National Biological Assessment and Criteria Workshop

Advancing State and Tribal Programs

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**SI 101**

# *Using Stressor Response Relationships to Identify Causes of Impairment*


***Presented by***

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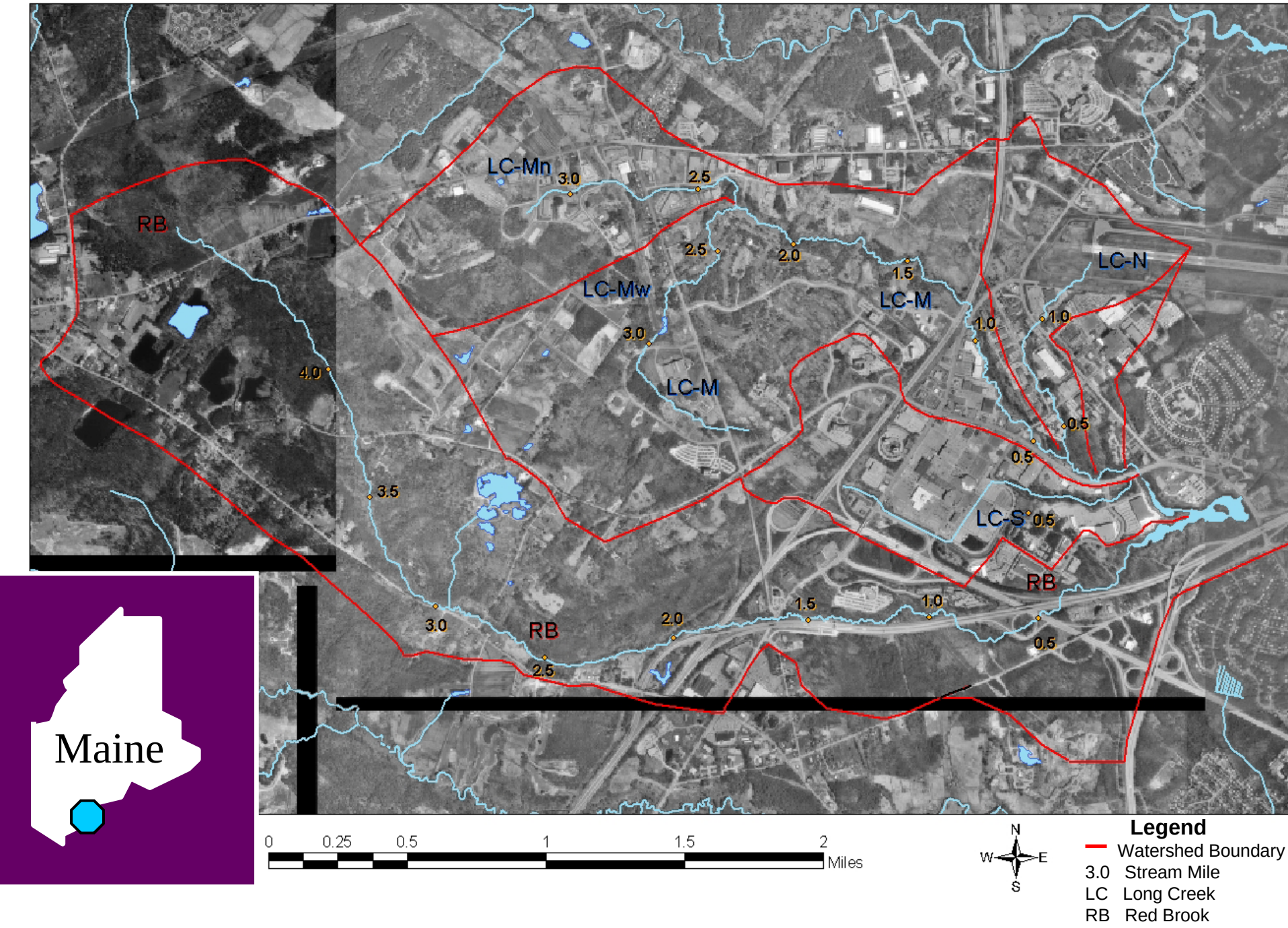
# Strength of Evidence

