NETLAKE Guidelines for automated monitoring system development

010 Depth of sensor deployment

Objective

In this factsheet, we describe some things that need to be considered when deciding what depth you are going to put your sensors at.

Considerations

- **What is the research question**? If this deployment is a long term, sentinel monitoring site, and you want to be able to keep the station running for years, than the simpler the design the better. A single station at the deepest point of the lake with sensors in the epilimnion should capture many of the sentinel indicators. The addition of a fixed thermistor chain will add some vertical resolution to this set up. If it a short-term deployment to answer a very specific research question, the system can be more complicated.

- **Is it a deep lake?** Are conditions at the surface likely to reflect conditions at depth, and do you care? In shallow lakes, two (or more) sondes or sets of sensors may capture some of the vertical variability if that is required for the research. A profiling system with a multiparameter sonde attached to a winch may be required to answer certain questions in a deeper lake.

- **Is there evidence of strong stratification?** If so, then it is more likely that you want sensors at different depths, as conditions may be quite different above and below the metalimnion. You may be interested in knowing what is going on below a very strong permanent stratification, with an anoxic hypolimnion. Alternatively, you may only be interested in the upper layers of the lake where levels of light and primary production will be greatest. An initial deployment of some simple standalone sensors may be useful to determine stratification.

- **Is the lake polymictic?** Data derived from a set of surface sensors will probably not be able to document the frequency and variability of mixing in a polymictic lake with frequent turnovers. Multiple sensors at different depths, or a profiling multiparameter sonde might be needed to adequately characterise the variability of mixing and its effects on lake processes.

- **What is the euphotic depth**? If it's quite shallow, perhaps a single chlorophyll fluorometer in the epilimnion will capture the primary productivity signal quite well. If it is deep or temporally variable, then even several fluorometers may not detect the highest signal and you should start to think about a profiling system.

- **Is there evidence of a deep chlorophyll maximum (DCM)?** If so, and it is moving, then a profiling system may be required to explore the dynamics of the DCM (if that's of interest).

- **Cost considerations.** Multiple sensors and/or a profiling winch all increase the cost. Do you really need them to answer your research question? Can you do some initial exploration and profiles at crucial times of the year to see how much spatial variability there is?

- **Power supply** Multiple sondes or a profiling winch both require more power. If power is limited, restrict your sensor placement according to the research question

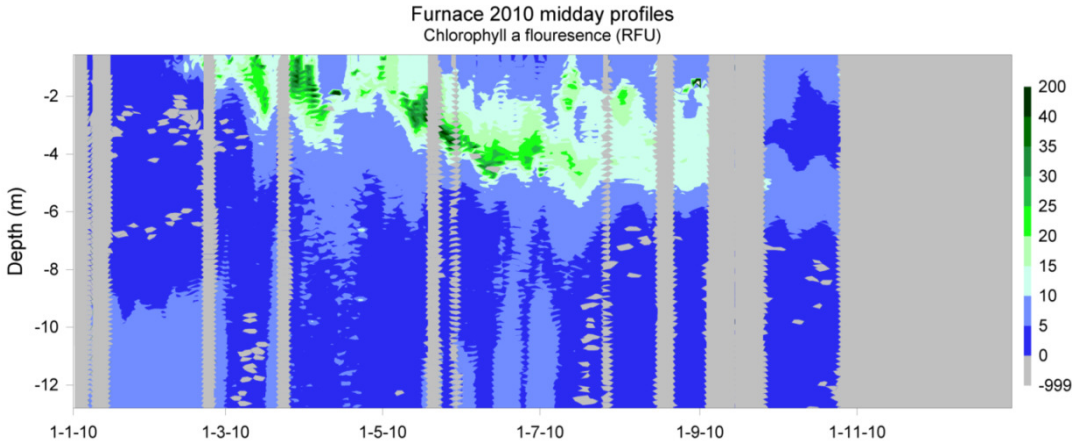
- **Inflow and outflows**: Are these surface or subsurface? Do surface inflows form plumes? Do you have a strong groundwater influence? If it is a reservoir, where are the out-takes? These may all affect the variables you want to measure, and determine where you place your sensors.

- **Data considerations:** The more sensors you have, the more data are going to be gathered. If these are at different depths, it adds complexity to data processing. Do you have the staff time to do this? If not, stick with a simpler system.

Examples

Here are some examples of what can be achieved with sensors at multiple depths.

Example 1: The deep chlorophyll maximum in a stratified lake (Lough Furnace, Ireland), characterized by a chlorophyll sensor on a Hydrolab datasonde S5x connected to a profiling winch, measuring at approximately every 17cm. (Grey areas indicate missing data). Source: Marine Institute Ireland, unpublished data.



