Attachment A –

Rationale for collecting continuous vertical profile data

Discrete vertical profile measurements provide a snapshot of lake mixing patterns. For that given point in time, they can answer questions like:

- Does the lake stratify?
- How strong is the stratification (what is the difference between surface and bottom temperatures?)
- What is the depth of the thermocline?
- What are DO levels throughout the water column?
- If multiple years of profile data are collected, how much do measurements vary from year to year? (see example in Figure 1)

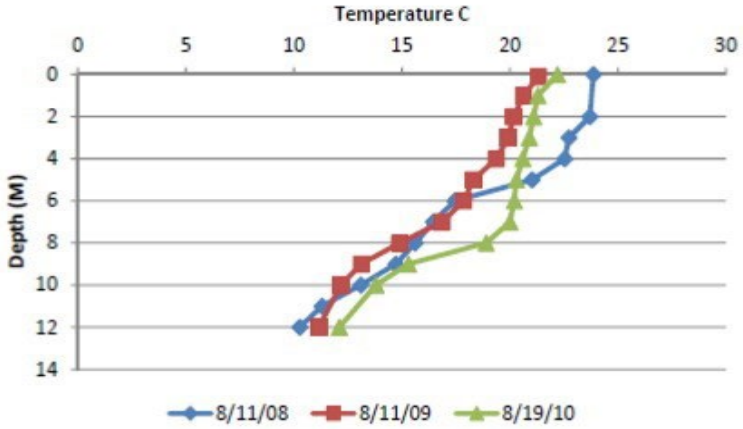

Figure 1. Example of the types of plots that can be generated to compare discrete vertical temperature profile measurements across multiple years (this figure shows summer measurements from Bear Head Lake from 2008-2010). This figure was provided by Minnesota Pollution Control Agency (MPCA) and Minnesota Department of Natural Resources.

More frequent measurements from continuous vertical profile sensors can answer more questions, such as:

- How many times a year does the lake stratify (if at all)? For how long?
- Is the lake stratifying earlier in the year? (and if so, if ice cover data are available, do these changes correspond with earlier ice-out dates?)
- How much does the depth of the thermocline vary throughout the year?
- How much does the extent/thickness of each layer (upper, middle and lower) vary throughout the year?
- How do stratification patterns influence oxythermal habitat for fish, particularly coldwater fish?

Continuous vertical profile data can be used to create more advanced graphics than Figure 1, such as the thermal heat map in Figure 2 and graphics like those shown in Figures 3 & 4 to evaluate year-to-year variability in the timing and duration of stratification.