**Impairment:** Lack of Brook Trout

**Case Study:** Long Creek & Red Brook, ME

**Technique:** Using Our Own Data


LC-Mn
3.0
2.5
RB
2.5
2.0
1.5
LC-N
LC-Mw
LC-M
3.0
1.0
1.0
4.0
LC-M
0.5
0.5
3.5
LC-S
0.5
RB
1.5
1.0
3.0
RB
2.0
0.5
2.5
Maine
0
0.25
0.5
1
1.5
2
Miles
N
W
E
S
Legend
Watershed Boundary
3.0 Stream Mile
LC Long Creek
RB Red Brook

# Brook Trout Abundance

(200 m study reaches)

I - 95

LC(N)

LC(M)

LC(S)

RB

I - 295

Scarb. Conn.

Clark's Pond

0

0

0

0

0

0

0

16

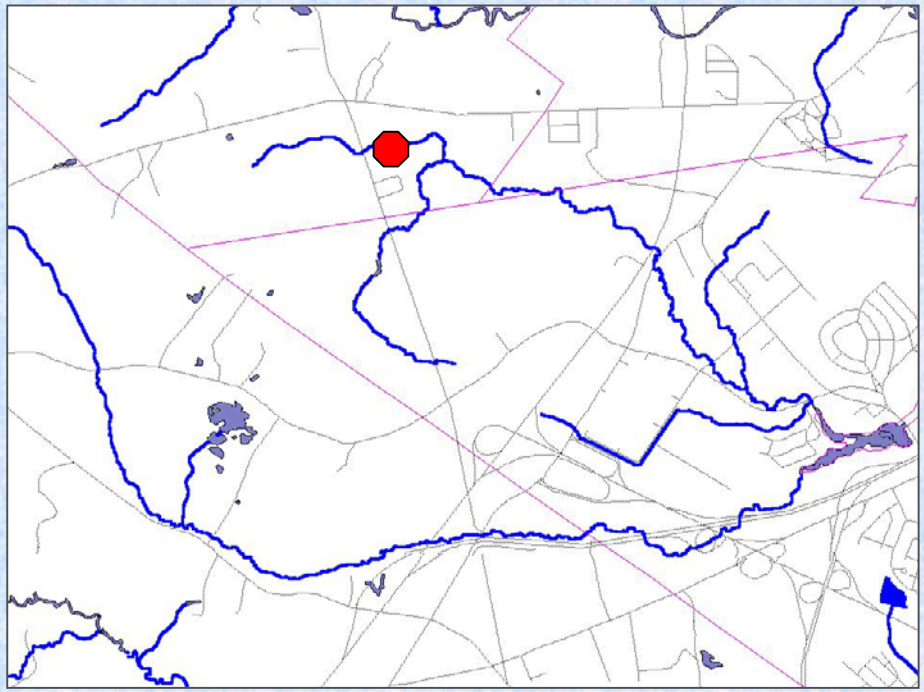
10

10

*Macroinvertebrate signals of stress were observed as well.*

# Potential Stressors

- ***Temperature***
- Dissolved Oxygen
- Sediment
- Toxins
  - Metals
  - Pesticides
  - PCBs
  - PAHs
- Food Quality
- Cover (LWD, etc.)
- Habitat Diversity



