

Urban Water Security Research Alliance



The Impact of Artificial Monolayers on Water Quality: Data from Tank and Field Trials

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Evaporation Loss

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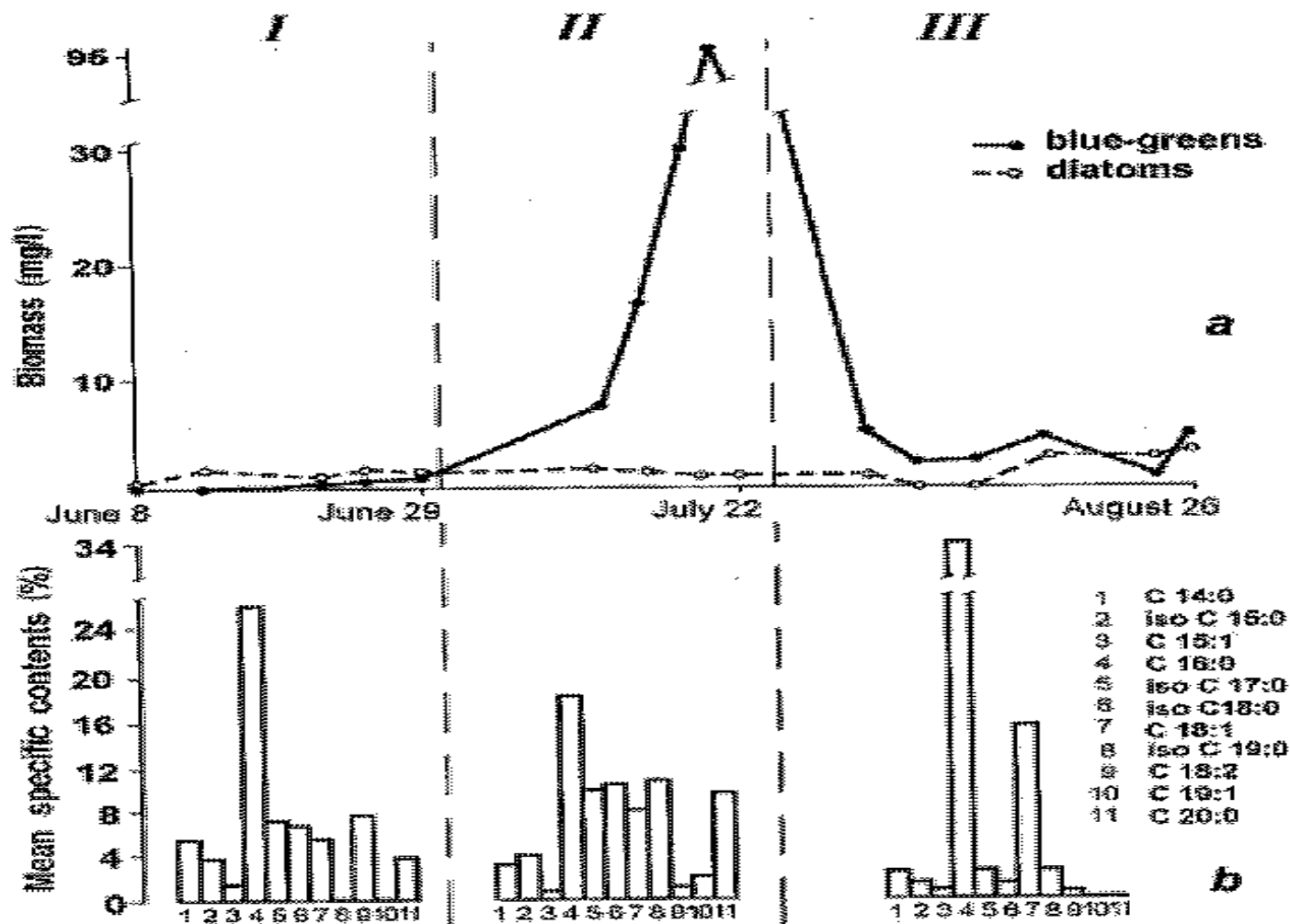


BENCHMARK IMPACT OF NATURAL MICROLAYERS, PRIOR TO MONOLAYER

Concentration of hydrophobic organic matter

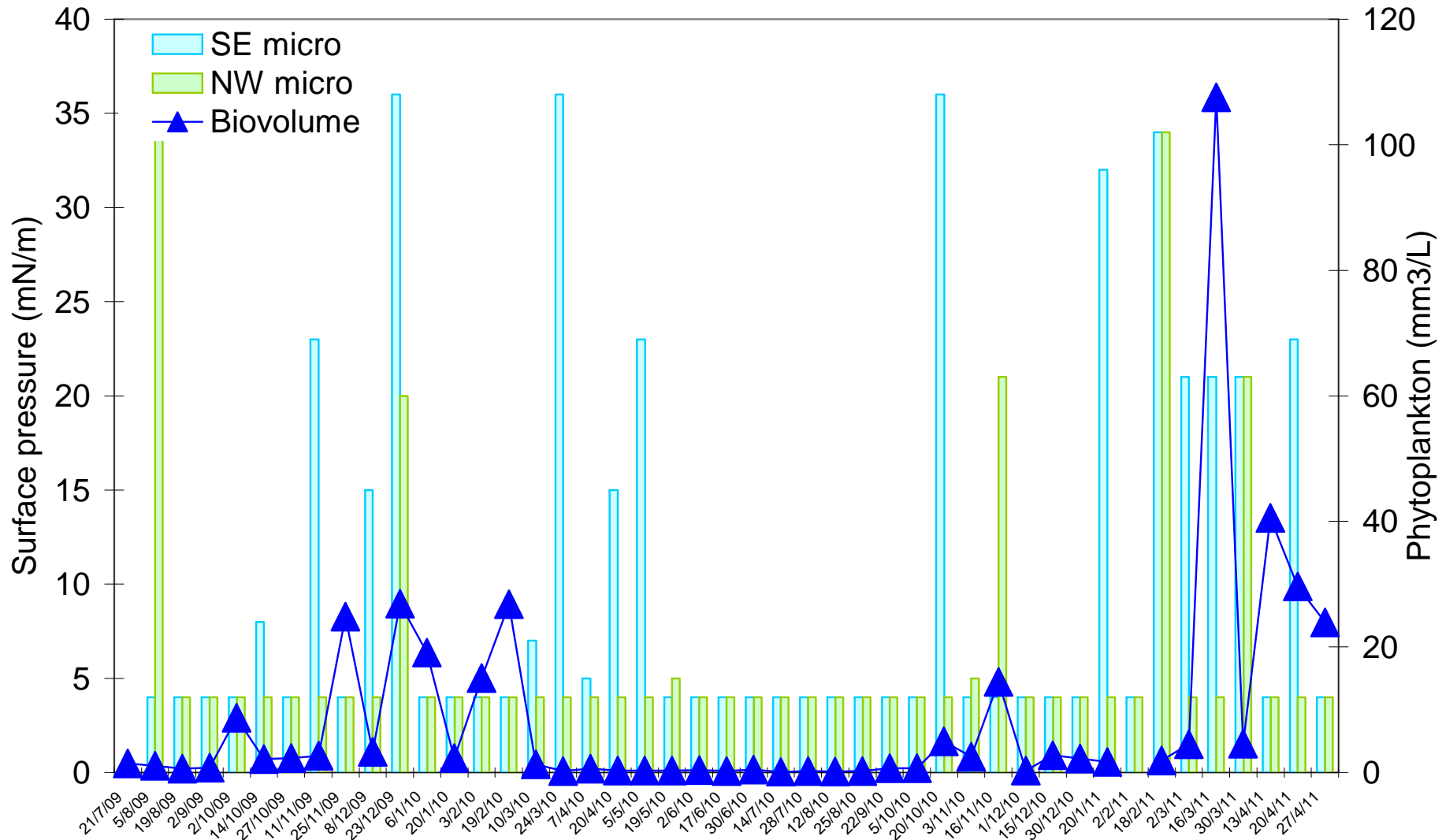
- 1.Reduces surface tension (>surface pressure)
- 2.Increases microbial activity (enrichment)
- 3.Modifies oxygen and heat transfer across air/water interface
- 4.Modifies light penetration & photodegradation