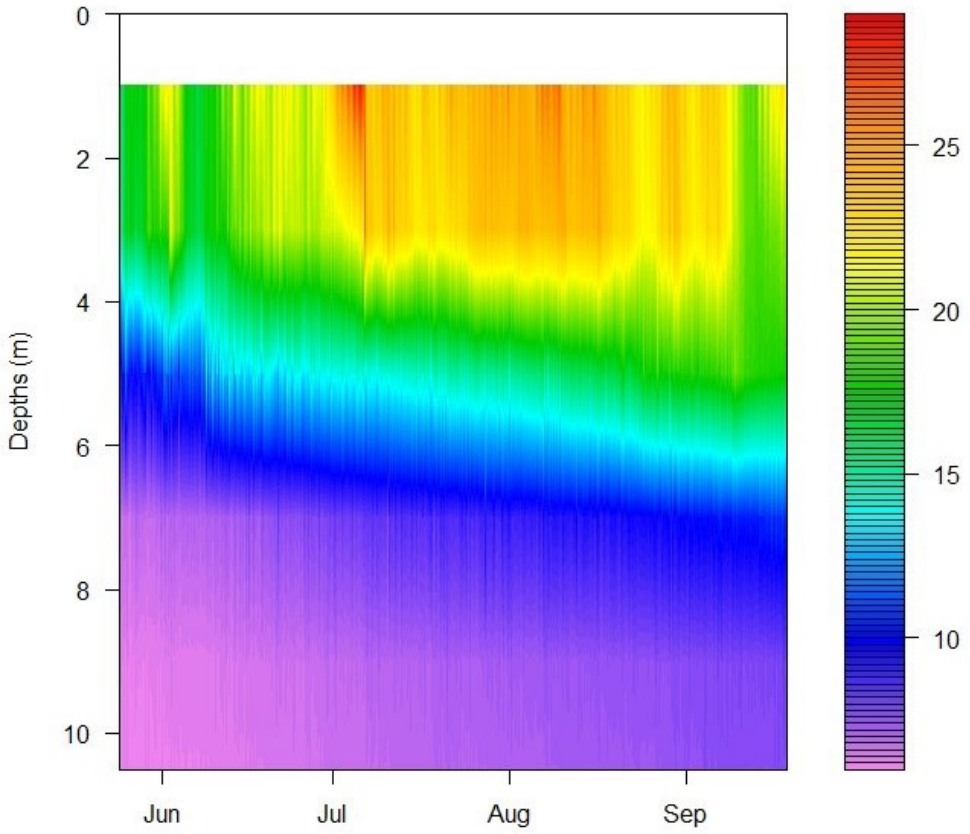

Figure 2. Heat map from Ellis Lake in Maine. Continuous sensors were deployed throughout the water column (at six depths: 1, 3, 5, 7, 9 and 10.5 meters). The heat map was generated with the rLakeAnalyzer package (Winslow et al. 2018). Data were provided by Maine DEP.

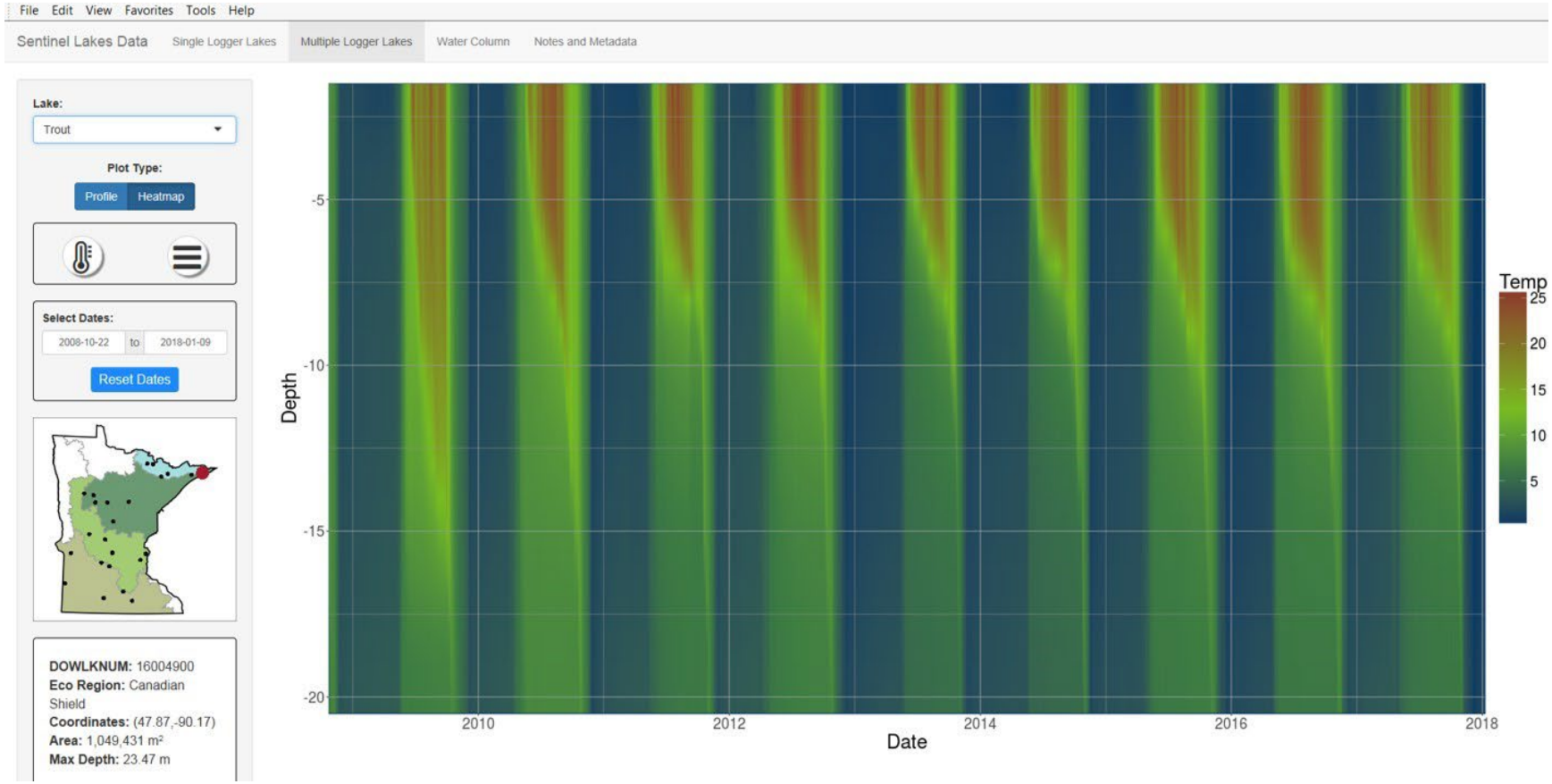

Figure 3. Minnesota DNR has been deploying fixed continuous temperature sensor arrays at its sentinel lakes since 2008. They are creating heat maps like the one shown here to evaluate year-to-year variability in lake thermal structure. This plot was provided by Tim Martin and Casey Schoenebeck from Minnesota DNR.

