Lake bottom imagery: a simple, fast and inexpensive method for surveying shallow freshwater ecosystems of permafrost regions

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A novel, highly integrated lake-bottom imagery strategy for surveying lake-bottom water and sediments prior to sampling.

**WHY?** Rationale

**WHERE?** Study sites

**HOW?** Integrated method

**(so) WHAT?** Examples, benefits and limitations

Permafrost freshwater ecosystems: widespread, diverse

*Importance of (paleo)limnological studies*
Lakes are very abundant in permafrost regions

[Graph and map showing distribution of lakes in permafrost regions]

Grosse et al. (2013)
Walter et al. (2007)
WHY?

When sampling, paleolimnologists have faith

“I believe.”

Several assumptions:

• Sediment coring site is representative
• Core was collected at deepest location
• Lake-bottom sediments were not disturbed
• Core was collected (perfectly) vertically

Really? Could we just make sure?
Lakes in the Canadian Arctic: Bylot Island (NU)

- Numerous glacial valleys
- Ice-rich permafrost
- Peat-silt layers
- Glacial & thermokarst lakes
- GHG emissions from ponds
Lakes in the Canadian Arctic: Ward Hunt (NU)

- Ward Hunt Lake (WHL)
- Perennial ice (up to 4 m)
- Recent substantial reduction in extent and thickness
- Limnological changes?
Combining GPS-assisted sonar technology...
HOW?

... with waterproof HD photo-video camera
WHAT?

Finding the best location for sediment coring

Bathymetric map
- Deep trench (> 10-m depth)
- Not at the center

Sediment core
- Top: organic mud
- Bottom: sand-gravel
Imaging lake-bottom under a thick ice cover
Other applications: greenhouse gas sampling
Other applications: lake-ice surveying

Kettle lake

Thermokarst lake
Benefits:

• The whole lake survey ‘tool-kit’ can be transported and deployed in the field by a single person;
• Allows new insights into limnological aspects of remote shallow aquatic ecosystems;
• Efficient for rapidly localizing the best sediment coring sites for paleolimnological reconstructions;
• Affordable, easy to deploy, and provides real-time data in the field that can then be used to guide sampling;
• Non-destructive;
• Can be applied to other disciplines.

Limitations:

• User must be careful when manipulating instruments (especially cables);
• GPS-sonar spatial resolution not adequate for very small (few meters) and shallow (< 1m) ponds;
• Sonar and camera batteries have a limited operation time (2-3 hours);
• Imagery depth limit is set by the underwater casing (often < 20 m).

Both limnological and paleolimnological investigations can greatly benefit from this approach.
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