MICROALGAE AS A NATURAL SOURCE OF ORGANIC MATTER IN MICROLAYERS



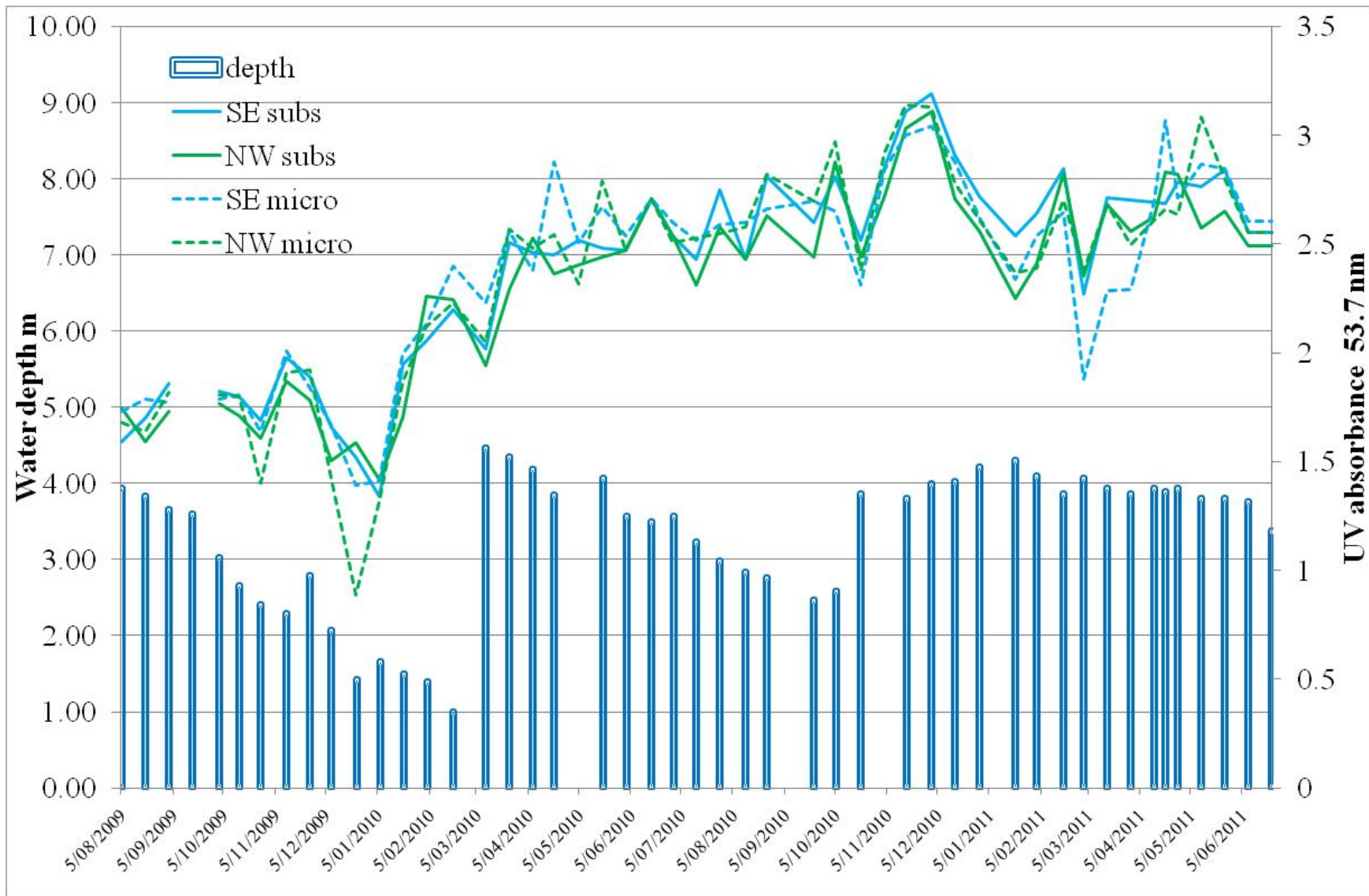
1=C18, 2 to 5= increasing ratios of collagen to C18, 5=collagen (Gladyshev 2002)

