

Assessing the Relative Toxicity of Different Road Salts and Effect of Temperature on Salinity Toxicity: LCx Values vs. No Effect Concentration (NEC) Values

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Research Article

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Abstract

Freshwater biota are at risk globally from increasing salinity, including increases from deicing salts in cold regions. A variety of metrics of toxicity are used when estimating the toxicity of substances and comparing the toxicity between substances. However, the implications of using different metrics is not widely appreciated. Using the mayfly *Colobruscoidea giganteus* (Ephemeroptera: Colobruscoidea) we compare the toxicity of seven different salts where toxicity was estimated using two metrics 1) the no effect concentrations (NEC) and 2) the lethal concentrations for 10, 25 and 50% of the test populations (LC_x). The LC_x values were estimated using two different models, the classic log-logistic model and the newer toxicokinetic-toxicodynamic (TKTD) model. We also compare the toxicity of two salts (NaCl and $CaCl_2$) for *C. giganteus* at water temperatures of 4°C, 7°C and 15°C using the same metrics of toxicity. Our motivation for using a mayfly to assess salinity toxicity was because mayflies are generally salt sensitive, are ecologically important and are common in Australian (sub-)alpine streams. Considering 144-hour LC_x values, we found toxicity differed between various salts, i.e., the lowest 144-hour LC_{50} (8 mS/cm) for a salt used by a ski resort was half that of the highest 144-hour LC_{50} from artificial marine salts and $CaCl_2$ applied to roads (16mS/cm). 144-hour LC_{50} results at 7°C showed that analytical grade NaCl was significantly more toxic (7.3mS/cm) compared to analytical grade $CaCl_2$ (12.5mS/cm). Yet for NEC values, there were comparably fewer differences in toxicity between salts and none between the same salts at different temperatures. We conclude that LC_x values are better suited to compare difference in toxicity between substances or between the same substance at different test temperatures, while NEC values are better suited to estimating concentrations of substances that have no effect to the test species and endpoint measured under laboratory conditions.

