Interim Report on the Latimer Brook Watershed: Nitrate Concentrations and Stream Mixing

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Outline

I. Introduction

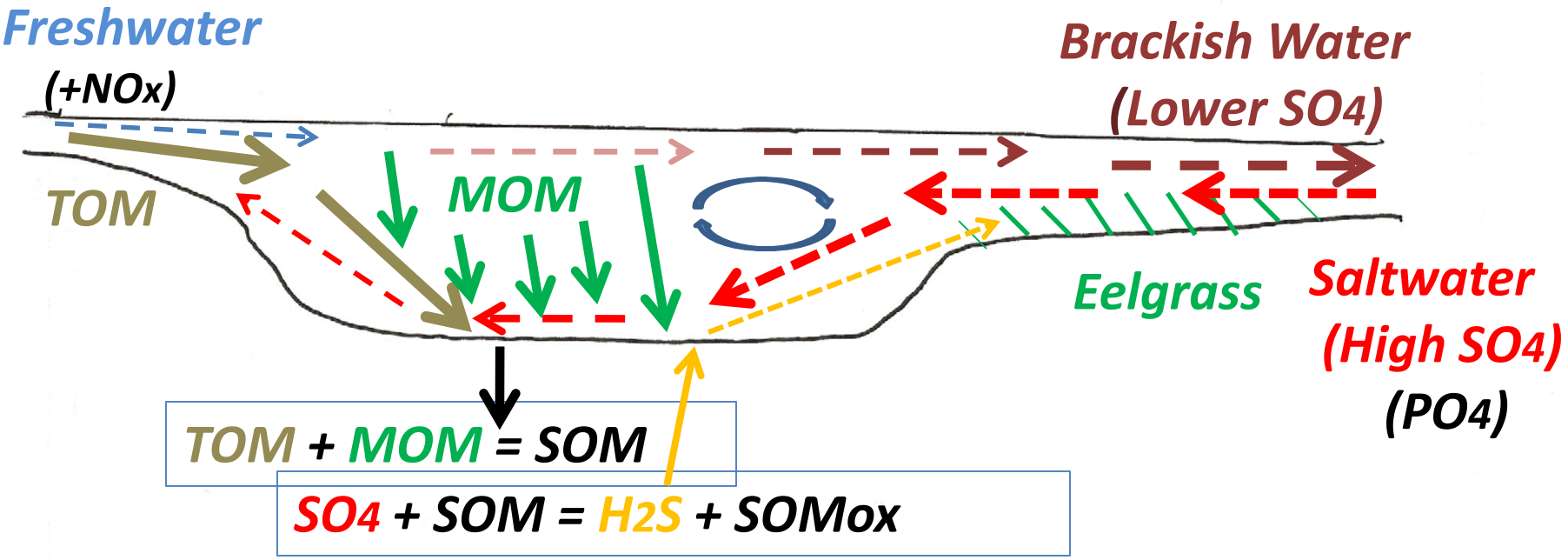
II. Absolute NO3 Flux from Latimer Brook to the Niantic River Estuary.

III. Relative Stream Fluxes via a T-based mixing model:

A. Latimer Brook – Cranberry Meadow Brook Confluence.

B. Unnamed Tributary- Cranberry Meadow Brook Confluence.

Biogeochemical Circulation of the Niantic River Estuary



II. Annual Nitrogen Influx to the Niantic River Estuary From Its Three Major Tributaries

	Nitrogen Flux (lbs /yr)	(% Total)
1. Latimer Brook	39,300	78
2. Oil Mill Brook	7,200	14
3. Stony Brook	3,750	8

(*Provisional data from J. Mullaney, USGS, 2012*)