IMPACT OF ALGAE ON SURFACE PRESSURE AT LOGAN'S PRE MONOLAYER

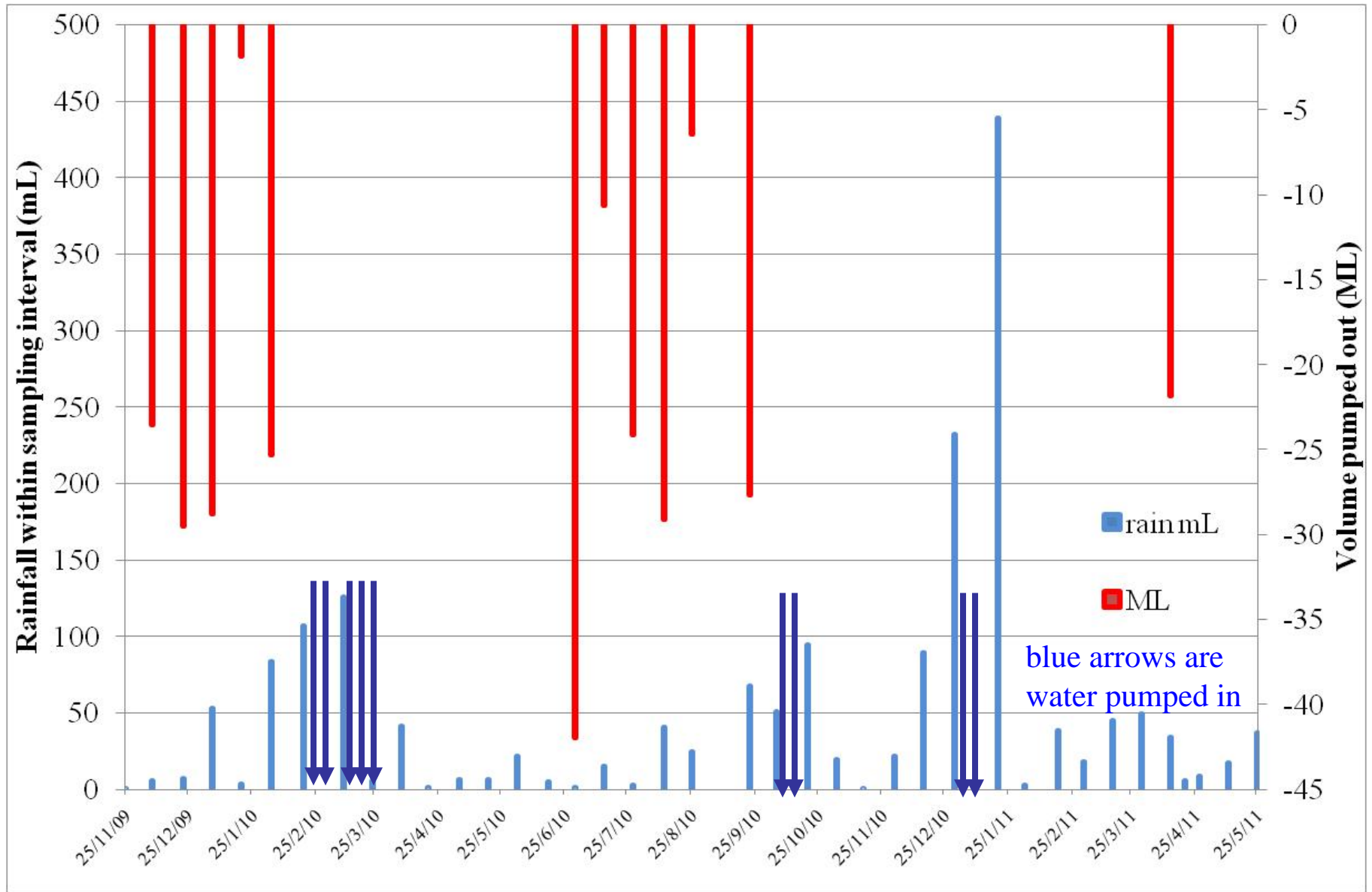


Maximum reading for surface pressure is 36 mN/m

SEASONAL CHANGE IN DEPTH & AQUATIC HUMIC SUBSTANCES AT LOGAN'S



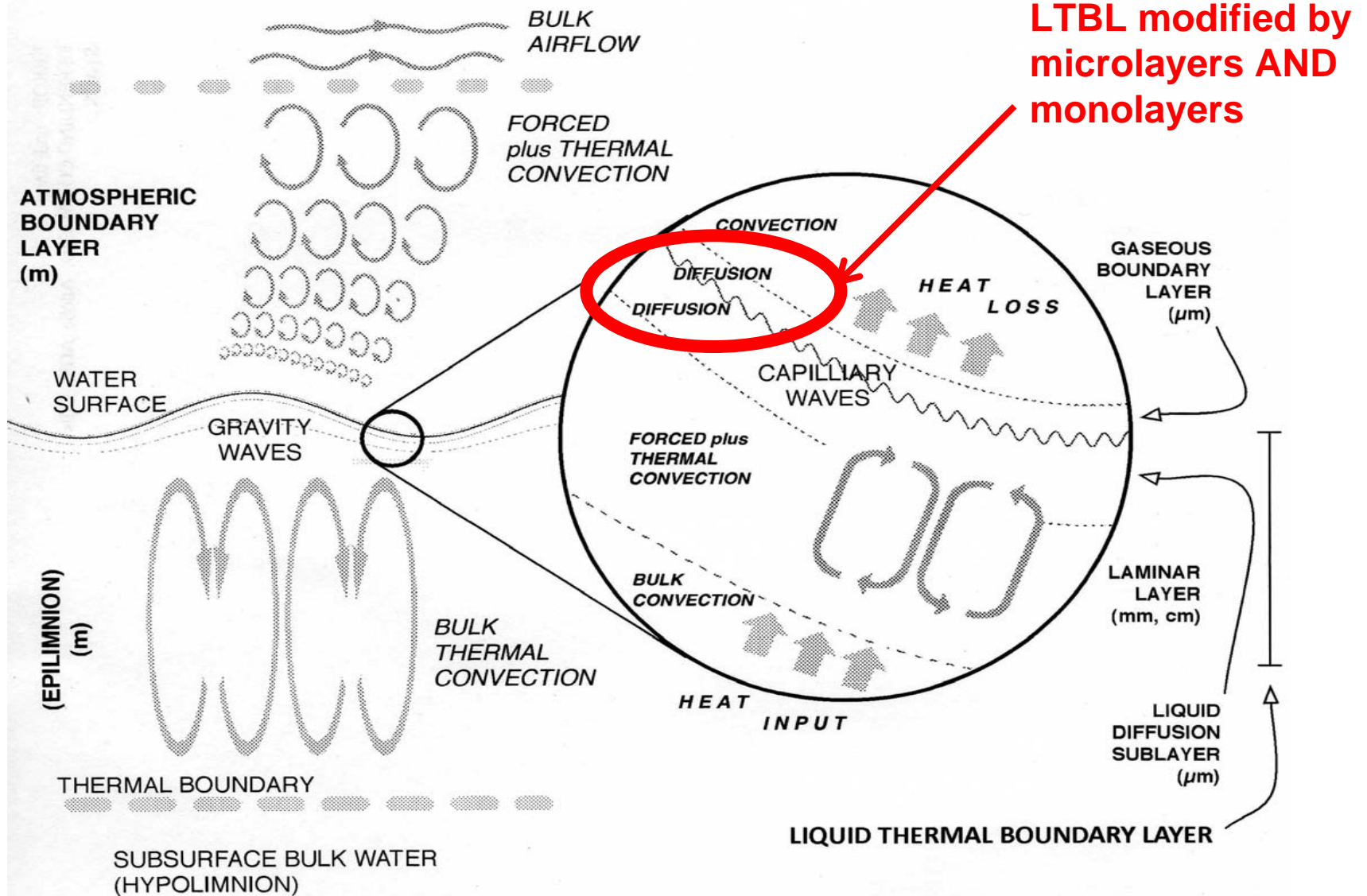
WATER INPUTS AND OUTPUTS AT LOGAN'S



POTENTIAL ADVERSE IMPACT OF A CONDENSED MONOLAYER