Full Text

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Figures

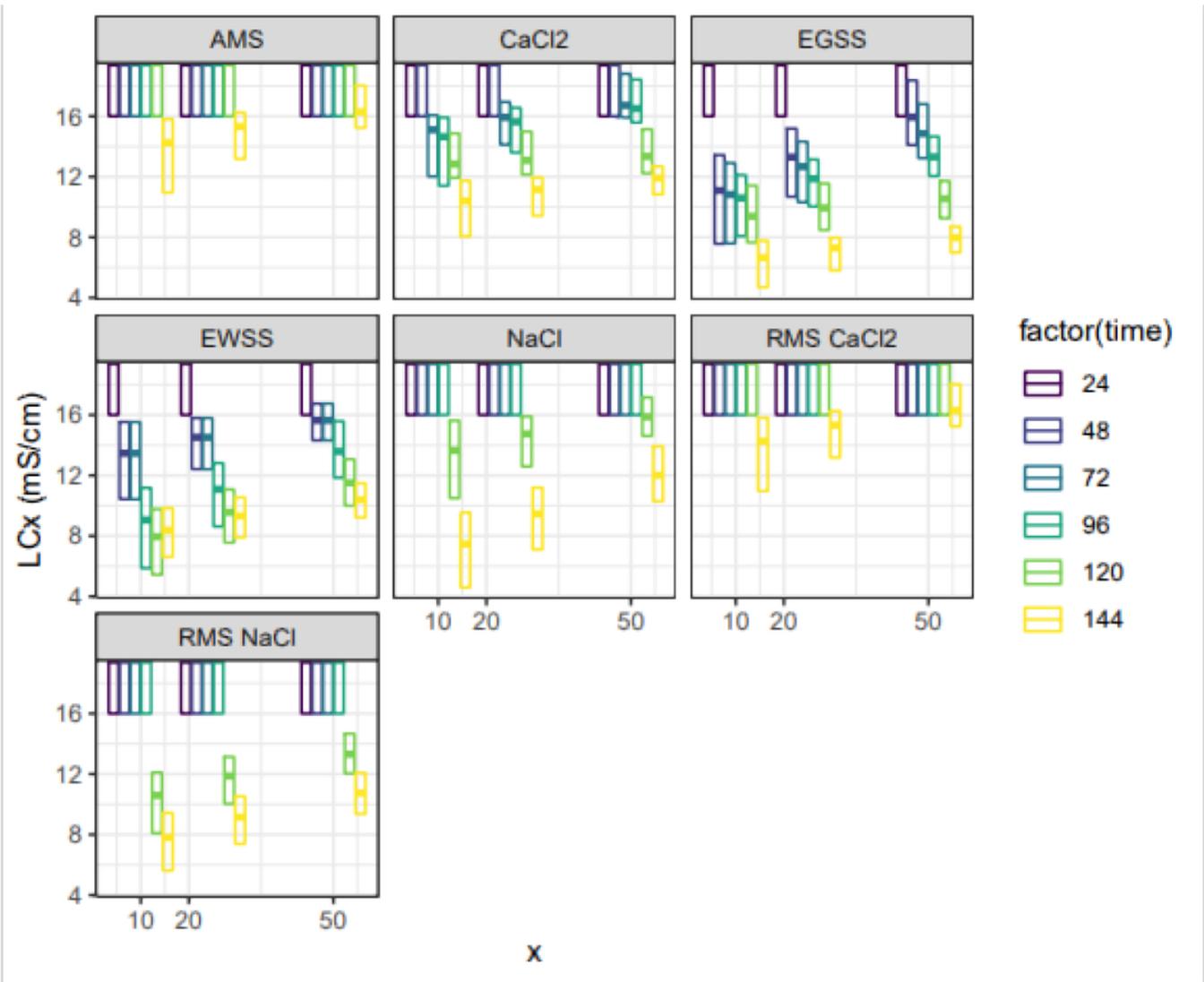


Figure 1

Classical (log-logistical) modeled lethal concentrations for x% of the test population or LCx (mS/cm) values for 7 different salts at $7^{\circ}\text{C} \pm 1^{\circ}\text{C}$ showing 5 different exposure periods (from left to right 24, 48, 72, 96, 120 and 144 hours); x= LCx 10, 25, 50 (from left to right). Median estimate indicated by horizontal line within box, 95% credibility intervals indicated by boxes. The y-axis is curtailed at 20 mS/cm and in those estimates without a median plotted, the upper 95% credibility interval continues to infinity. A full listing of all LCx estimates shown here is given in Supplementary Table S1.