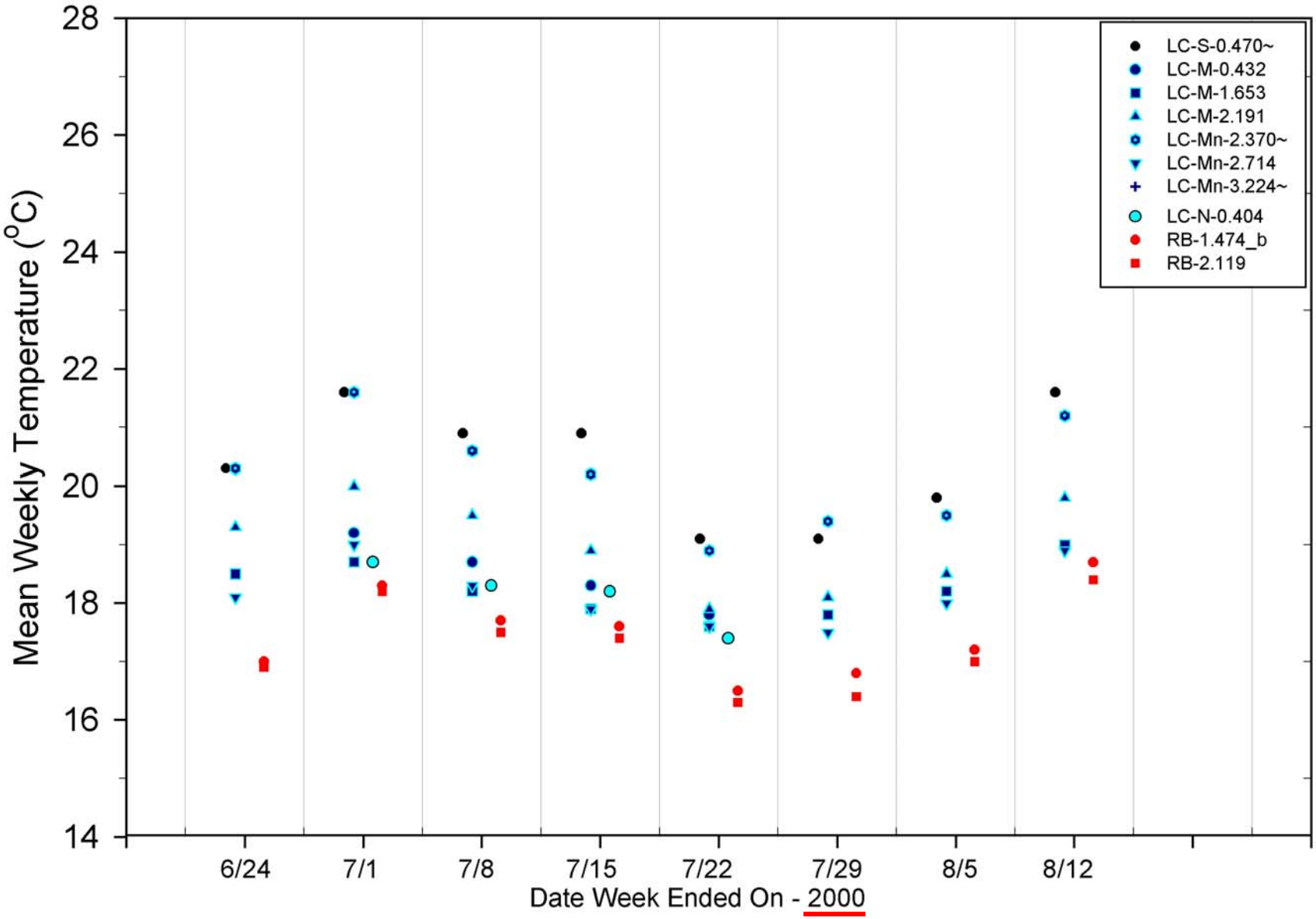



Figure 3.4.6. Mean weekly temperatures at various sites throughout the Long Creek and Red Brook watersheds. Note that symbols in this figure for 2000 do not exactly match those used in the 1999 mean temperature figure.

# Summary of Temperatures (°C) Observed to be Detrimental to Brook Trout[1]

## I. *Field Observations*

| Upper Limit of Temp. Observed (°C) | | Reference | |
|---|---|---|---|
| a) | 22 | a) Southern Ontario | (Barton et al. 1985) |
| b) | 25.6 | b) Southern Ontario | (Barton et al. 1985) |
| c) | 22-24 | c) Ontario | (Meisner 1990; also see review in Meisner 1990) |
| d) | 19-20 | d) Virginia | (Burton and Odum 1945) |
| e) | 22.3 | e) National database | (Eaton et al. 1995) |
| f) | 19-20 | f) | (*Review* in Hokanson et al. 1973) |

[1] Adapted from **McCullough, D. A.** 1999. A review and synthesis of effects of alterations to the water temperature regime on freshwater stages of salmonids, with special reference to chinook salmon. Prepared for the USEPA. EPA 910-R-99-010. 279 pp.