Latimer Brook: Calculation of NO_3 Flux

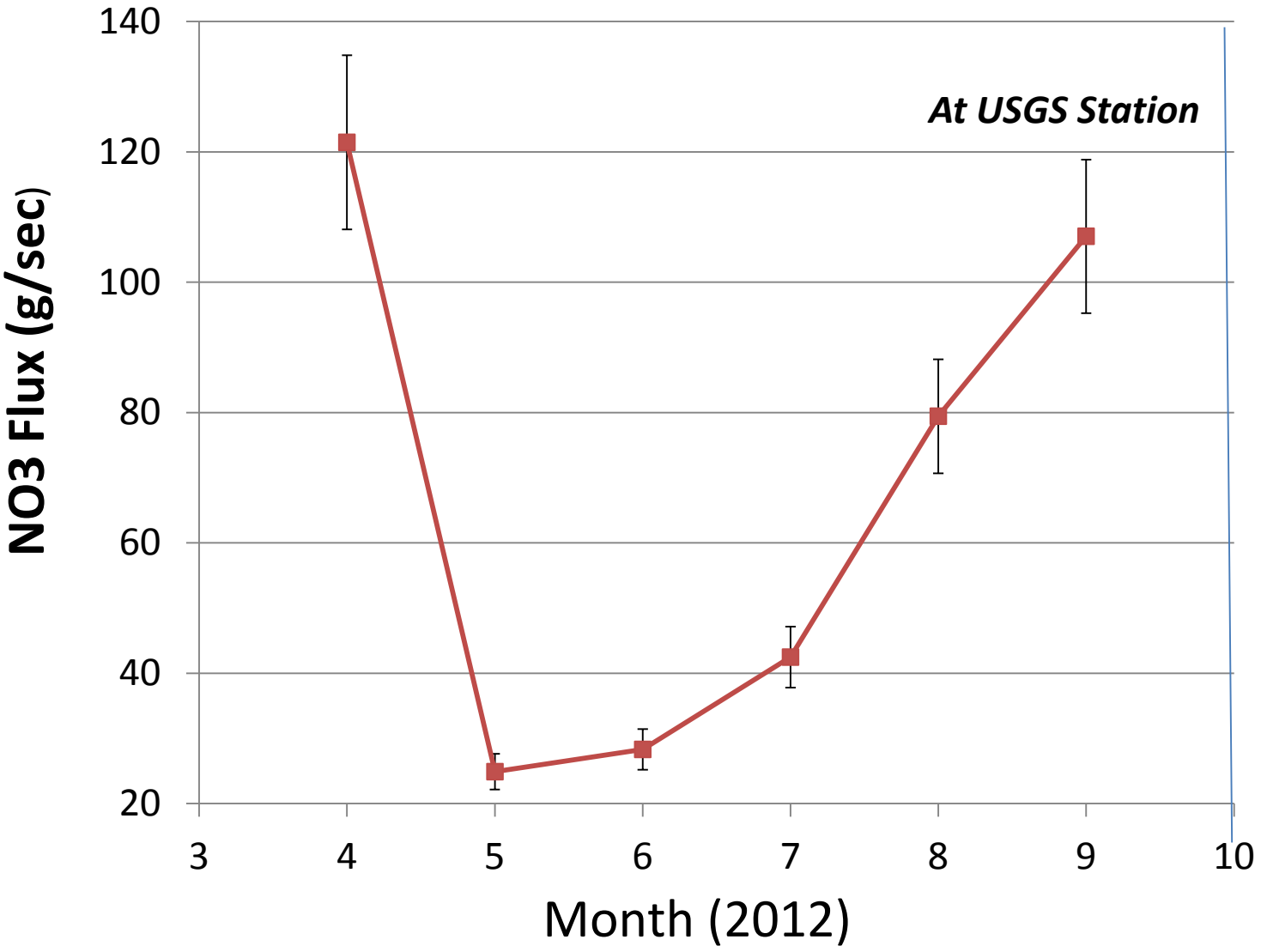
$$F_{NO3} = F_{water} * C_{NO3}$$

F_{NO3} = Flux of Nitrogen (grams N/sec);
F_{H2O}= Flux of water (grams water/sec); and,
C_{NO3} = Concentration of N (grams N/sec).

Dimensional Analysis:

$$\frac{M(NO3)}{T} = \frac{M(W)}{T} * \frac{M(N03)}{M(W)}$$

Monthly NO_X-Flux from LB to the Niantic River Estuary



NOx flux to the NRE is at a minimum in the warm months. What happens in the cold months?

(Calculated from USGS and NRWC data.)

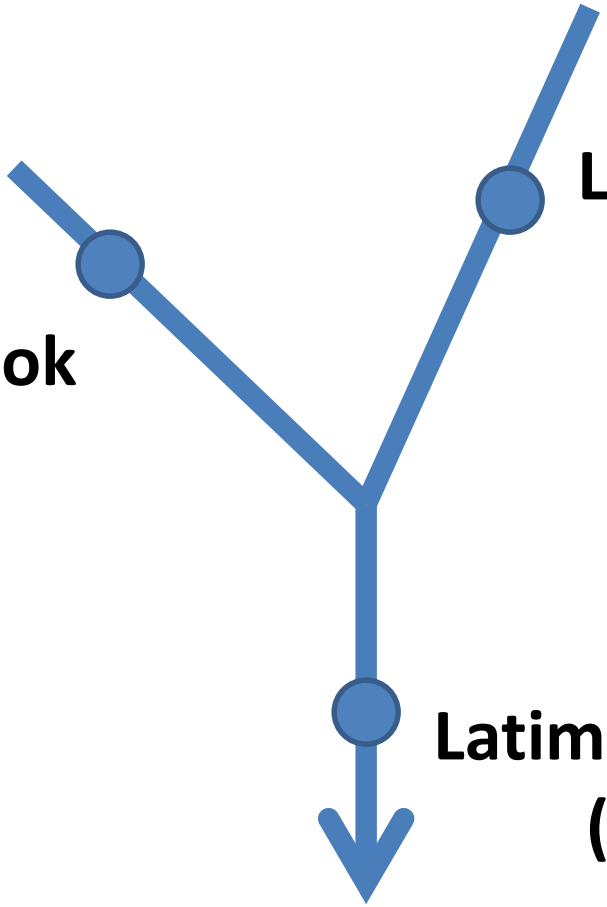
III. Relative Stream Fluxes via a T-based Mixing Model:

A. Latimer Brook – Cranberry Meadow Brook Confluence.

B. Unnamed Tributary- Cranberry Meadow Brook Confluence.

III.A. Stations for LB-CMB Mixing:

The Confluence of the LB and CMB

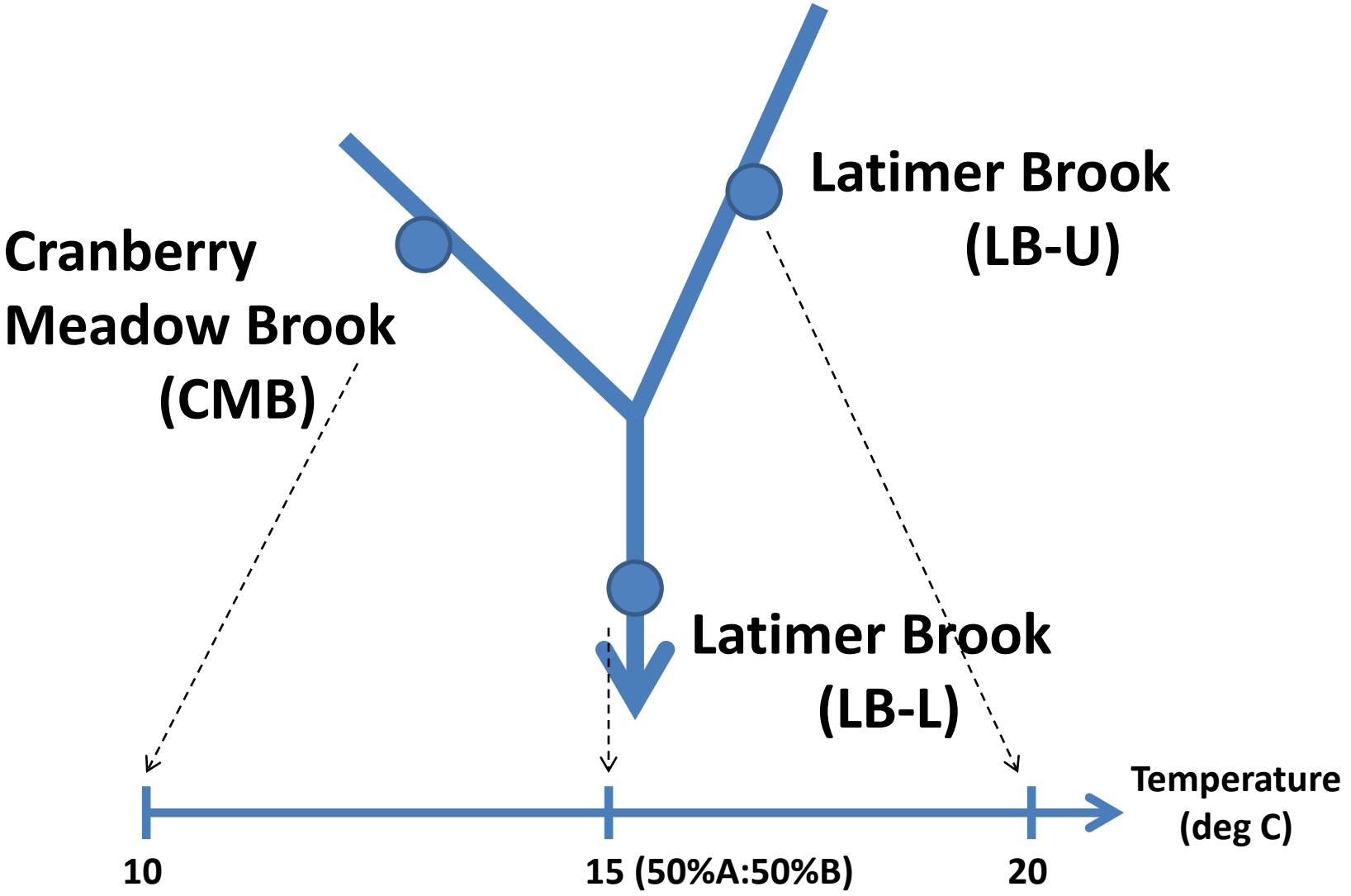


Latimer Brook
(LB-U)

Cranberry
Meadow Brook
(CMB)

Latimer Brook
(LB-L)

Temperature-Mixing Model



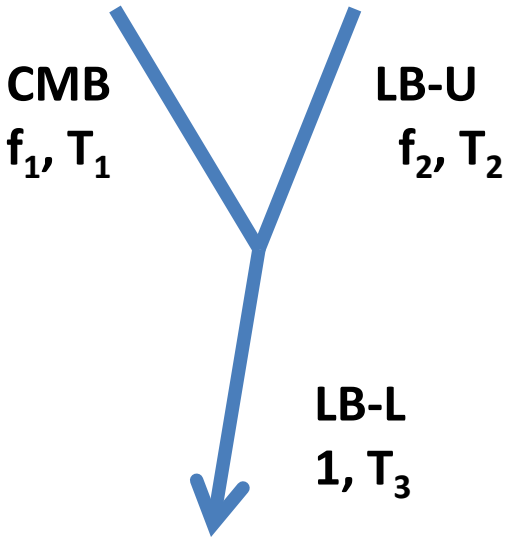
Calculation of *Relative* NO3 Fluxes:

NO3 Fluxes from the Cranberry Meadow Brook + upper Latimer Brook → the lower Latimer Brook.

1. Mass fractions of water to the lower Latimer Brook is estimated by the temperature-mixing model.

2. Allows estimation of proportions of NO3 from the CMB and the *upper* LB and relative NO3 to the lower LB and the Niantic River Estuary.

Two Endmember Temperature Mixing Model



Assumptions:

1. Conservation of mass and energy
2. Two endmember model

Governing Equations:

Mass fraction: $f_1 + f_2 = 1$

Energy balance: $f_1 T_1 + f_2 T_2 = T_3$

CMB Fraction of flow: $f_1 = (T_3 - T_1)/(T_1 - T_2)$

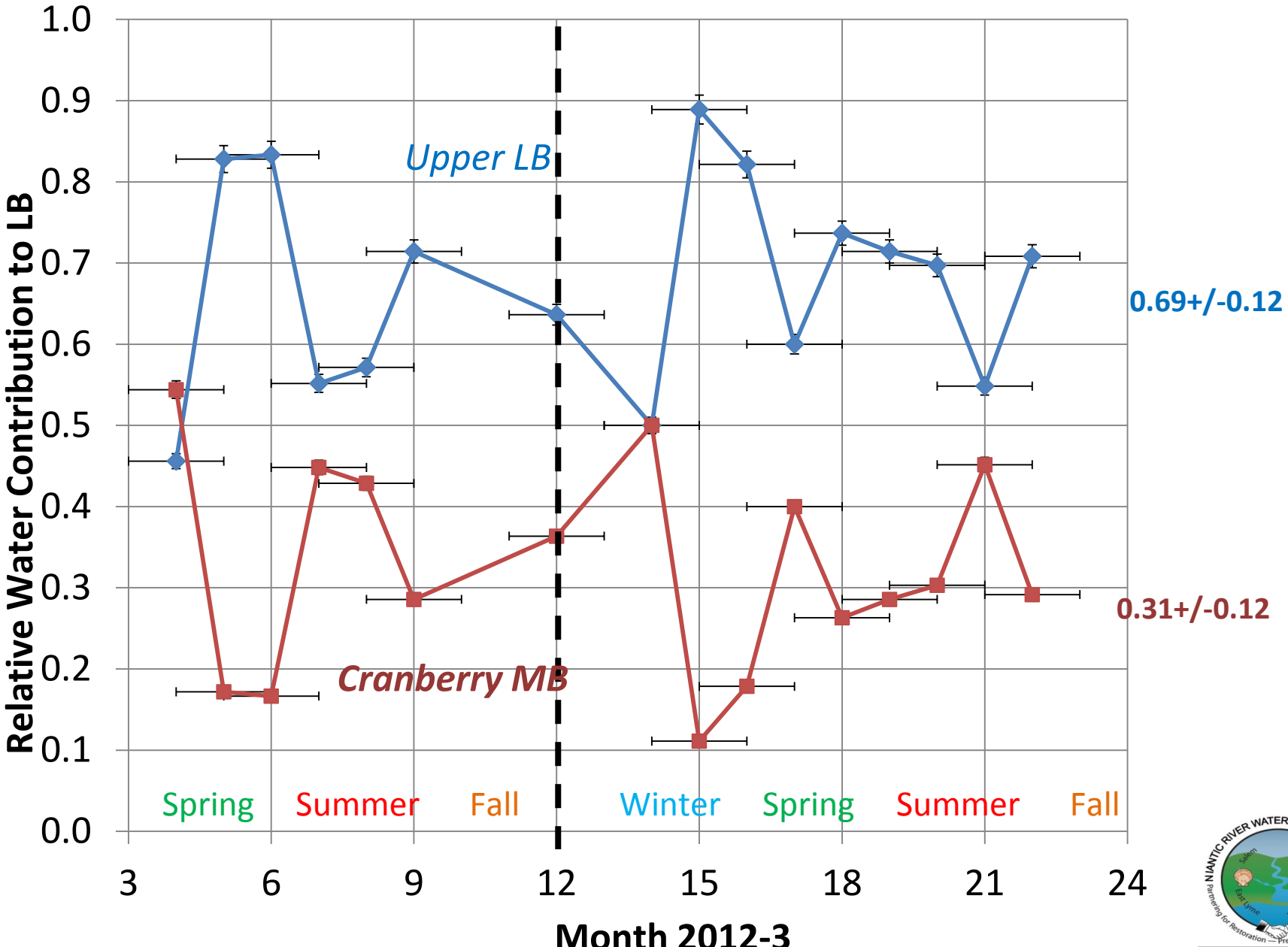
LB-U fraction of flow: $f_2 = 1 - f_1$

Mass Flux NO_3: $F_{CMB} + F_{LB\text{-}U} = F_{LB\text{-}L}$

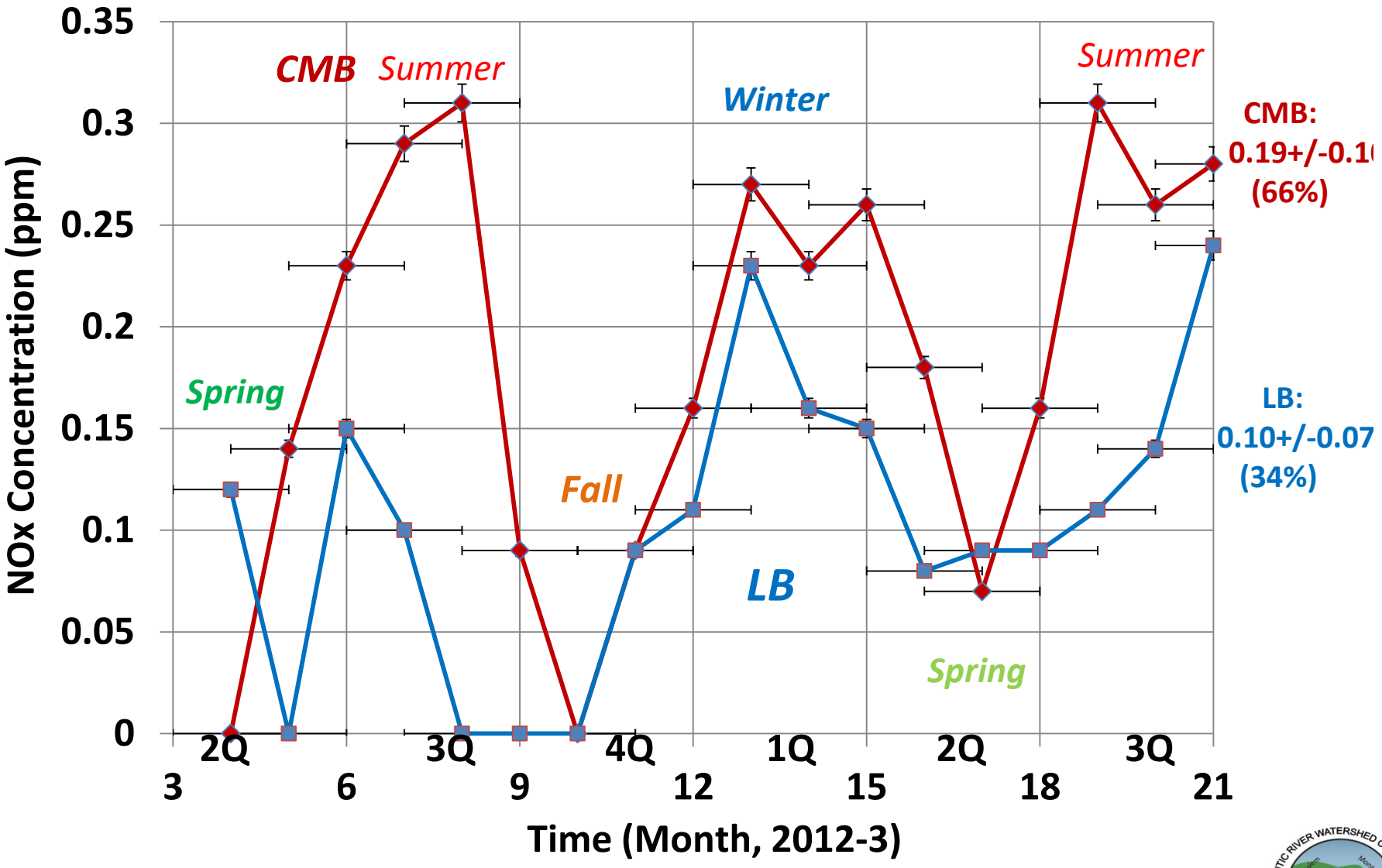
Relative NO_3 mass flux (RF):