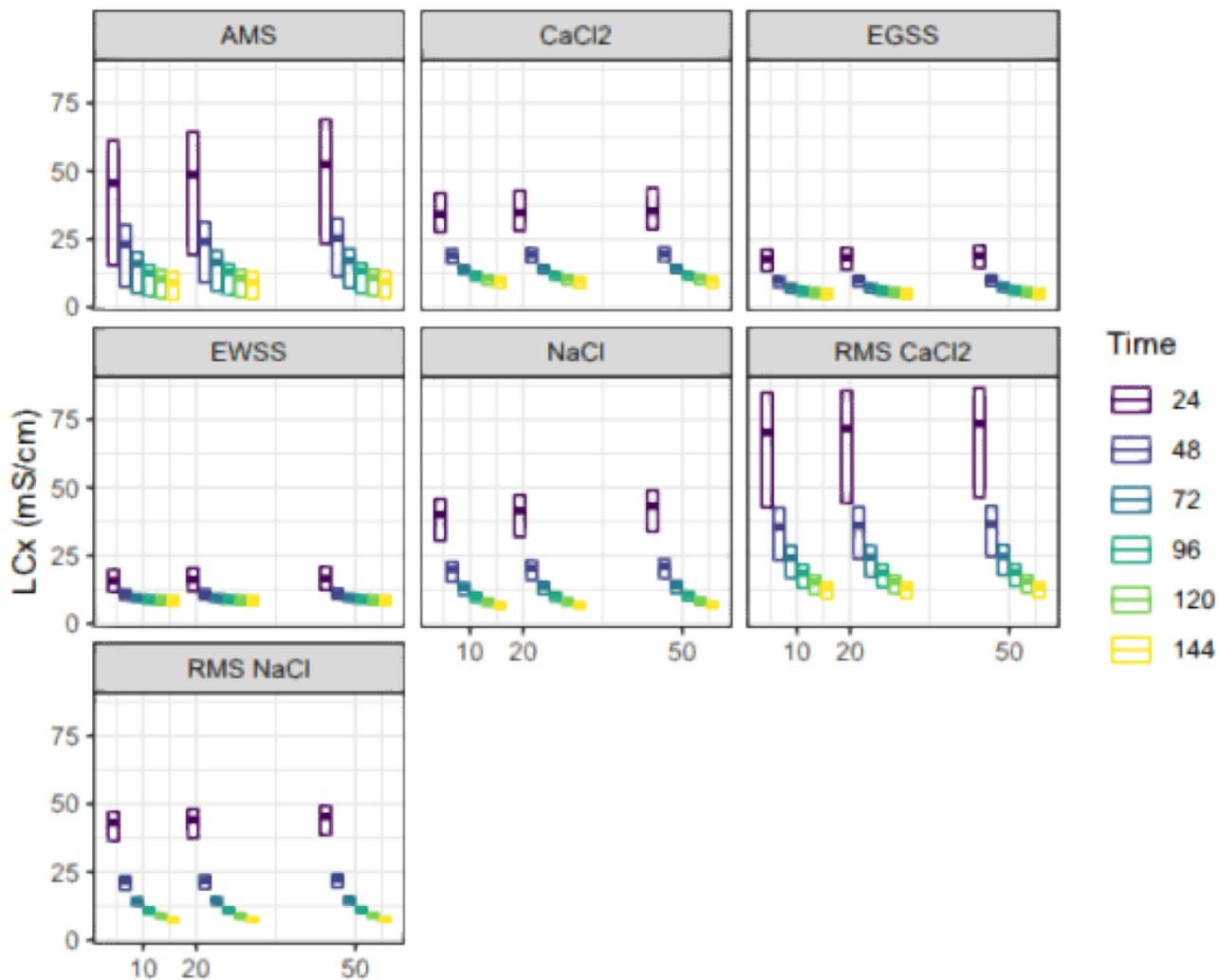


Figure 2

TKDT modelled lethal concentrations for x% of the test population or LCx (mS/cm) values for seven different salts at $7^{\circ}\text{C} \pm 1^{\circ}\text{C}$ showing six exposure periods (from left to right 24, 48, 72, 96, 120 and 144 hours); x= LCx 10, 25, 50 (from left to right). Median indicated by horizontal line within box, 95% credibility intervals indicated by boxes. A full listing of all LCx estimates shown here is given in Supplementary Table S2. See also Supplementary Figure S3.