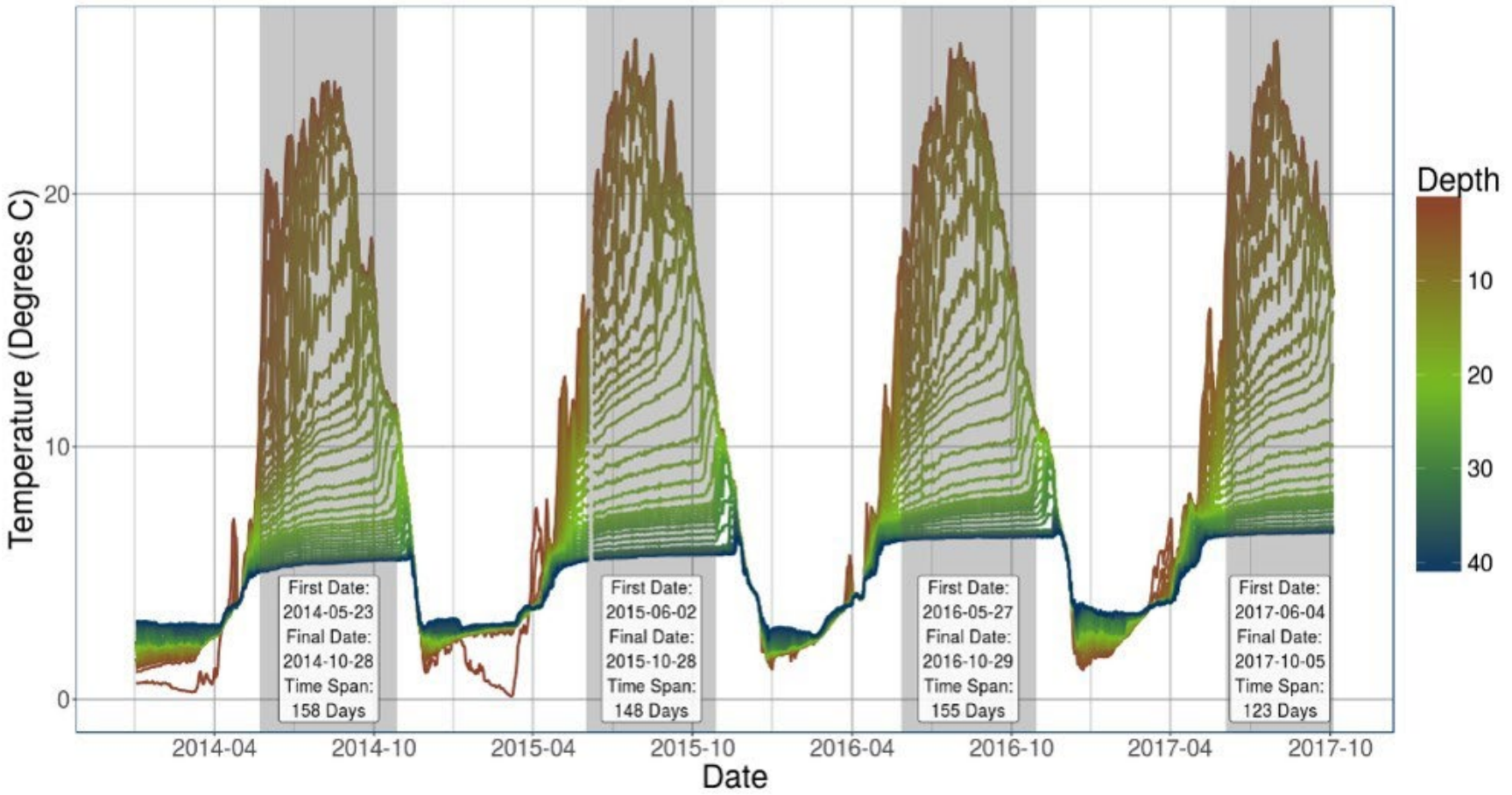

Figure 4. Minnesota DNR has been creating time series plots like the one shown here to evaluate timing (first and last date) and duration of stratification. This plot was provided by Tim Martin and Casey Schoenebeck from Minnesota DNR.