# Summary of Temperatures (°C) Observed to be Detrimental to Brook Trout[1]

## II. *Laboratory Experiments*

| Life Stage | Important Temperatures (°C) | Reference |
|---|---|---|
| Egg / Alevin | a) > 16 | a) (Hokanson et al. 1973). |
| | b) > 15; > 9 | b) (Hokanson et al. 1973, Humpesch 1985). |
| | c) ≥ 18 | c) (McCormick et al. 1972). |
| Juvenile | d) 24[a] - 25.5[b] | d) [a]Cherry et al. (1977) [b]Fry et al. (1946) |
| Adult | e) 16-19 | e) (Hokanson et al. 1973). |
| | f) 19 | f) (Hokanson et al. 1973). |
| | g) 9 | g) (Hokanson et al. 1973). |

[1] Adapted from **McCullough, D. A.** 1999. A review and synthesis of effects of alterations to the water temperature regime on freshwater stages of salmonids, with special reference to chinook salmon. Prepared for the USEPA. EPA 910-R-99-010. 279 pp.

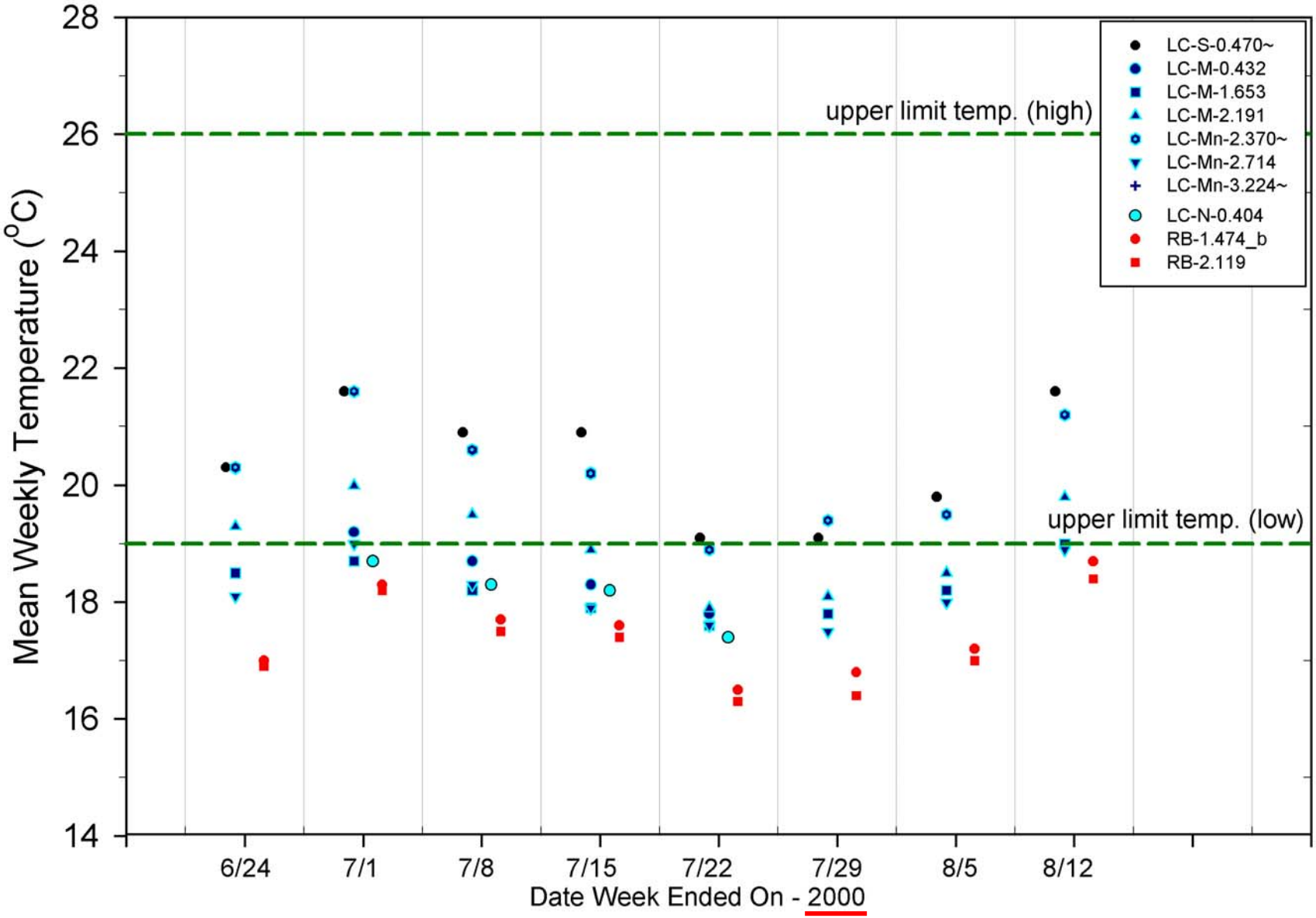



Figure 3.4.6. Mean weekly temperatures at various sites throughout the Long Creek and Red Brook watersheds. Note that symbols in this figure for 2000 do not exactly match those used in the 1999 mean temperature figure.