Example 2: Metabolism estimates at different depths, in comparison to estimates made with a fixed DO sensor at 1 m (reproduced with permission from Obrador, B., P. A. Staehr, and J. P. C. Christensen. "Vertical patterns of metabolism in three contrasting stratified lakes." Limnology and Oceanography 59.4 (2014): 1228-1240)

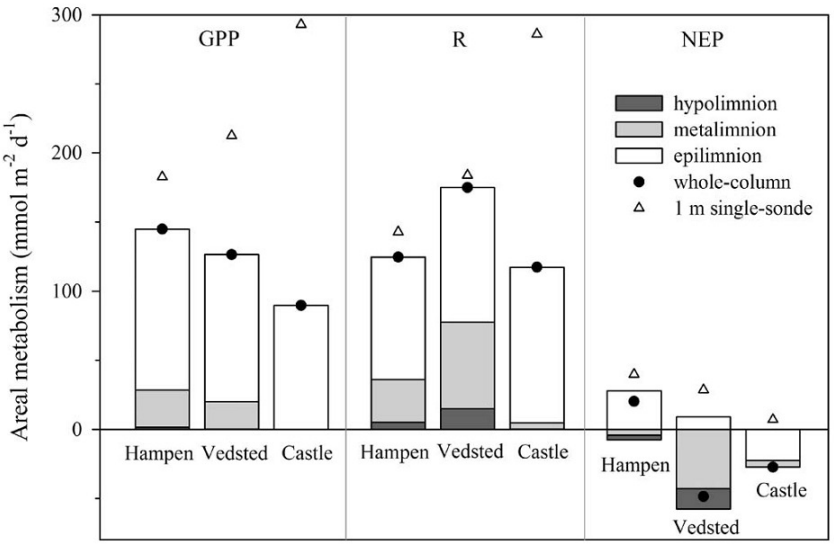
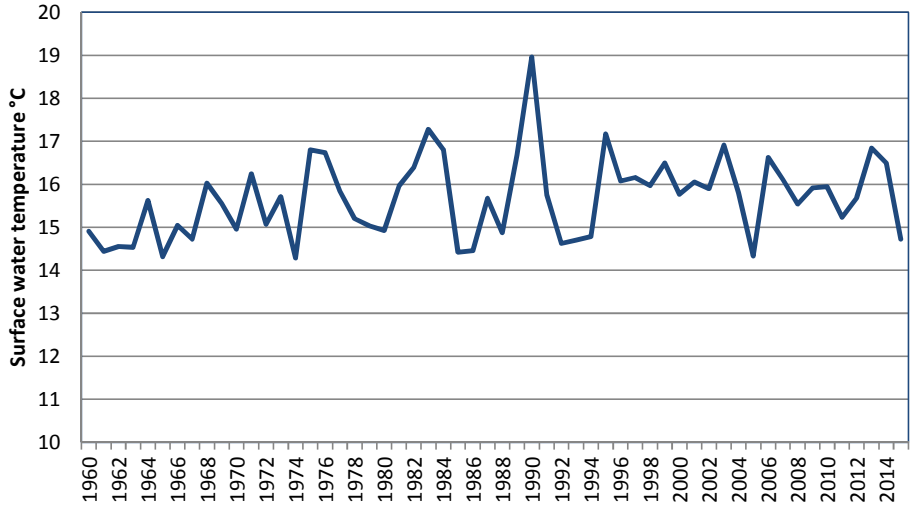


Fig. 4. Mean areal rates (GPP, R, and NEP, in mmol m^{-2} d^{-1}) of the depth layers (bars) and integrated whole-column rates (circles) for the three studied lakes. The estimates derived from single-sonde (1 m depth) measurements are also shown (triangles).

Example 3: Long term summer surface water temperatures of Lough Feeagh Ireland. This example is from a sentinel site, where the primary objective is long term ecological monitoring. In this case, you want to keep the sensors, data acquisition and data collation as foolproof as possible. Source: Marine Institute Ireland, unpublished data.



Likely Problems

While it could be argued that single sensors near the surface are inadequate for monitoring lakes, the reality is that multiple sensors at many depths leads to increased costs and data processing time. Decide what you want to find out, and design the minimum deployment options that will allow you to answer that question.

More information

If you decide you want profiling capability, here are some options:

- ***https://www.ysi.com/File%20Library/Documents/Brochures%20and%20Catalogs/E78-YSI-Vertical-Profiler-Brochure.pdf***
- ***http://www.flydogmarine.com/products/***
- ***http://www.idronaut.it/cms/view/products/monitoring_system/inland_waters/s275***

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