$RF_{CMB} = f_1 C_{CMB}$ $\qquad$ $RF_{LB\text{-}U} = f_2 C_{LB\text{-}U}$

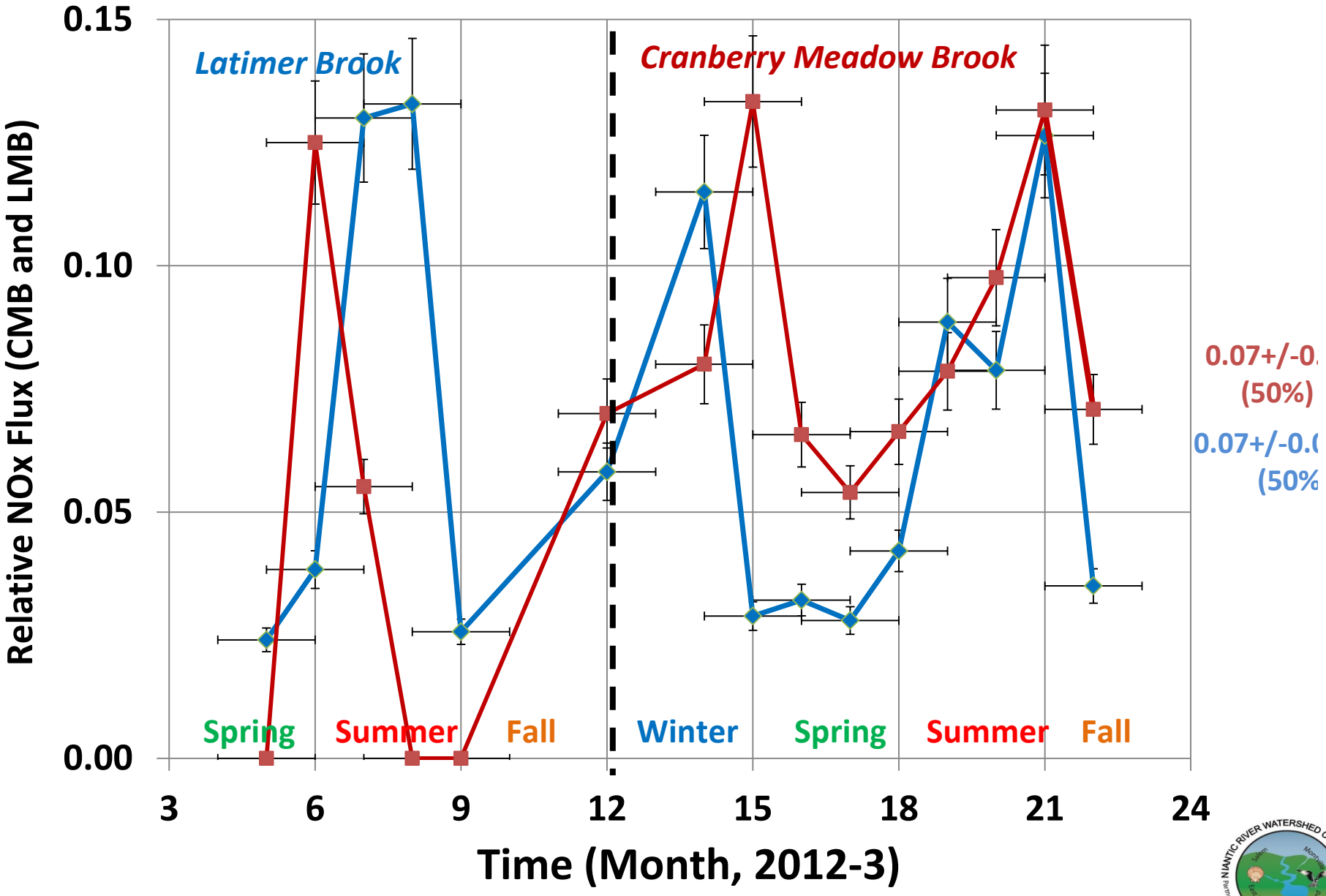
Relative Water Contribution at Latimer Brook Station



