TEMPERATURE PROFILING
IN LAKES

A GUIDE TO UNDERSTANDING AND ESTABLISHING THERMAL STRATIFICATION AS A REAL-TIME MONITORING SOLUTION

FONDRIEST ENVIRONMENTAL

WHAT'S INSIDE

WHY MONITORING MATTERS

Many lakes greater than 12 feet in depth will stratify, forming layers of water with different temperature. This thermal stratification occurs due to differences in density between warm and cold waters, with cold water being denser and less viscous than warm water. Limnologists categorize the resulting layers from top to bottom — and therefore warmest to coolest — as the epilimnion, the thermocline and the hypolimnion. During the winter, however, lakes undergo inverse stratification, with ice forming above the coolest layer of liquid water, and the warmer layer resting on the bottom. In early spring, the lake "turns over," reverting to its standard thermal stratification.

Monitoring the yearly evolution of thermal stratification is a critical component in lake management and research, as the phenomenon can impact many aspects of the lake, including spatial distribution of fish, microbial growth and oxygen content. In many lakes in the summer, tiny invertebrates and microorganisms consume dead algae and zooplankton. The decomposition process uses oxygen. Because lakes do not mix in the summer, the hypolimnion does not receive fresh oxygen, making it possible for anoxic zones to form during this time.

Lake management guidelines vary from state to state, so there is no standard requirement for temperature profiling. However, there are common configurations for lake temperature monitoring systems based on the size and volume of the lake. A buoy-based real-time monitoring solution can enable lake managers and researchers to respond to unusual or troubling temperature readings.

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LAKE MANAGEMENT

Definition & Approaches

"Lake management" is a broad term that can apply incorporate many disciplines and applications. Management of a single lake can include conservation, improvement, restoration and rehabilitation projects, as well as studies of the local watershed and other waterbodies in the system.

The North American Lake Management Society recommends "iterative steps" when managing lakes and watersheds. Small efforts toward an established goal cost less than major improvements, and are less likely to negatively impact non-targeted organisms and other aspects of the lake. It warns, however, that certain techniques are only effective when performed at a larger scale, potentially raising the cost and impact of lake management. Compromises may be necessary to achieve a desired effect under constrictions of time and funding, but local regulations should be consulted to determine whether any action to a lake or watershed is appropriately justified.

There are a variety of approaches to lake management, and many techniques capable of altering a lake's nutrient content, oxygen levels, biotic distributions and sediment composition. These can be as "simple" as harvesting plants, adding bacteria and removing certain fish species, or can include more complicated measures, such as lowering water levels, dredging sediment or controlling various hydraulic factors. Any of these operations can interfere with a lake's thermal profile, so it is advisable to maintain a temperature monitoring system before, during and after a project.

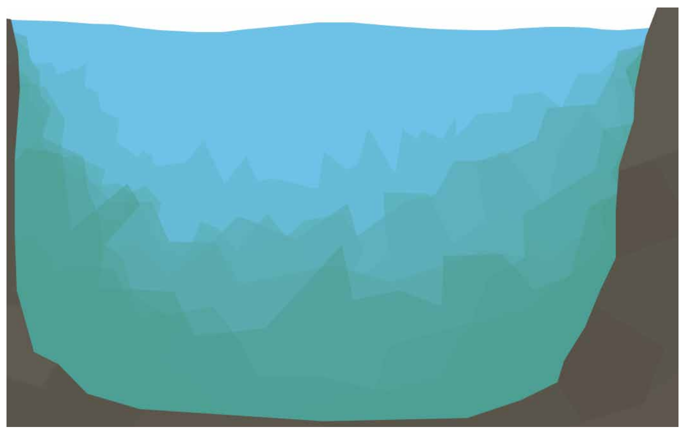
IMPACTS OF LAKE TEMPERATURE

Temperature has a significant impact on water chemistry, and a number of phenomena can occur when a lake's water temperature and chemical properties reach certain thresholds. Not all of these phenomena are necessarily negative; many are naturally occurring (as in without anthropogenic influence) and some are unavoidable. But the implementation of a real-time temperature profiling system can enable lake managers to respond to troubling signs in advance.

