	88.5	7.39
			6.0	23.70	445.10	0.79	9.0	7.04
			7.0	18.55	440.30	0.00	0.0	6.90
			8.0	15.44	443.90	0.00	0.0	6.64
			9.0	13.43	433.10	0.00	0.0	6.56
			10.0	12.51	432.60	0.00	0.0	6.57
			11.0	11.90	434.40	0.00	0.0	6.58
			12.0	11.47	442.40	0.00	0.0	6.59
			13.0	11.10	447.00	0.00	0.0	6.63
			14.0	10.76	451.70	0.00	0.0	6.67
Great Cove	7.3	1.6	0.2	26.13	448.10	7.75	99.4	7.57
			1.0	26.10	448.40	7.74	99.1	7.60
			2.0	26.05	448.90	7.68	98.1	7.57
			3.0	26.04	449.60	7.81	97.3	7.57
			4.0	26.00	456.30	7.46	95.3	7.54
			5.0	25.96	451.20	7.42	94.9	7.49
			6.0	25.93	452.40	7.18	91.6	7.49
			6.3	25.41	456.10	6.17	78.1	7.10
			6.6	21.41	456.60	0.00	0.0	6.92
			7.0	19.61	450.00	0.00	0.0	6.87
King's Cove	2.7	1.2	0.2	25.65	452.20	6.43	85.5	7.37
			1.0	25.63	455.10	6.62	84.0	7.35
			2.0	25.52	455.40	6.48	82.1	7.33
			2.5	25.42	455.50	5.89	73.4	7.27



Habitat Range: 0.00 m to 5.70 m Total Habitat: 5.70 m