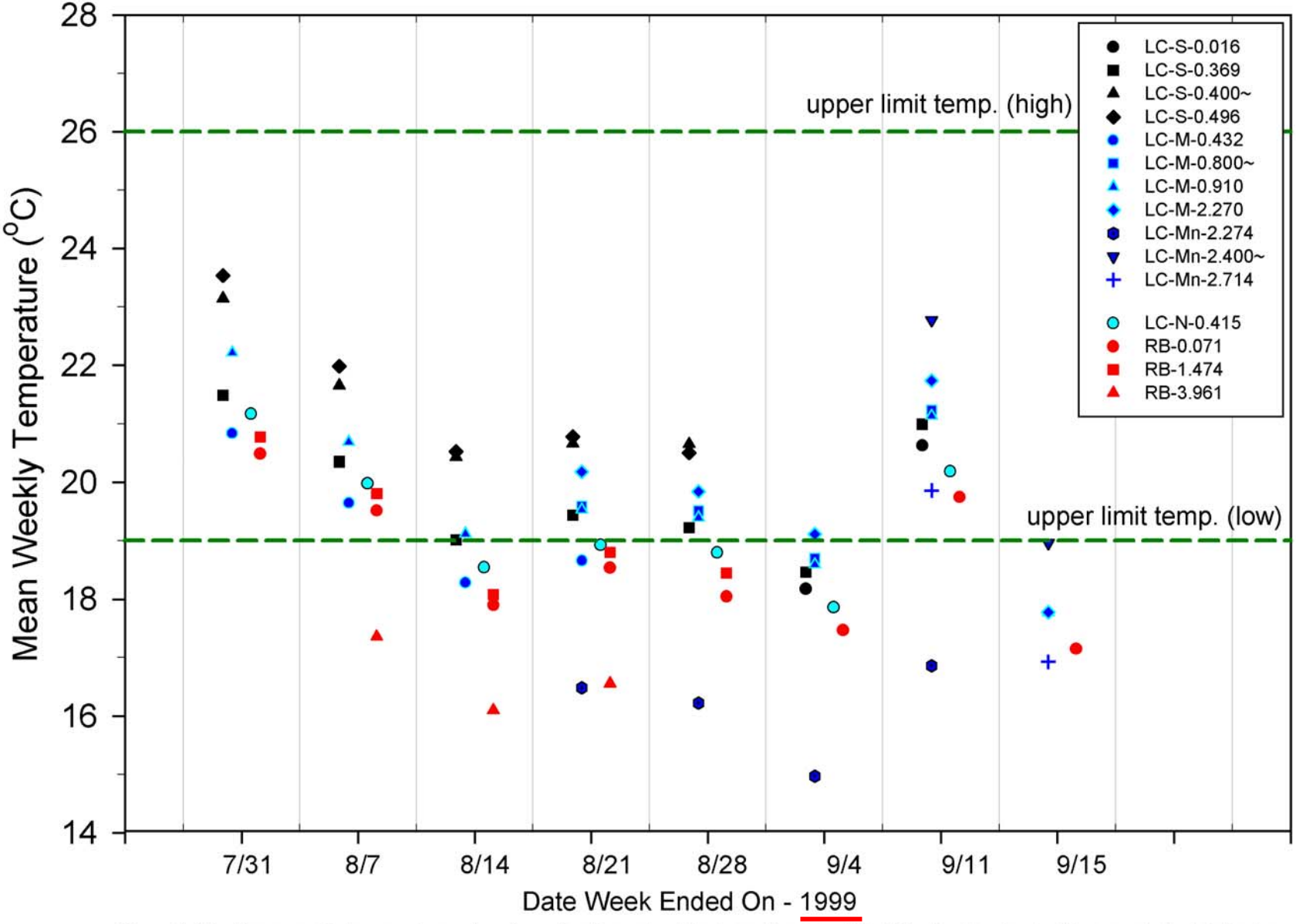



Figure 3.4.3. Mean weekly temperatures at various sites throughout the Long Creek and Red Brook watersheds. Please note that, in the legend, the space between LC-Mn-2.714 and LC-N-0.415 is an artifact of the software program and nothing else.