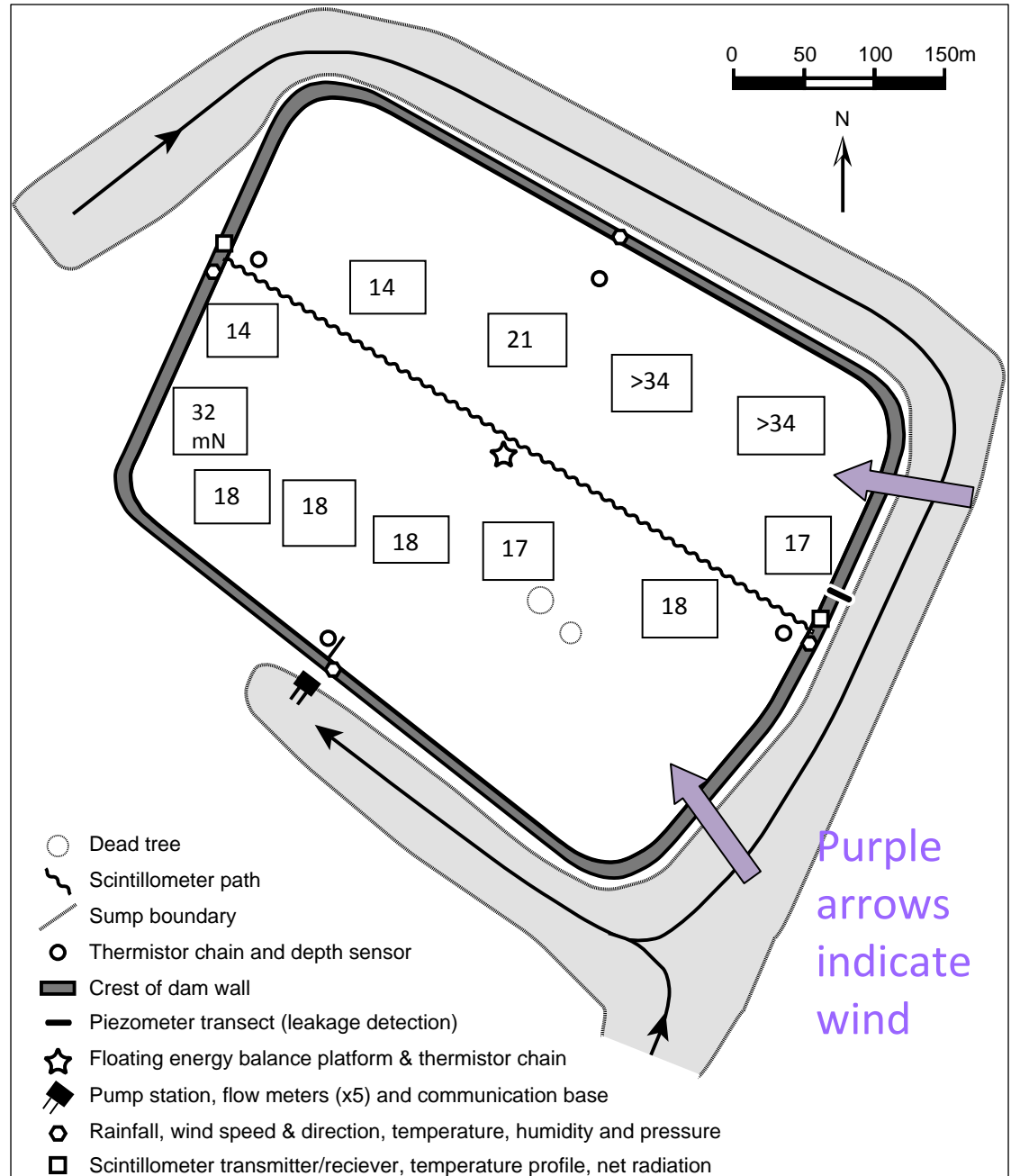
1. Increase in surface pressure
2. Increase in surface water temperature
3. Reduction in dissolved oxygen concentration?
4. Increase in concentration of organic carbon in microlayer?
5. Increase in microbial activity in microlayer?

IMPACT OF A MICROLAYER ON THE LIQUID THERMAL BOUNDARY LAYER (LTBL)