Thermal Pollution

Thermal pollution is the occurrence of artificially high temperatures in a lake. It is nearly always the result of municipal or industrial waste effluence. Rainwater runoff passing over asphalt and pavement can also negatively impact lakes, slightly raising temperature and carrying leaked oil and other toxic chemicals into a waterbody. In recent studies, juvenile salmon were shown to experience a 100 percent mortality rate when exposed to urban highway runoff.

Many sources of thermal pollution provide a negligible impact to lake temperature in isolation. Only when multiple pollutants flow into a lake do the effects become noticeable. This makes direct, measurable thermal pollution rather uncommon. Streams that flow into lakes, however, are more sensitive to the effects of thermal pollution, and can act as a source of contamination when they become damaged themselves.



Eutrophication

When overgrown blooms of algae die and decompose, the increased loads of organic matter — and the organisms responsible for decomposition — consume available oxygen in the water, causing hypoxic "dead zones" to form. These dead zones reduce the liveable space in a lake, and can increase competition and kill off other organisms, such as fish. The process is natural in most water bodies, but anthropogenic activity, such as agricultural fertilization, can speed it up.

While eutrophication is mostly a function of nutrient loads, temperature can have a major impact on the phenomenon. Higher temperature can increase biomass production, therefore contributing to the overall rate of oxygen depletion. Furthermore, highly stratified lakes are more vulnerable than well-mixed lakes, as the thermocline prevents exchange between any anoxic zones and oxygenated waters.

Stratification

Lake stratification is a product of the relationship between water density and temperature. Unlike other compounds, water is more dense as a liquid than a solid — that's why ice floats. Water is most dense at 4 degrees Celsius, and becomes less dense as it warms or cools. At that point, of course, there is a lot more room for water to warm rather than cool, as it freezes at 0 degrees Celsius.

In the summer, solar radiation heats the epilimnion, or top layer of a lake, causing the water there to become less dense. The hypolimnion receives less light, if any, and remains cold and dense. Differences in density cause the epilimnion to float atop the hypolimnion without mixing, forming a dividing layer known as the thermocline. Algae and zooplankton live in the epilimnion during the summer, but when they die, invertebrates and microorganisms living in the benthic sediment decompose the remains, using up oxygen in the process. Because the lake does not mix during the summer, the hypolimnion can become anoxic under certain conditions.