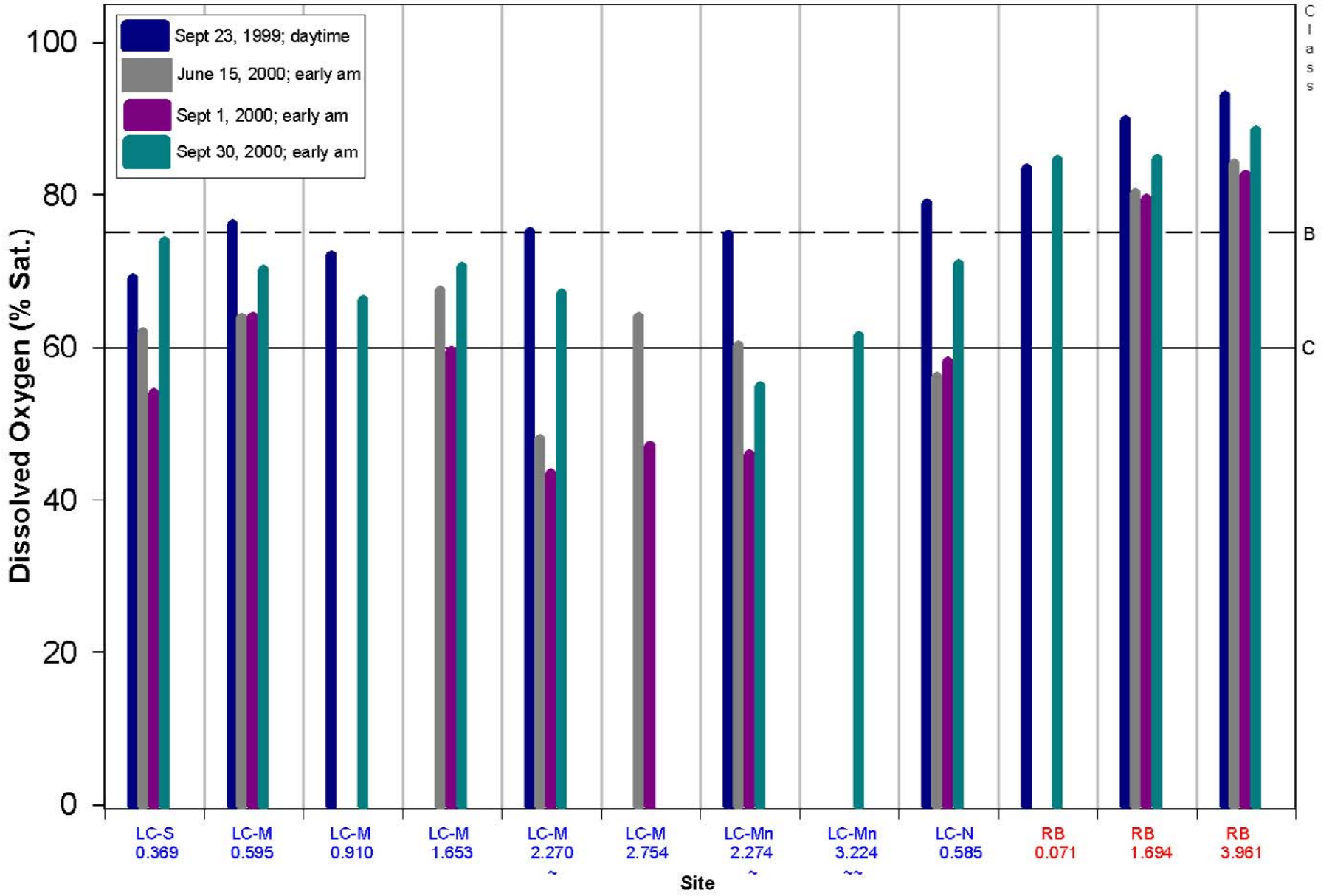

Sept 23, 1999; daytime
June 15, 2000; early am
Sept 1, 2000; early am
Sept 30, 2000; early am
Dissolved Oxygen (% Sat.)
100
80
60
40
20
0
Class
B
C
LC-S 0.369
LC-M 0.595
LC-M 0.910
LC-M 1.653
LC-M 2.270 ~
LC-M 2.754
LC-Mn 2.274 ~
LC-Mn 3.224 ~~
LC-N 0.585
RB 0.071
RB 1.694
RB 3.961
Site

Table 4.3. A summary of findings on temperatures observed to be detrimental to brook trout as reported in a literature review written by McCullough (1999)[1]. Please refer to his document for more complete information. Part I details information about field observations while Part II details information about laboratory experiments.

I. *Field Observations*

| Upper Limit of Temperatures Where Brook Trout Were Observed($^{o}$C) | Comments |
|---|---|
| a) 22 | a) Upper limit (3-week mean temperature) for self-sustaining populations in southern Ontario streams (Barton et al. 1985). |
| b) 25.6 | b) Upper limit (instantaneous observed temperature) for self-sustaining populations in southern Ontario streams (Barton et al. 1985). |
| c) 22-24 | c) Various Ontario streams (Meisner 1990; also see review in Meisner 1990) |
| d) 19-20 | d) Various Virginia streams (Burton and Odum). |
| e) 22.3 | e) A study analyzed a large national database of brook trout presence/absence data and weekly mean temperatures. The authors eliminated the upper-end 5% of temperatures where brook were found to be present to get a more conservative estimate of an upper thermal tolerance limit. After eliminating the upper-end 5%, they found the 95%-ile thermal tolerance temperature to be 22.3 $^{o}$C (Eaton et al. 1995). |