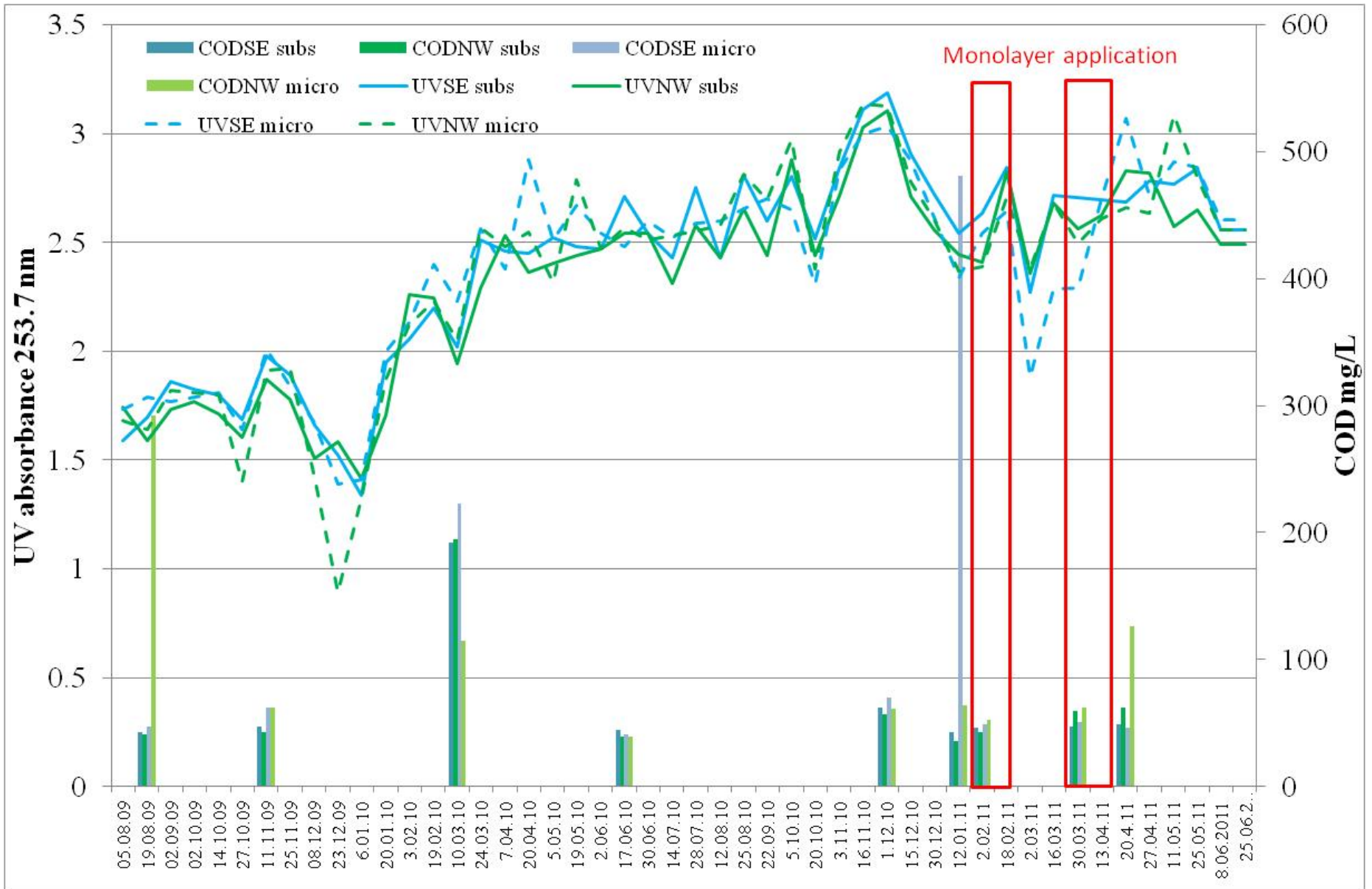


Surface pressure <1hr of product application (8 am 2/2/2011) shown in boxes.

Surface pressure <4 mN across entire storage 48 hrs after application (6 am 2/2/2011).