NOx Concentrations in CMB-Lower and LB#4

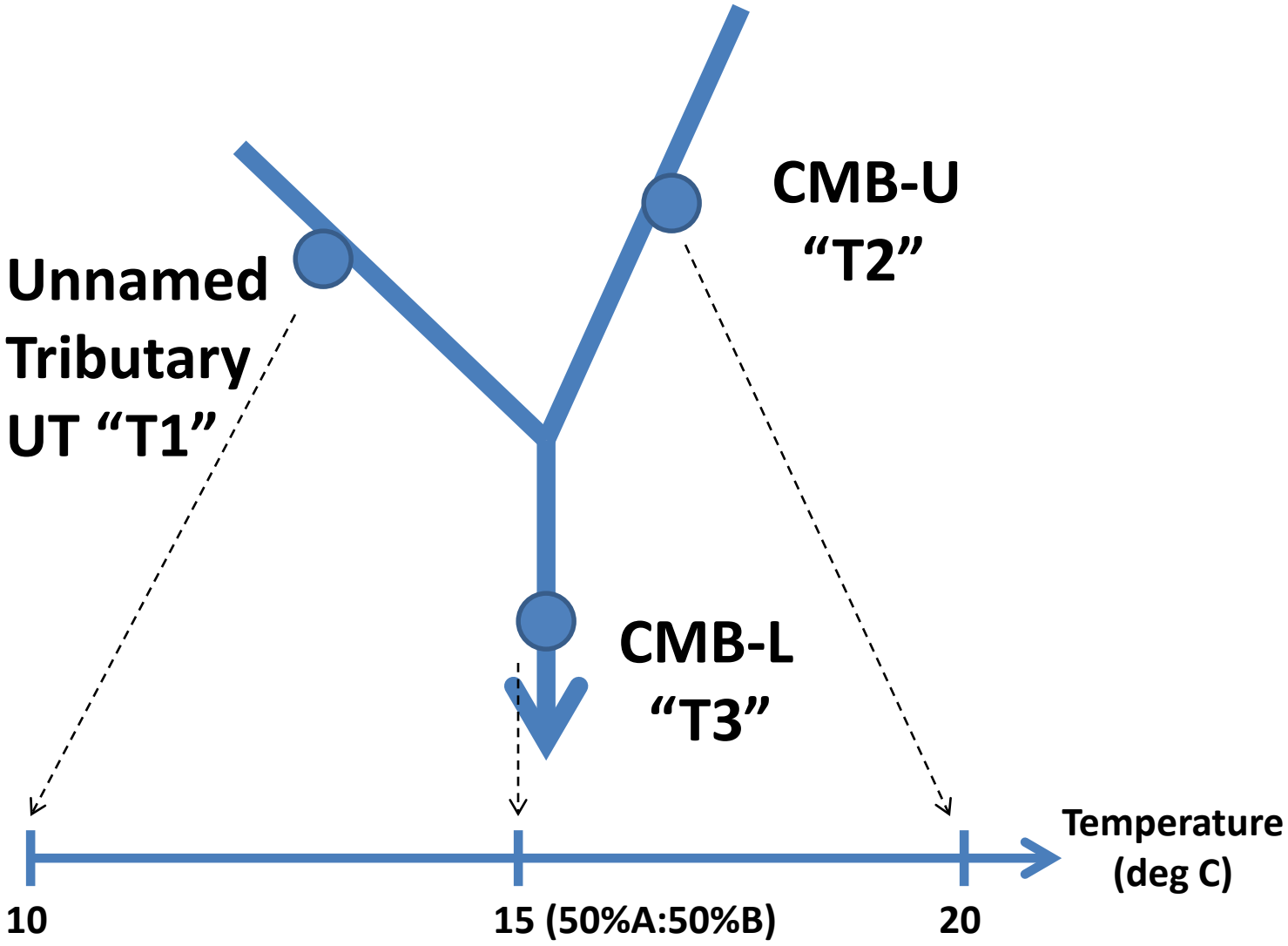


Relative NOx Flux from CMB and LB at LB Station 3

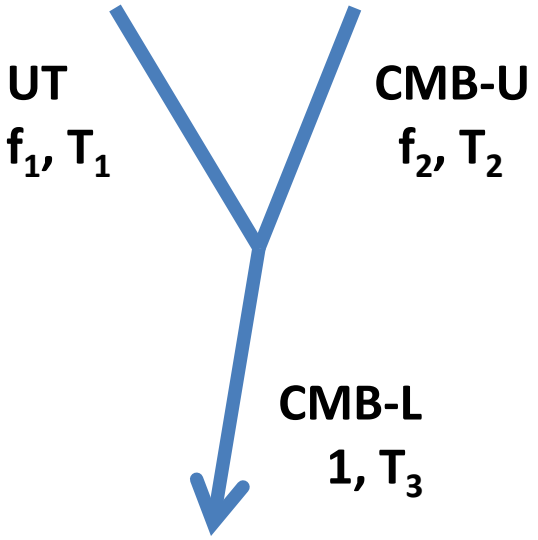


III.B. Modeling the Water Flows at the Convergence of the CMB and an Unnamed Tributary near the Antares Solar Field

Temperature-Mixing Model



Two Endmember Temperature Mixing Model



Assumptions:

1. **Conservation of mass and energy**
2. **Two endmember model**

Governing Equations:

Mass fraction:

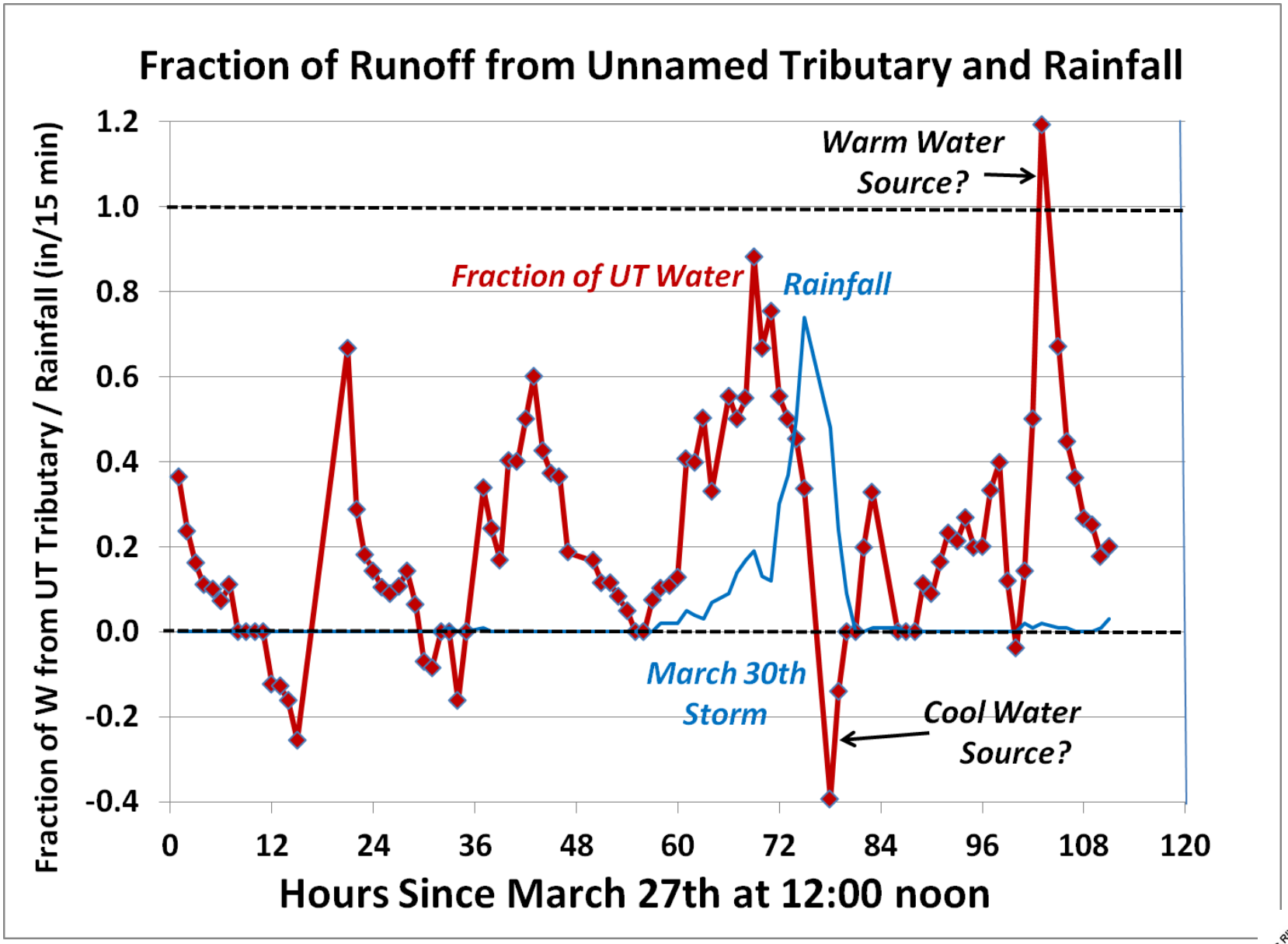
$$f_1 + f_2 = 1$$

Energy balance

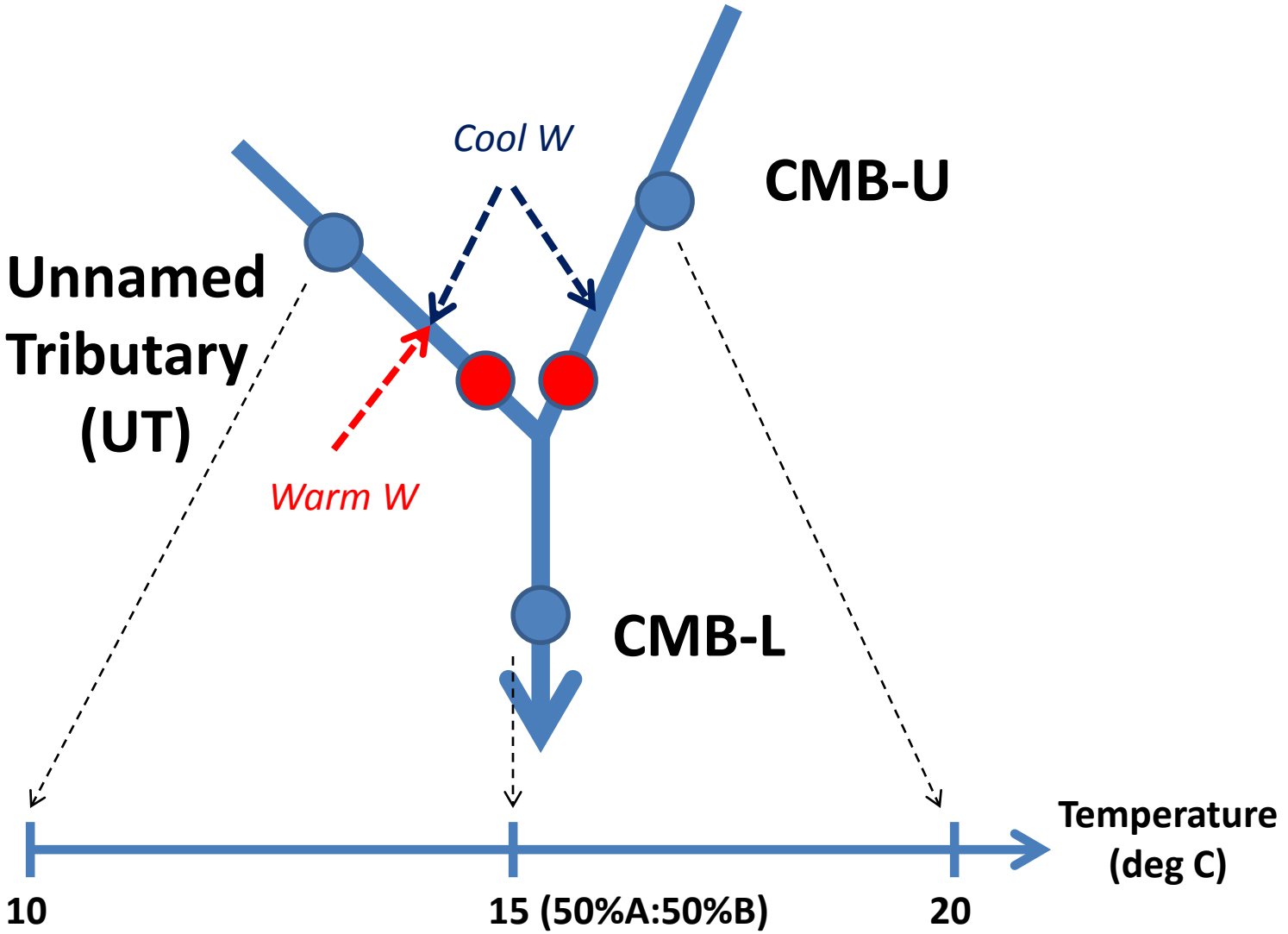
$$f_1 T_1 + f_2 T_2 = T_3$$

UT Fraction of Flow:

$$f_1 = (T3 - T_1)/(T_1 - T2)$$


Fraction of Runoff from Unnamed Tributary and Rainfall
Fraction of W from UT Tributary / Rainfall (in/15 min)
1.2
1.0
0.8
0.6
0.4
0.2
0.0
-0.2
-0.4
0
12
24
36
48
60
72
84
96
108
120
Hours Since March 27th at 12:00 noon
Warm Water Source?
Fraction of UT Water
Rainfall
March 30th Storm
Cool Water Source?

Improved T-Mixing Model



Summary

Latimer Brook- and CMB waters are modeled by a linear T-mixing system.

Part 1. The NO3 mass flux from the Latimer Brook to the Niantic River Estuary is *generally lowest* in the warmer months. (*What about cooler months*?)

Part 2. The *proportion* of NO3 from the CMB entering the lower LB is *generally highest* in the warmer months.

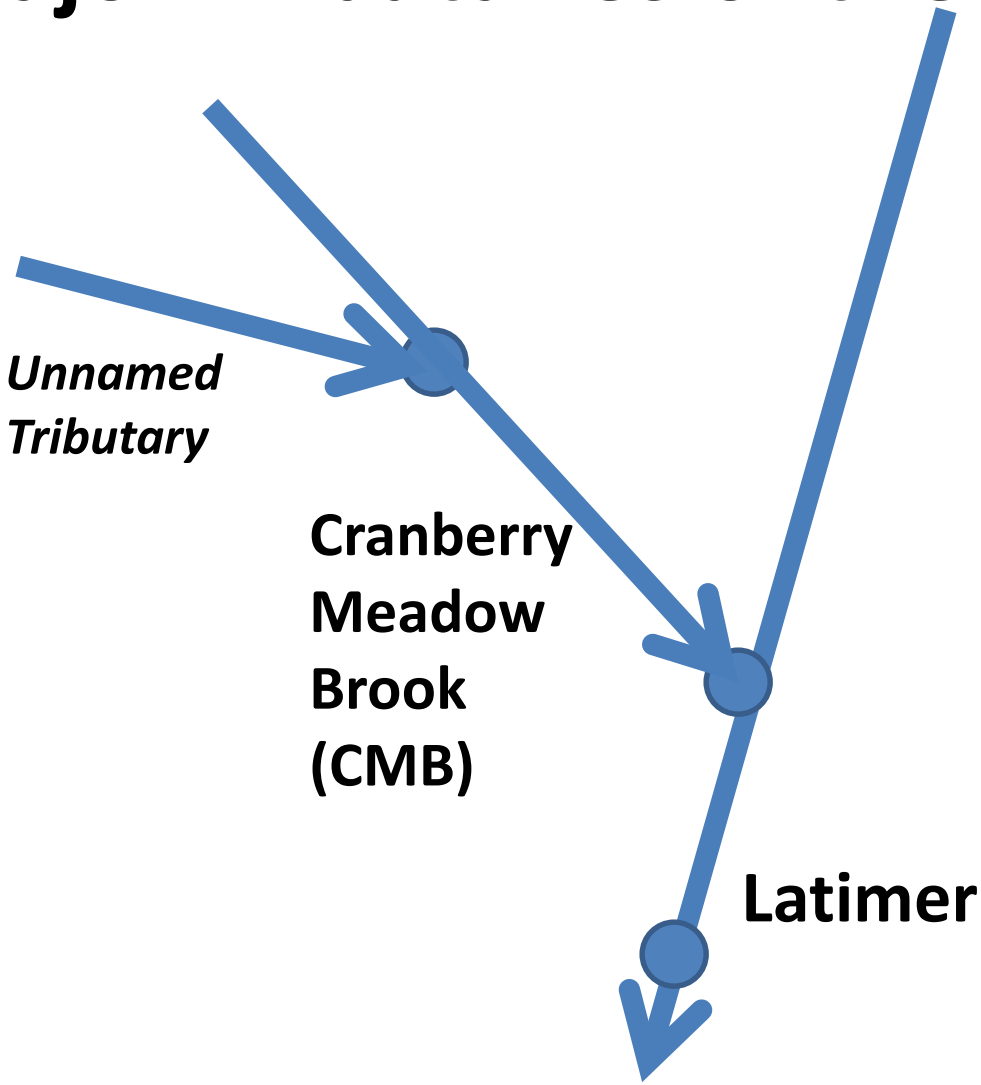
Part 3. Contributions to the downstream CMB-Lower flow were estimated with water-T data collected at 3 points. While most of the results fall within the expected model range of 0-1.0, there are notable excursions.