| f) 19-20 | f) Self-sustaining populations of brook trout tend to be limited to stream zones with temperatures < 19-20 $^{o}$C (review in Hokanson et al. 1973). |

II. *Laboratory Experiments*

| Brook Trout Life Stage | Important Temperatures ($^{o}$C) | Comments |
|---|---|---|
| Egg / Alevin | a) > 16 | a) When pre-spawning brook trout adults were held in 16 $^{o}$C water, the percentage of normal egg hatching was 0%. As test temperatures were lowered, percent-hatching increased. At 6-8 $^{o}$C, percent hatching was > 90% (Hokanson et al. 1973). |
| | b) > 15<br>> 9 | b) When eggs were held at 1.5 - 9.0 $^{o}$C, percent survival to hatching was 80-85%. Percent survival to hatching was 0% at 15 $^{o}$C. (Hokanson et al. 1973, Humpesch 1985). |
| | c) $\geq$ 18 | c) Considered detrimental to newly hatched alevins (McCormick et al. 1972). |
| Juvenile | d) 24[a] - 25.5[b] | d) Range of upper incipient lethal temperatures (UILT) determined by [a]Cherry et al. (1977) and [b]Fry et al. (1946). [UILT = a temperature, given a previous acclimation to a constant temperature, that 50% of the fish can tolerate for 7 days. The acclimation temperature for "[b]" was 24 $^{o}$C, while it was not reported for "[a]".] |
| Adult | e) 16-19 | e) For spawning female brook trout (Hokanson et al. 1973). |
| | f) 19 | f) For spawning male brook trout (Hokanson et al. 1973). |
| | g) 9 | g) Optimal conditions for spawning brook trout (Hokanson et al. 1973). |