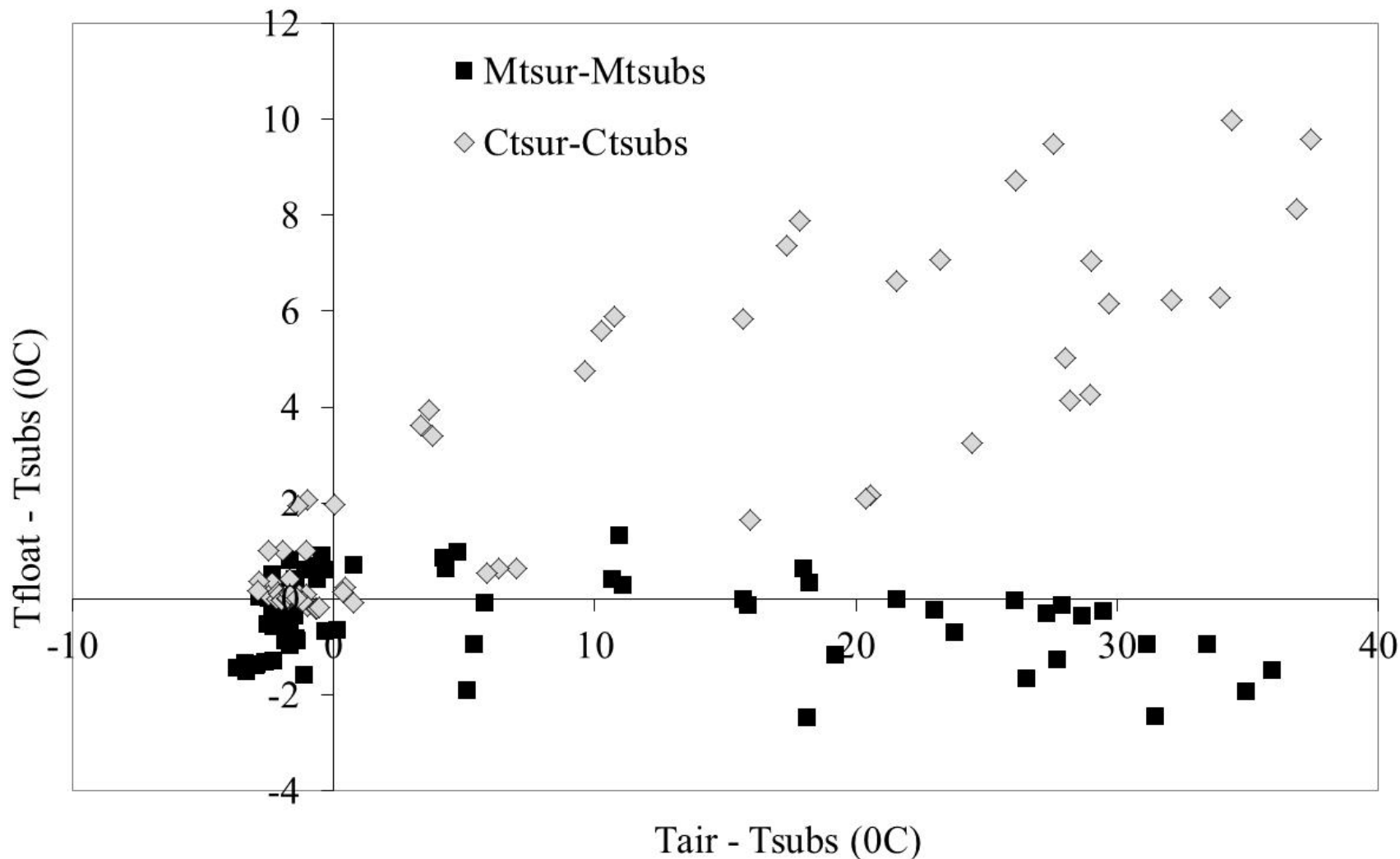
LIMITATIONS OF MONOLAYER STUDY



IMPACT OF C₁₈OH ON MICROLAYER DYNAMICS IN COVERED TANK TRIALS

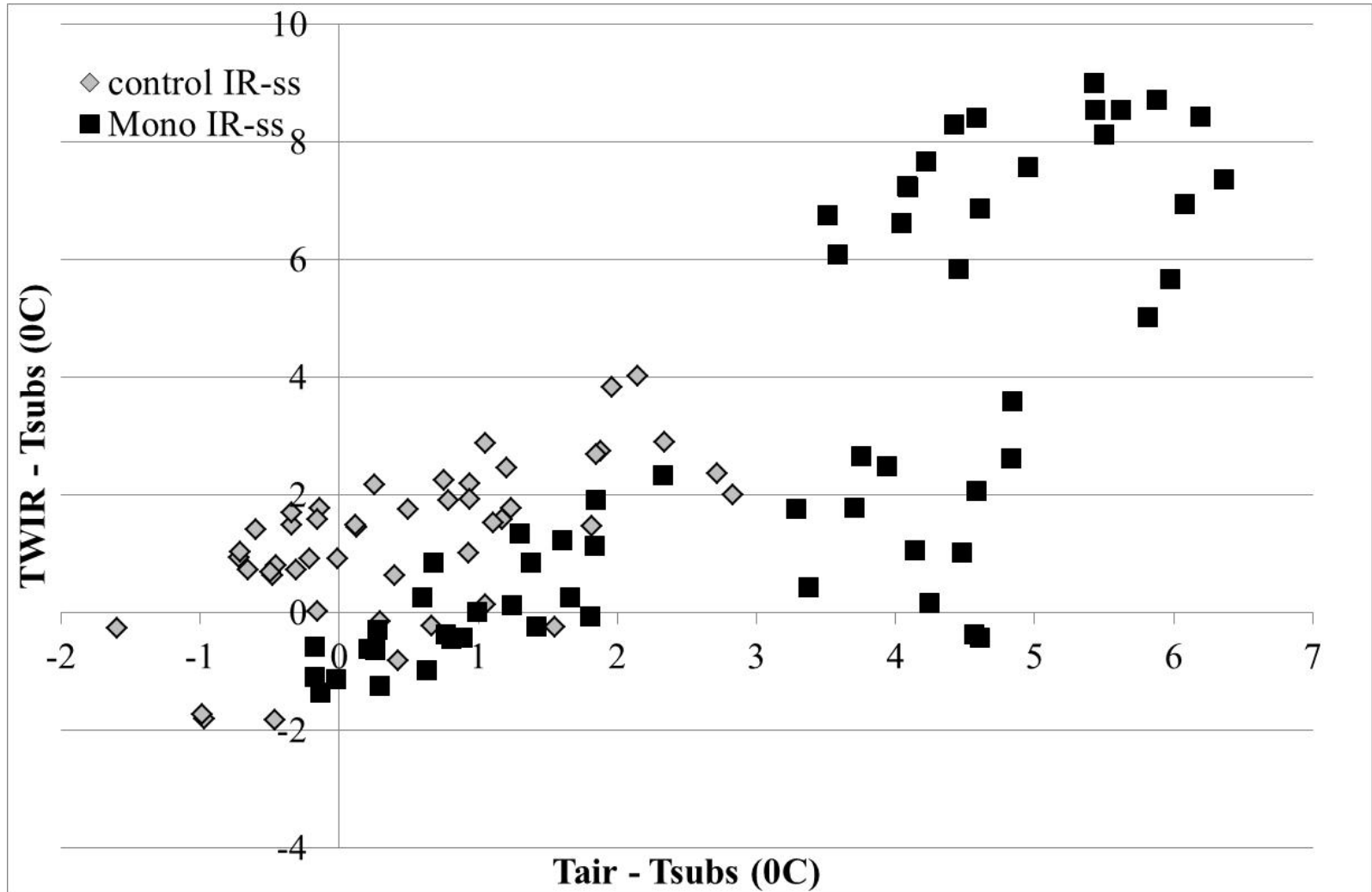
- x3 10m diam. 0.7 m deep tanks
- x2 covered, with x1 continuous twice weekly C₁₈OH application for 4 months
- x1 uncovered control
- Black cover wind & light-impervious, white cover more wind turbulence and greater light penetration