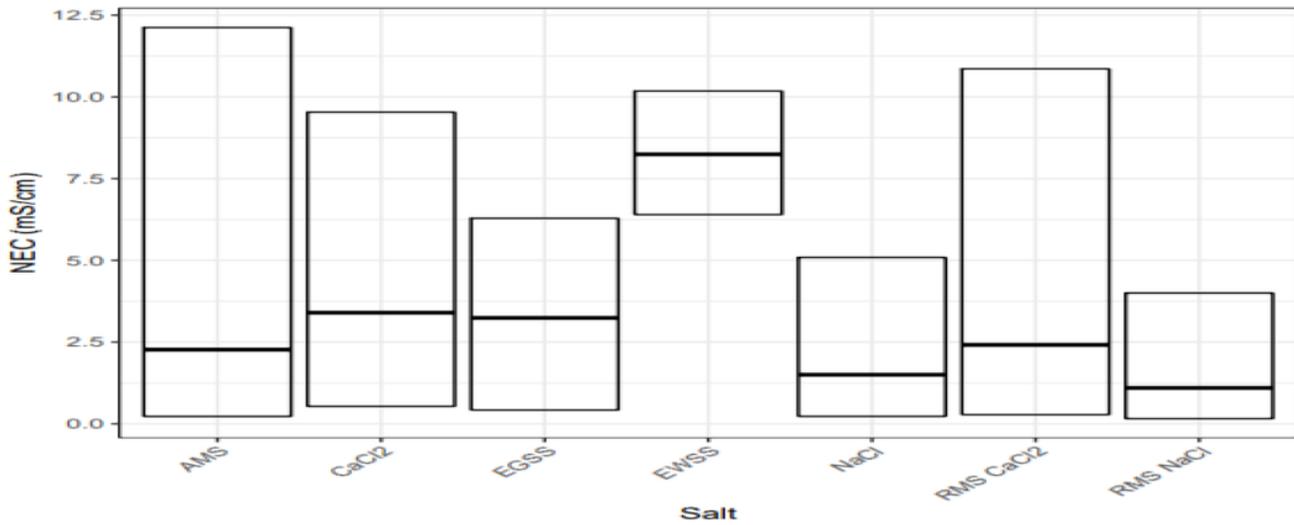


Figure 3

No observed effect concentrations or NECs (mS/cm) values for seven different salts at $7^{\circ}\text{C} \pm 1^{\circ}\text{C}$ using the TKDT model. Median indicated by error bars; 95% credibility intervals indicated by boxes. A full listing of all NEC estimates shown here is given in Supplementary Table S3.

