



Environmental Analysis Program

Pomona College
Biogeochemistry Laboratory

SOP-F307

Lake and Reservoir Profiling

Standard Operating Procedure

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1. Purpose

This procedure describes the collection of vertical depth profiles of water quality parameters (temperature, dissolved oxygen, pH, conductivity, turbidity, and chlorophyll fluorescence) in lakes, reservoirs, and deep ponds. Depth profiling characterizes thermal stratification, the location and extent of the thermocline and oxycline, and vertical gradients in water chemistry that control nutrient cycling, habitat availability, and water treatment operations (Kalff, 2002; Wetzel, 2001).

2. Scope

- **Applies to:** Vertical profiling from boats, docks, or platforms in lentic water bodies (lakes, reservoirs, ponds) and slow-moving deep river pools. Covers both manual sonde profiles and Secchi depth measurements.
- **Does not apply to:** Continuous deployed sonde monitoring (see future SOP); horizontal spatial surveys; stream cross-section water quality (see [SOP-F200](#) for general sonde operation); bathymetric mapping
- **Location:** All EA Program lake and reservoir field sites

3. Responsibilities

Role	Responsibility
PI / Field Lead	Approve profiling plan, coordinate boat access and permits
Trained Personnel	Calibrate sonde, perform profiling per this SOP
New Students	Complete training and boat safety orientation before participating

4. Definitions

- **Epilimnion:** The warm, well-mixed, oxygen-rich surface layer of a thermally stratified lake; bounded below by the thermocline; the zone of primary production and gas exchange with the atmosphere.
- **Hypolimnion:** The cold, dense, isolated bottom layer of a thermally stratified lake; oxygen depleted in productive lakes due to decomposition of settling organic matter; often enriched in dissolved nutrients and reduced metals (Fe^{2+} , Mn^{2+}).
- **Metalimnion:** The layer of rapid temperature change between the epilimnion and hypolimnion; also called the thermocline layer; may harbor distinct biological communities (e.g., deep chlorophyll maxima) and chemical gradients.
- **Oxycline:** The depth zone of rapid decline in dissolved oxygen concentration; typically coincides with or lies below the thermocline in stratified lakes; marks the transition from aerobic to anaerobic conditions.
- **Secchi depth:** The depth at which a Secchi disk (a white or black-and-white patterned disk lowered on a calibrated line) becomes invisible; an index of water transparency and light penetration; negatively correlated with phytoplankton biomass and suspended sediment concentration.
- **Sonde:** A multi-sensor instrument lowered through the water column on a cable to measure temperature, dissolved oxygen, conductivity, pH, turbidity, and chlorophyll a at defined depth intervals; the primary instrument for lake profiling.
- **Stratification:** The separation of a water body into distinct horizontal layers of differing density, driven primarily by temperature differences; limits vertical mixing and controls the distribution of oxygen, nutrients, and organisms.
- **Thermocline:** The plane or narrow zone of maximum rate of temperature decrease with depth; defined operationally as a gradient exceeding $1\text{ }^{\circ}\text{C m}^{-1}$; the boundary between the epilimnion and metalimnion.

- **Trophic state:** A classification of a lake's biological productivity based on nutrient concentrations, phytoplankton biomass, and water clarity: oligotrophic (low nutrients, clear), mesotrophic (intermediate), eutrophic (high nutrients, low transparency), hypereutrophic (very high nutrients, algal bloom prone).

5. Safety and Hazards

Hazards

- **Drowning:** All lake work involves drowning risk. Personal flotation devices (PFDs) are mandatory for all personnel on boats, docks, and platforms.
- **Weather:** Lightning, high winds, and sudden storms pose serious hazards on open water. Abort profiling if thunderstorms are within 10 miles or winds exceed safe boating conditions for the vessel.
- **Sun exposure:** Extended time on open water increases UV exposure and heat stress.
- **Equipment:** Heavy sonde and cable assemblies can cause hand and back injuries when deployed over the side of a boat.

5.1. Required PPE

- ☐ Personal flotation device (PFD) – worn at all times on the water
- ☐ Closed-toed shoes with non-slip soles
- ☐ Nitrile gloves (when handling calibration solutions)
- ☐ Sun protection (hat, sunscreen, sunglasses)

5.2. Emergency Procedures

Refer to [SOP-F001 Field Safety](#). All boat occupants must know the location of PFDs, throwable flotation devices, and communication equipment (VHF radio or charged cell phone). If a person falls overboard, deploy the throwable device immediately and maneuver the boat to the person.

6. Equipment and Materials

Item	Notes
Eureka Manta2 multiprobe or equivalent sonde	Calibrated per SOP-F200
Sonde cable (length sufficient for maximum expected depth)	Graduated at 0.5 m or 1 m intervals
Secchi disk and graduated line	Per SOP-F207
Depth sounder or weighted line	For measuring total water depth at the profiling station
Boat, canoe, kayak, or dock access	Appropriate to site conditions

Item	Notes
Anchor(s) or tie-off lines	To hold the boat stationary during profiling
GPS unit	For recording station coordinates per SOP-F006
Field notebook and profiling data sheet	Waterproof (Rite in the Rain); see Appendix A
Camera	For photo-documenting site and weather conditions
Water sample bottles and cooler	If discrete-depth water samples are collected alongside the profile