HOURLY SURFACE TEMPERATURE DEVIATION $C_{18}OH$ IN COVERED TANKS



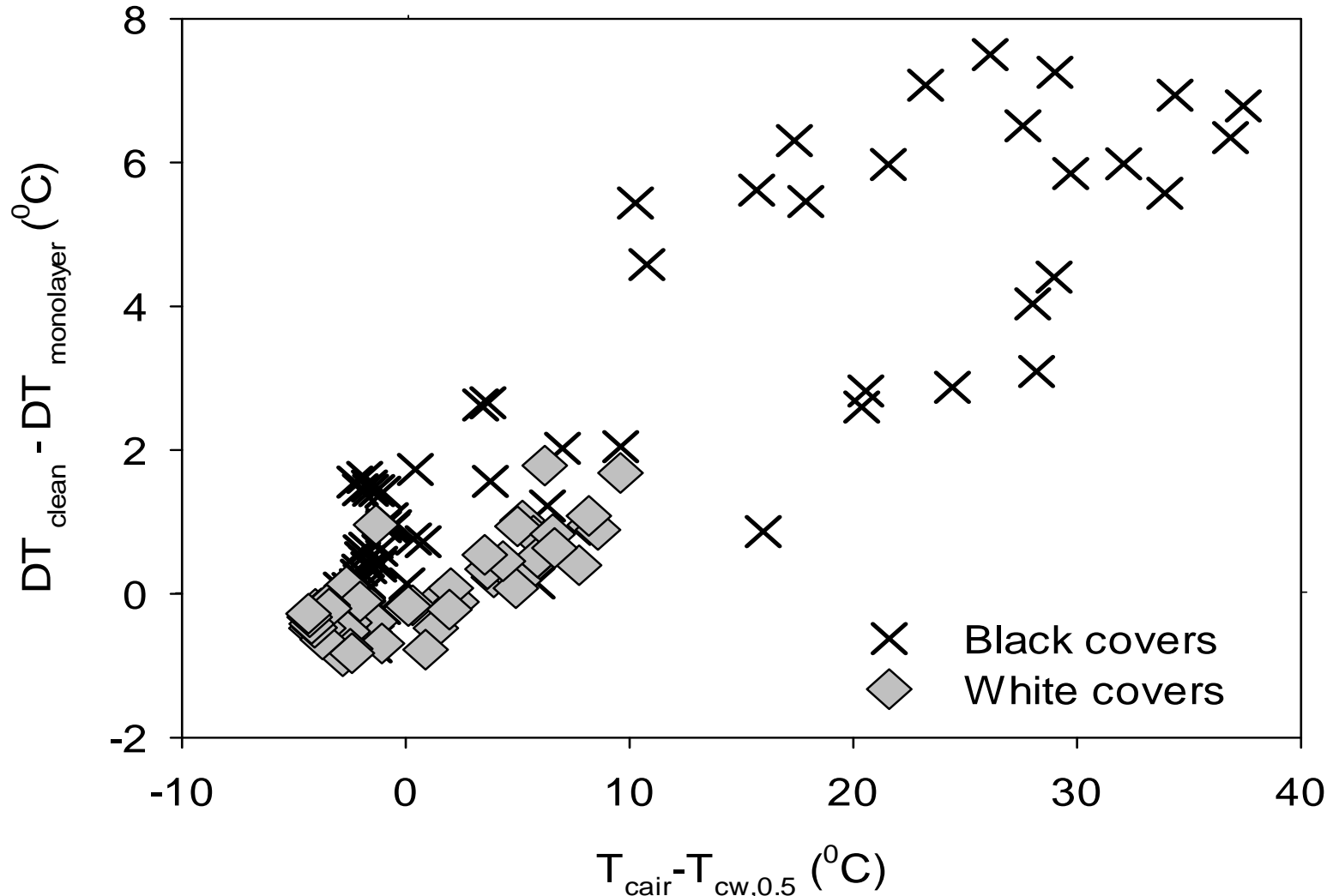
72 hrs with wind <6 m sec $^{-1}$ no/light rain (LTBL dominant)

HOURLY SURFACE DEVIATION TEMPERATURE DIFFERENCE AT LOGAN'S



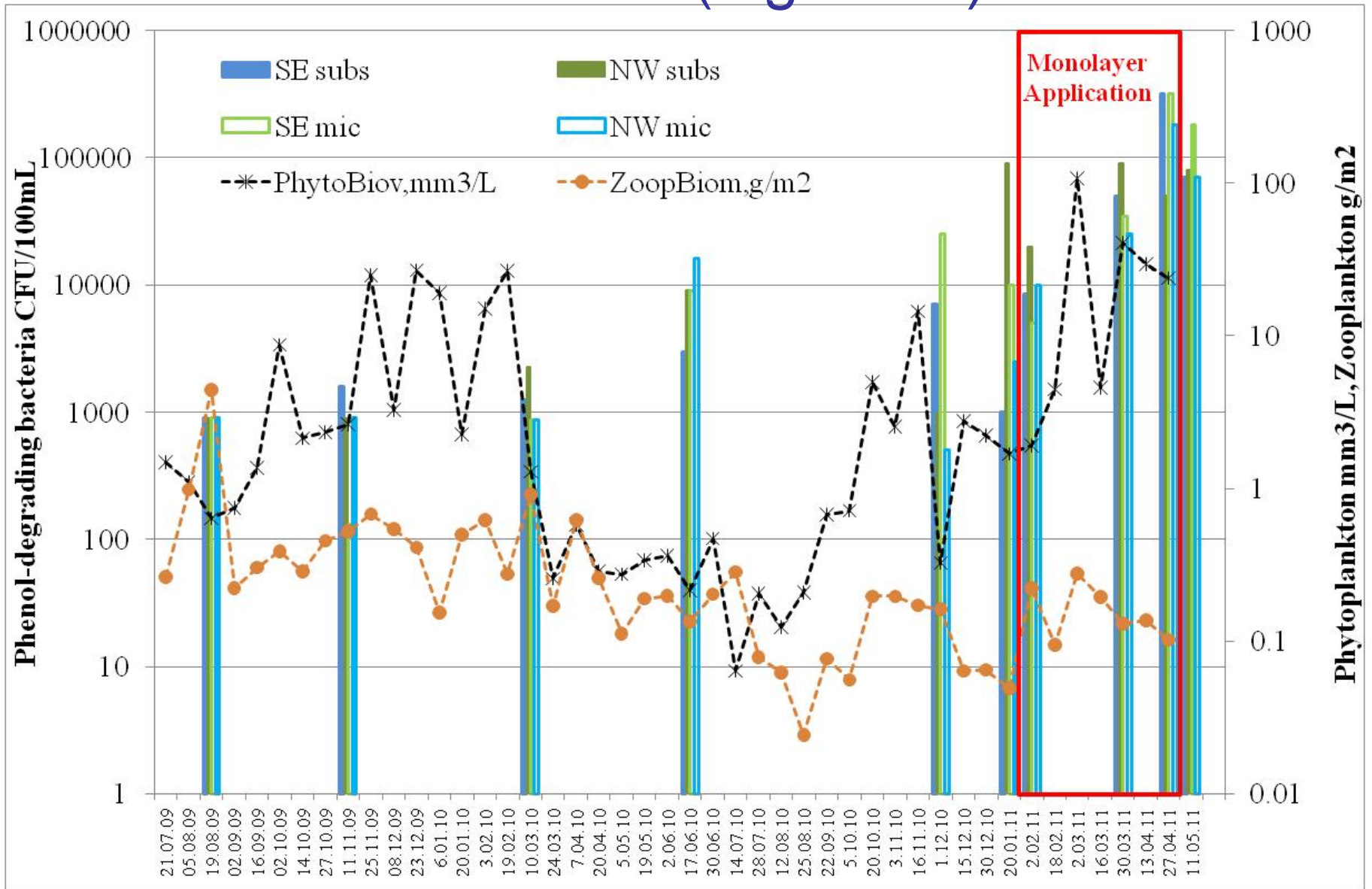
72 hrs with wind <6 m sec-1 no/light rain (LTBL dominant)