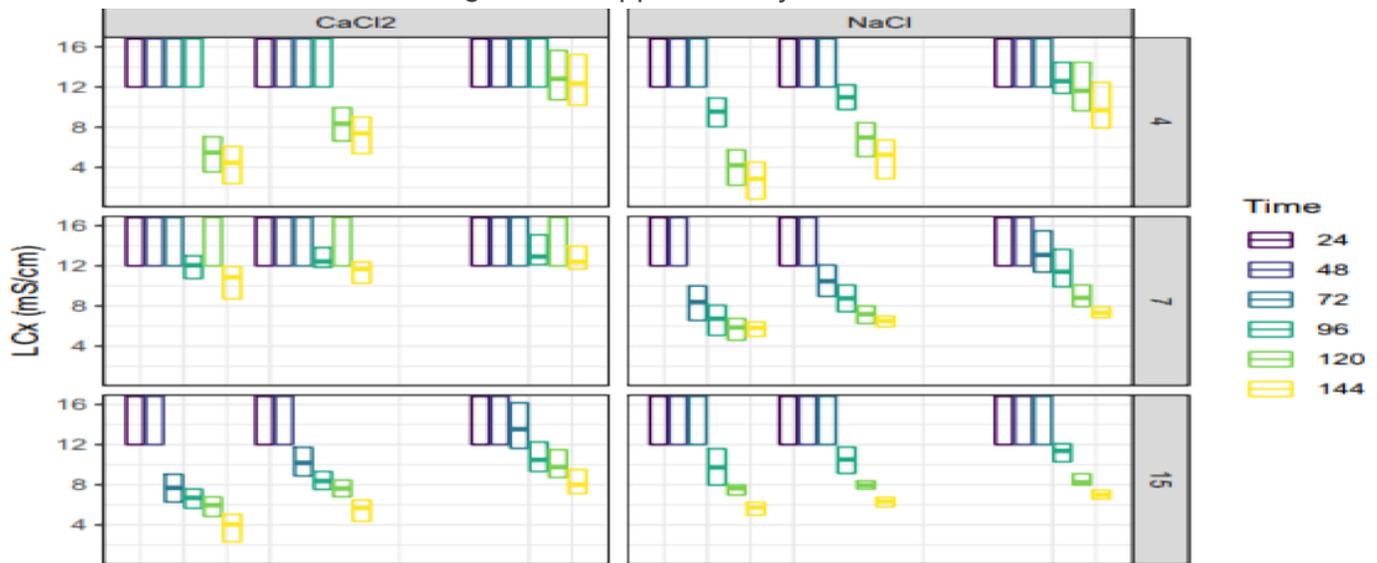


Figure 4

Classical (log-logistical) modelled lethal concentrations for x% of the test population or LCx values (mS/cm) to analytical grade CaCl₂ and NaCl and temperature (4°C , 7°C , 15°C). The multiple estimates for each x represent estimates (from left to right 24, 48, 72, 96, 120 and 144 hours). x= LCx 10, 25, 50 (from left to right). Median indicated by the horizontal line within box, 95% credibility intervals indicated by boxes. The y-axis is curtailed at 17 mS/cm and in those estimates without a median plotted, the upper 95% credibility interval continues to infinity. A full listing of all LCx estimates shown here is given in Supplementary Table S3.