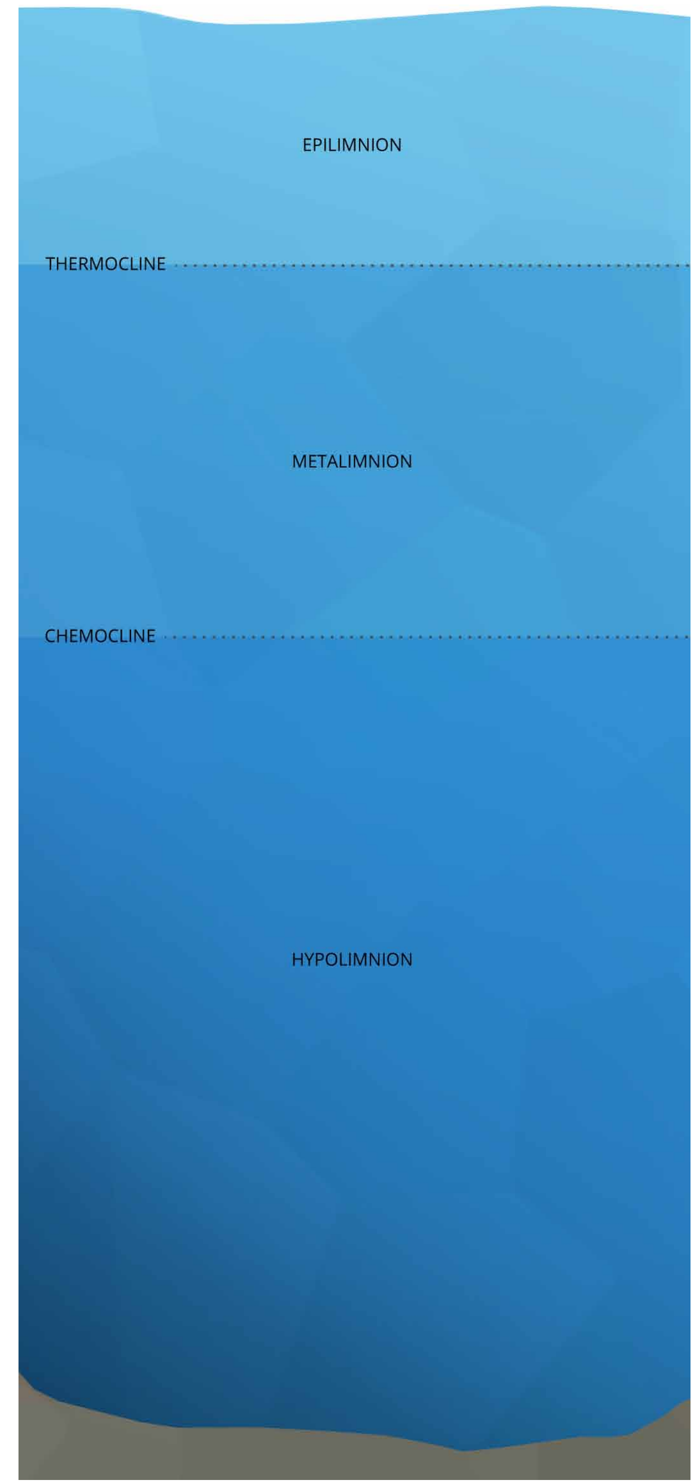
As the weather cools and sunlight grows less intense in the fall, the epilimnion begins to cool, reducing the difference in density between it and the hypolimnion. A combination of wind and shifting water density helps mix the layers, distributing oxygen and nutrients throughout the water column.

Some lakes ice over in the winter, preventing the wind from mixing the water. A thin layer of cool water forms beneath the ice, while warmer, denser water sits at the bottom of the lake, resulting in a phenomenon called inverse stratification. Just as in the summer, the hypolimnion receives no new oxygen. Lake hypoxia in the winter often produces a "winter kill," in which oxygen-dependent fish and other organisms die en masse. The same chemical processes that lead to anoxic conditions can cause phosphorous release, leading to increased algae growth in the warmer months.

Lakes that mix twice a year are known as dimictic lakes. Shallow lakes exhibit different hydrological qualities, and can mix more often than deeper lakes.

Flushing

While not a central function of lake stratification, flushing, or the process of completely renewing a lake's water volume, can affect how a lake responds to atmospheric and watershed inputs. To determine flushing rate (known also as hydraulic residence time), divide lake volume by outflow rate. Larger lakes and lakes with fewer inputs and outputs will have longer residence times than their smaller counterparts. Residence times can vary from hours to days to years. Typically, this period is a matter of days or months.