TEMPERATURE BUFFERING EFFECT OF MONOLAYER RELATIVE TO CLEAN WATER



72 hrs with wind <6 m sec⁻¹ no/light rain (LTBL dominant)

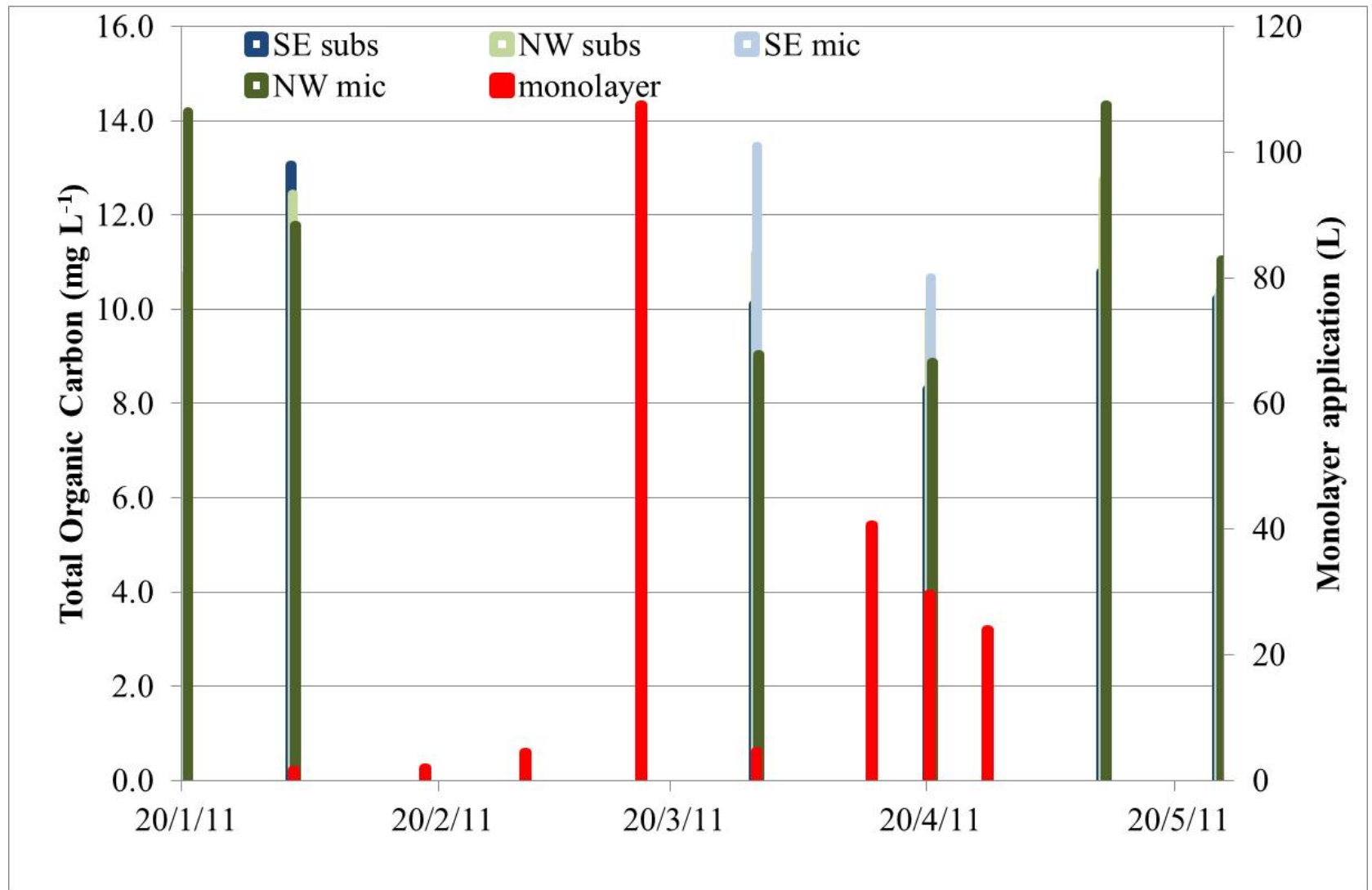
MONOLAYER IMPACT ON MICROBIAL ACTIVITY (log scale)



MICROLAYER ENRICHMENT DURING LOGAN'S MONOLAYER APPLICATION

| Sampling date | MPN SE shore | TOC SE shore | MPN NW shore | TOC NW shore |
|----------------|--------------|--------------|--------------|--------------|
| 11/12/10 | 4 | 1 | 0.5 | 1.3 |
| 20/1/11 | 10 | 1 | 0.03 | 1.3 |
| 2/2/11 | 1 | 0.9 | 0.5 | 0.9 |
| 30/3/11 | 1 | 1.3 | 0.3 | 0.8 |
| 20/4/11 | 1 | 1.3 | 3.6 | 0.9 |
| 11/5/11 | 1 | 0.9 | 2.6 | 1.1 |

MONOLAYER IMPACT ON TOTAL ORGANIC C



C₁₈OH IMPACT ON BOD AND MONOLAYER-DEGRADING BACTERIAL POPULATIONS

| Sampling date | Biochemical Oxygen Demand (mg mL ⁻¹) | | | MPN Phenol-degrading bacteria (CFU 100 mL ⁻¹) | | |
|---------------------------|--|----------------------------------|------------------|---|----------------------------------|--------------------|
| | Tank 1 covered | Tank 2 cover +C ₁₈ OH | Tank 3 uncovered | Tank 1 covered | Tank 2 cover +C ₁₈ OH | Tank 3 (uncovered) |
| 19/1/'10 Black | 4 | 4 | 3 | 2 | 1 | 9 |
| 23/2/'10 White | 2 | 2 | 6 | 2 | 2 | 2 |
| 25/3/'10 Black & white | 4 | 2 | 2 | 12 | 9 | 12 |
| 15/4/'10 | 2 | 2 | 10 | 12 | 9 | 12 |

ADVERSE IMPACT OF MONOLAYERS ON WATER QUALITY?

- Monolayers affect molecular diffusion within LTBL, under low wind speed and light or no rain
- Monolayers buffer heat exchange within the LTBL (< heat loss with a negative air to water temp., < heat gain with a positive air to water temp.)
- Low application rates minimise change in water chemistry and biology

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Acknowledgements:

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and N. Hancock

THANK YOU

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