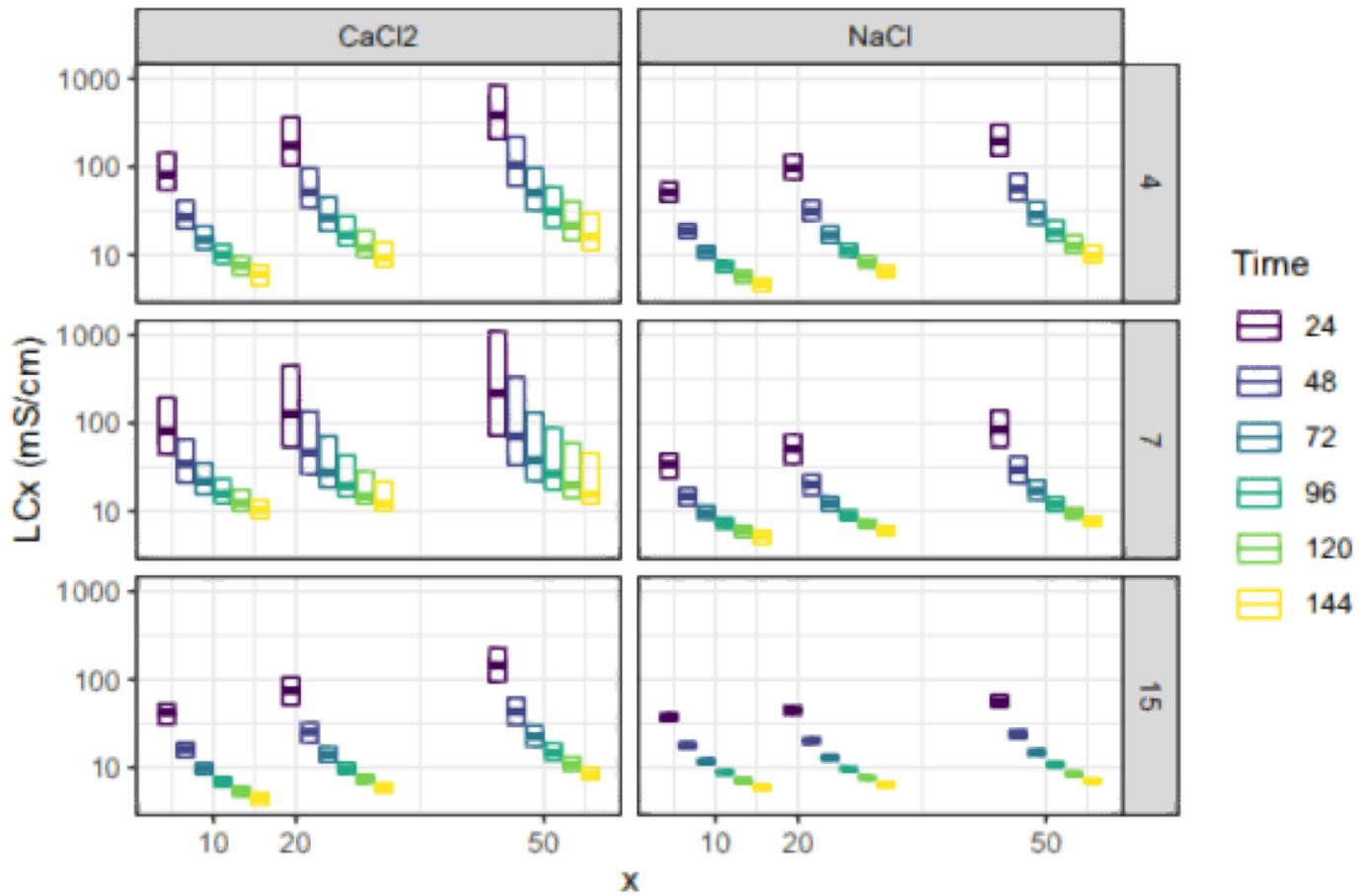


Figure 5

Log scale TKDT modelled lethal concentrations for x% of the test population or LCx values (mS/cm) to analytical grade CaCl₂ and NaCl and temperature (4°C, 7°C, 15°C). The multiple estimates for each x represent (from left to right 24, 48, 72, 96, 120 and 144 hours. x= LCx 10, 25, 50 (from left to right). Median indicated by error bars; 95% credibility intervals indicated by boxes. A full listing of all LCx estimates shown here is given in Supplementary Table S4. See also Supplementary Figure S4.

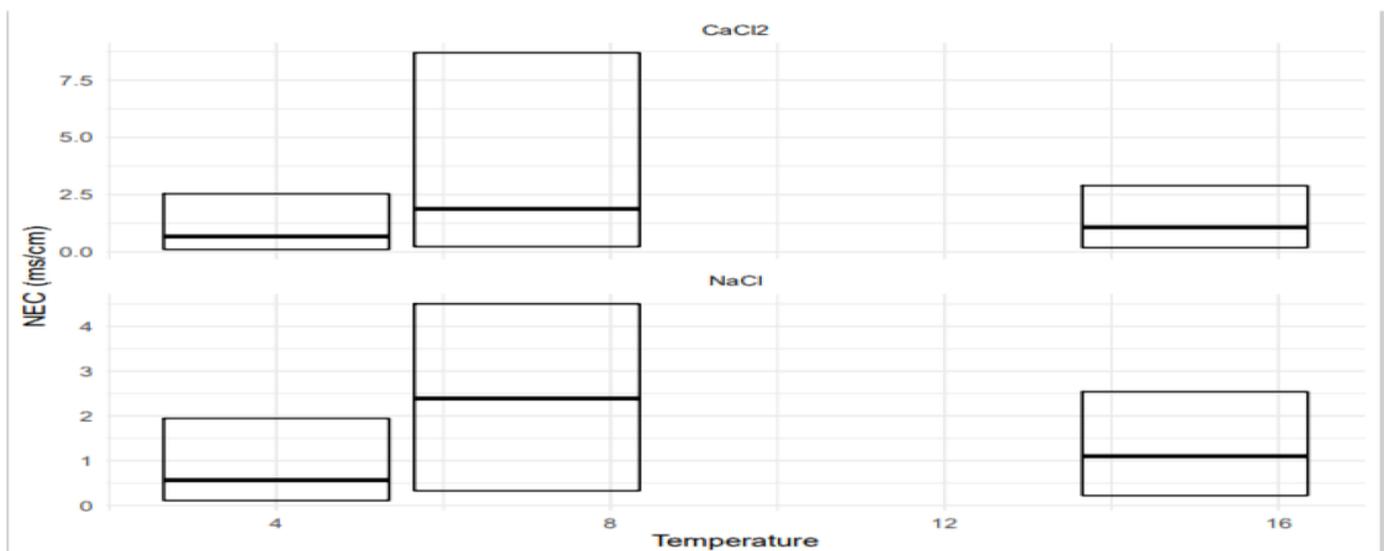


Figure 6

No observed effect concentrations or NECs (mS/cm) values for NaCl and CaCl₂ for temperature ranges (4°C,7°C,15°C); median indicated by error bars, 95% credibility intervals indicated by boxes.

Supplementary Files

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- [SupplementaryMaterialLCxNEC210528BK.docx](#)