A REAL-TIME SOLUTION

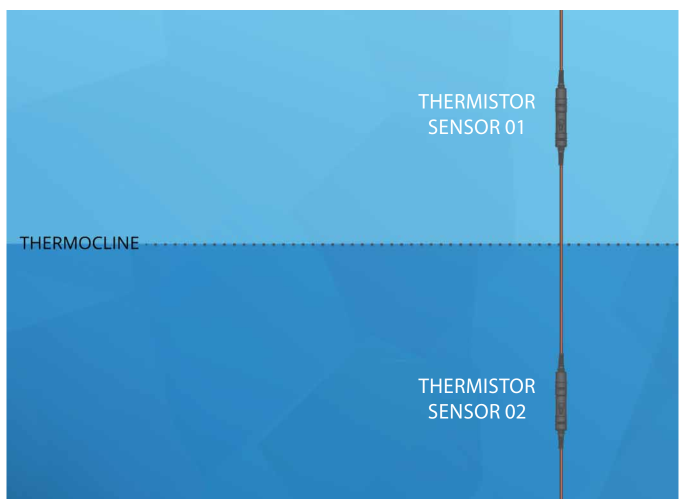
Unlike other water quality parameters, lake temperature can be accurately measured in real time or at scheduled intervals. The addition of data logging and telemetry instruments enables researchers and managers to study temperature readings remotely at their convenience. To ensure that temperature is being measured throughout a lake's stratified layers, thermistor strings should be used, rather than individually mounted temperature sensors.

Measuring Thermal Stratification in Lakes

Thermal stratification in lakes can be quantified with the aid of thermistors, a type of resistor that exhibits precise and predictable variations in electrical resistance when exposed to changing temperatures. These instruments come in two basic types, Negative Temperature Coefficient and Positive Temperature Coefficient. NTC thermistors exhibit a decrease in resistance as the temperature increases, while PTC thermistors' resistance increases as temperature increases due to increased current flow.

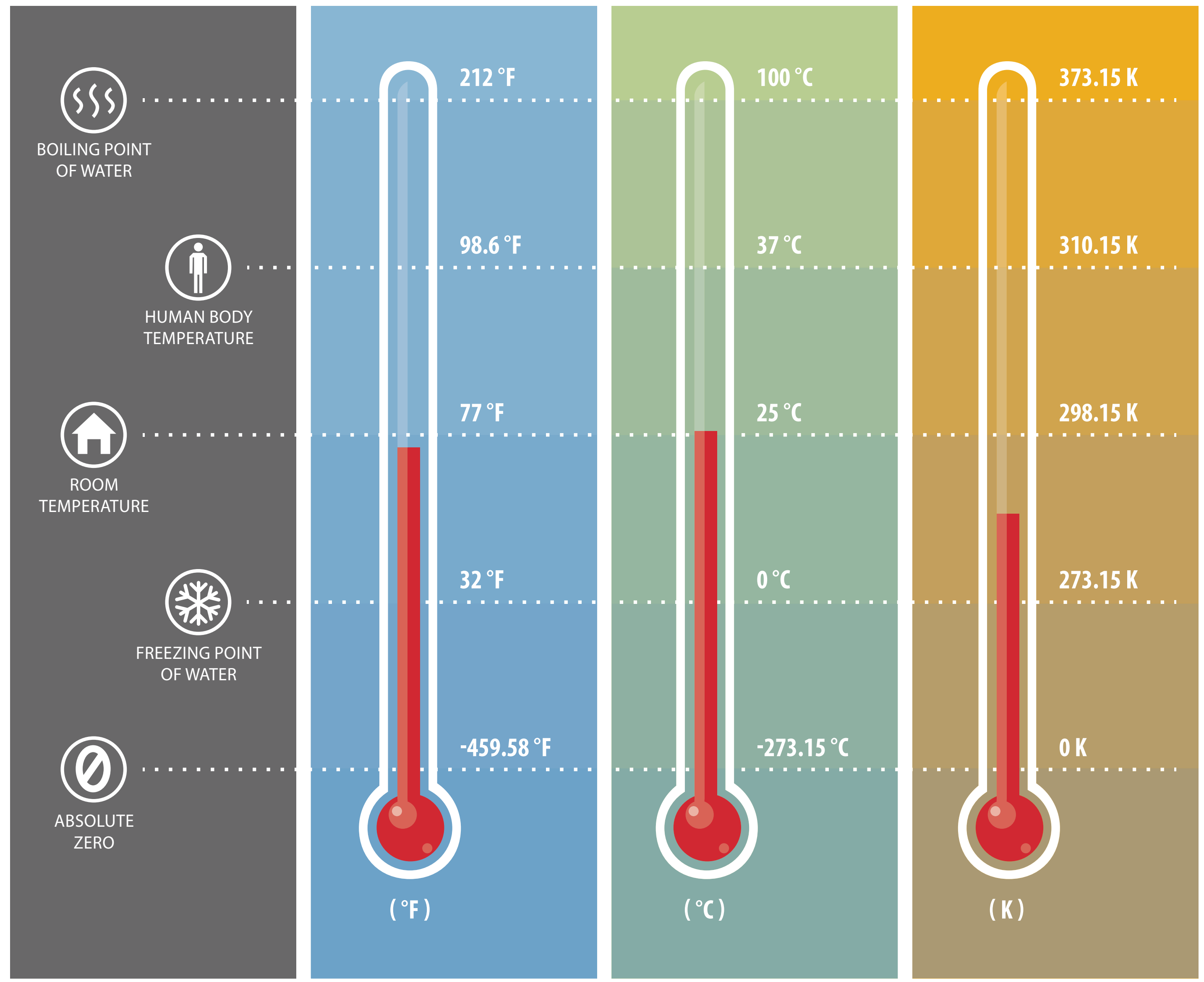
Thermistors are more predictable and stable than standard thermometers, and in many industries they are accepted as the standard sensor for temperature measurement and control. NTC thermistors are most commonly used for temperature sensing applications, while PTC thermistors are more often used for applications that require "switching" after a certain temperature threshold, such as in current limiters on circuit boards. NTC thermistors are designed to operate within a certain temperature range, usually between -90 degrees Celsius and 130 degrees Celsius. Although not generally required when operating within a narrow range, calibration could become necessary following a sharp change in operating conditions.