7. Procedure

7.1. Pre-Field Preparation

1. Calibrate the sonde per [SOP-F200 Eureka Manta2](#) before departing for the field
2. Verify that the sonde cable is marked at depth intervals (0.5 m or 1 m). If using a direct-read cable, confirm depth readings against a tape measure.
3. Check weather forecast; postpone if thunderstorms are likely or sustained winds exceed the vessel's safe operating threshold
4. Review the profiling station coordinates and planned depth intervals

7.2. Station Setup

1. Navigate to the profiling station (typically the deepest point of the lake or a fixed monitoring location)
2. Record GPS coordinates, date, time, weather conditions (sky cover, wind speed and direction, air temperature), and total water depth
3. Anchor or tie off the boat to minimize drift during the profile
4. Perform the Secchi disk measurement per [SOP-F207](#)

7.3. Sonde Deployment and Profile Collection

1. Lower the sonde to 0.5 m below the surface. Allow at least 60 seconds for the sensors to equilibrate (longer for optical DO in cold water).
2. Record all parameters (temperature, DO, pH, conductivity, turbidity, chlorophyll) at that depth. If the sonde is logging internally, note the time and depth; if reading from the handheld display, record values on the data sheet.
3. Lower the sonde to the next depth increment (typically 0.5 m in the epilimnion and through the thermocline; 1 m increments are acceptable in deep hypolimnetic water where parameters change slowly).
4. At each depth, allow 30–60 seconds for sensor equilibration before recording.
5. Continue to within 0.5 m of the bottom. Do not allow the sonde to contact the sediment (stirs up sediment and can foul sensors).

6. After the deepest reading, raise the sonde steadily to the surface. If time permits, record an ascending profile for comparison.

 Tip

In productive lakes, the most rapid changes in temperature and DO occur at the thermocline and oxycline. When you detect these transitions, switch to 0.5 m or even 0.25 m intervals to resolve the gradient.

7.4. Discrete-Depth Water Sampling (Optional)

If the study design requires water samples at specific depths (e.g., epilimnion, metalimnion, hypolimnion):

1. Use a Van Dorn or Kemmerer bottle lowered to the target depth
2. Trip the sampler and raise to the surface
3. Dispense into pre-labeled sample bottles per [SOP-F300](#) preservation requirements
4. Record the collection depth and time for each sample

7.5. Post-Profiling

1. Rinse the sonde sensors with deionized water
2. Replace the sonde in its calibration/storage cup with storage solution (especially the pH sensor)
3. Download logged data or scan the data sheet for completeness
4. Confirm that GPS coordinates, Secchi depth, total depth, and all profile readings are recorded

8. Data Interpretation

A typical stratified lake profile shows three zones:

Zone	Characteristics
Epilimnion	Warm, well-mixed surface layer; high DO, uniform temperature
Metalimnion (thermocline)	Rapid temperature decrease with depth (at least 1 C per meter)
Hypolimnion	Cold, dense bottom layer; may be anoxic in productive lakes

 Note

Not all lakes stratify. Shallow, wind-exposed, or polymictic lakes may be fully mixed during some or all seasons. Record whether stratification is present and the depths of the thermocline boundaries.

9. Quality Control

- Calibrate the sonde on the day of profiling; record calibration results on the calibration log
- Allow adequate sensor equilibration time at each depth (minimum 30 seconds; 60 seconds at the first depth and near the thermocline)
- Record an ascending profile periodically to check for sensor drift during the profile
- Verify depth markings on the cable against a tape measure at least once per season
- If the sonde includes an internal depth (pressure) sensor, compare cable-marked depth to the sensor depth at several points; discrepancies greater than 0.3 m require investigation
- For long-term monitoring, profile at the same station, same time of day (within 2 hours), and same depth intervals for comparability

10. References

Kalff, J. (2002). *Limnology: Inland water ecosystems*. Prentice Hall.

Wetzel, R. G. (2001). *Limnology: Lake and river ecosystems* (3rd ed.). Academic Press.

11. Related SOPs

SOP	Title	Relationship
F001	Field Safety	Required prerequisite
F200	Eureka Manta2 Multiprobe	Sonde calibration and operation
F207	Secchi Disk	Transparency measurement
F300	Surface Water Sampling	Discrete-depth water samples
F305	Sediment Sampling	Lake sediment collection
L300	pH and Conductivity (Bench)	Lab verification of field readings
L310	Chlorophyll Extraction	Lab chlorophyll from depth samples

12. Training Record

Before performing lake profiling independently, personnel must:

1. Read this SOP, [SOP-F001](#), and [SOP-F200](#) in full
2. Complete boat safety orientation (PFD use, boat handling, man- overboard procedures) for the vessel type used at the site
3. Observe a trained operator perform a complete depth profile including sonde calibration, Secchi measurement, and data recording
4. Perform a supervised profile and demonstrate proper sensor equilibration timing and depth-interval decisions at the thermocline
5. Be signed off by the PI or field lead

13. Appendix A: Profiling Data Sheet

Print on waterproof paper. One sheet per station per date.

Station ID: _____ **Date:** _____ **Time start:** _____ **Time end:** _____

GPS: Lat _____ Lon _____ **Total depth (m):** _____ **Secchi depth (m):** _____

Weather: Sky _____ Wind _____ Air temp _____ C

Sonde ID: _____ **Calibration date:** _____

Depth (m)	Temp (C)	DO (mg/L)	DO (%)	pH	SpC (uS/cm)	Turb (NTU)	Chl (ug/L)	Notes
0.5								
1.0								
1.5								
2.0								
2.5								
3.0								
3.5								
4.0								
5.0								
6.0								
7.0								
8.0								
9.0								
10.0								

Observer: _____