Summary (cnt'd.)

These model results suggest that a two endmember model does not adequately capture the full physical reality of this confluence of streams– *i.e*., there are more than two endmembers: plausibly a *cool* ground-water source and a *warm* surfacewater source.

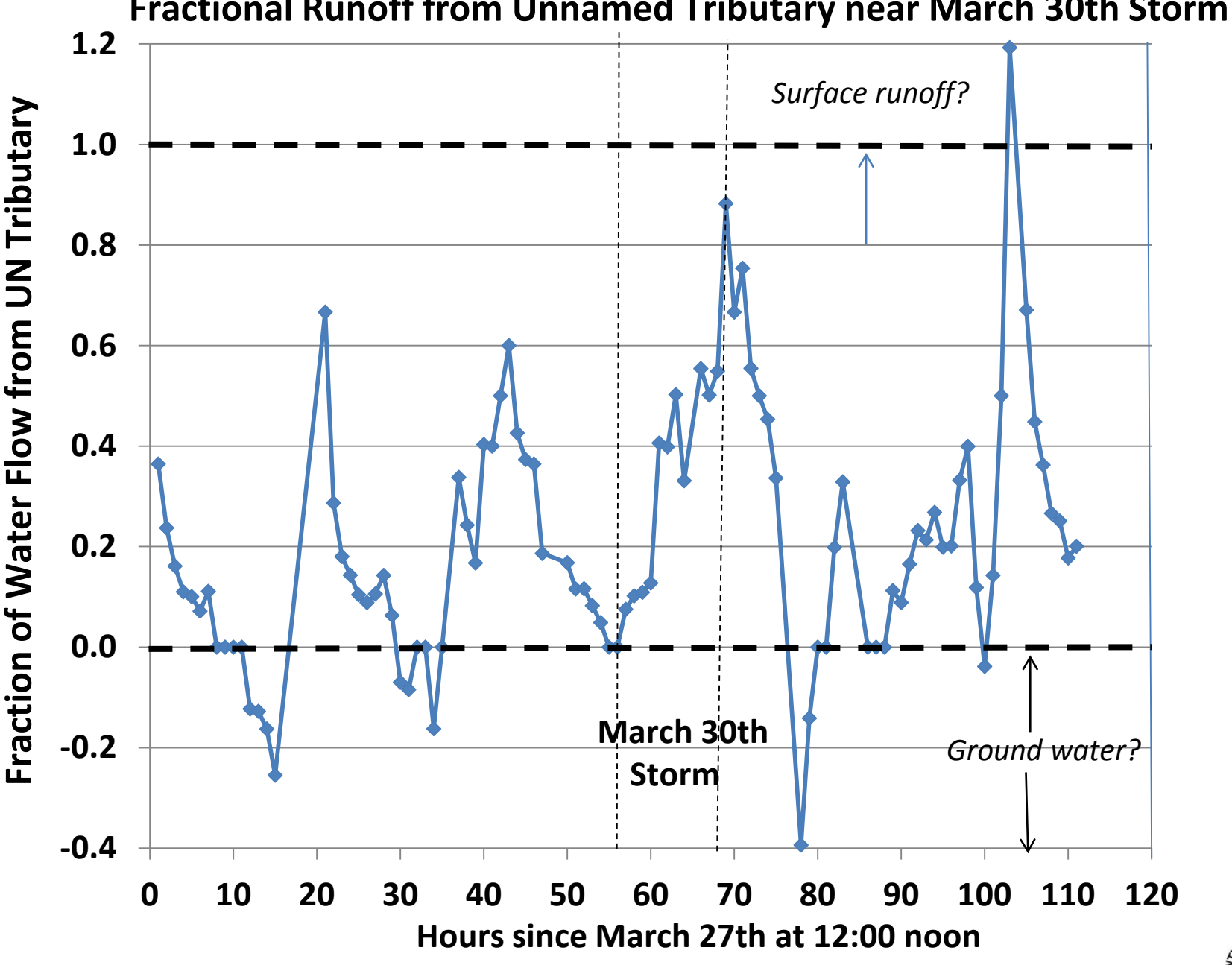
Prospectus: Consider moving the upstream temperature gages further nearer the confluence so that they capture the illusive additional water sources. With that, the system may be better described by a two endmember mixing model.

Major Tributaries of the Latimer Brook



Major Goals:

1. Mitigate CMB Nitrate flux.
2. Remove excess sediments From Latimer Brook.


Fractional Runoff from Unnamed Tributary near March 30th Storm
Fraction of Water Flow from UN Tributary
1.2
1.0
0.8
0.6
0.4
0.2
0.0
-0.2
-0.4
Surface runoff?
March 30th
Storm
Ground water?
0
10
20
30
40
50
60
70
80
90
100
110
120
Hours since March 27th at 12:00 noon