Establishing a lake's temperature profile is best accomplished a string of thermistors suspended vertically from a buoy. Most thermistor strings are designed with sensors at a standard interval, for instance, every 10 meters. This allows for an accurate temperature profile addressing every layer of a stratified lake. Many thermistor strings can be augmented with additional sensors such as fluorometers. An ideal thermistor-buoy arrangement might include a solar-charged battery built into the buoy, a submersible data logger to record temperature readings and a telemetry package — whether radio, cellular or Iridium satellite-based — allowing for real-time monitoring from a remote location with a computer or mobile device.



Temperature Profile Units and Reporting

Lake temperature is measured in degrees Celsius, the standard scale in the scientific community. Some states may have have water quality standards dictating the healthy temperature range for a lake, others may base their standards on natural conditions.



TYPICAL TEMP PROFILING SYSTEM

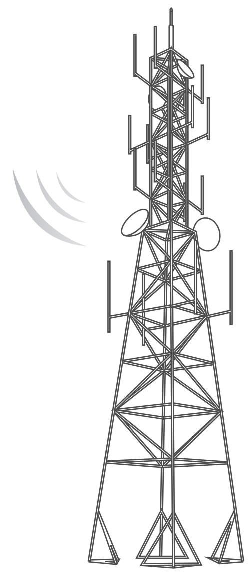
The system used to monitor temperature stratification in a lake will vary based on its depth, width and other hydrological properties. Man-made features such as dams can also influence lake stratification, and therefore require special considerations for size and placement of a monitoring system.

To be effective, measurement data should be provided in real time. The easiest and most efficient way to do this is with a buoy-based temperature monitoring system. A data buoy can house sensors at multiple depths within the water column. This system can then securely transmit the data to the Internet in real time for access from any computer or mobile device.
Buoy systems are flexible and customizable based on the lake's requirements .A single buoy suspending a string of four thermistors may be suitable for smaller lakes, while larger lakes or lakes with multiple inputs and outputs might necessitate multiple buoys at different points.

A suitable data buoy can house as many sensors as needed, and all equipment is powered via a marine battery and recharging solar panel system. With multiple telemetry options to choose from, continuous real-time data are always available. This ensures that lake managers and researchers can respond to unusual temperature readings at a moment's notice.

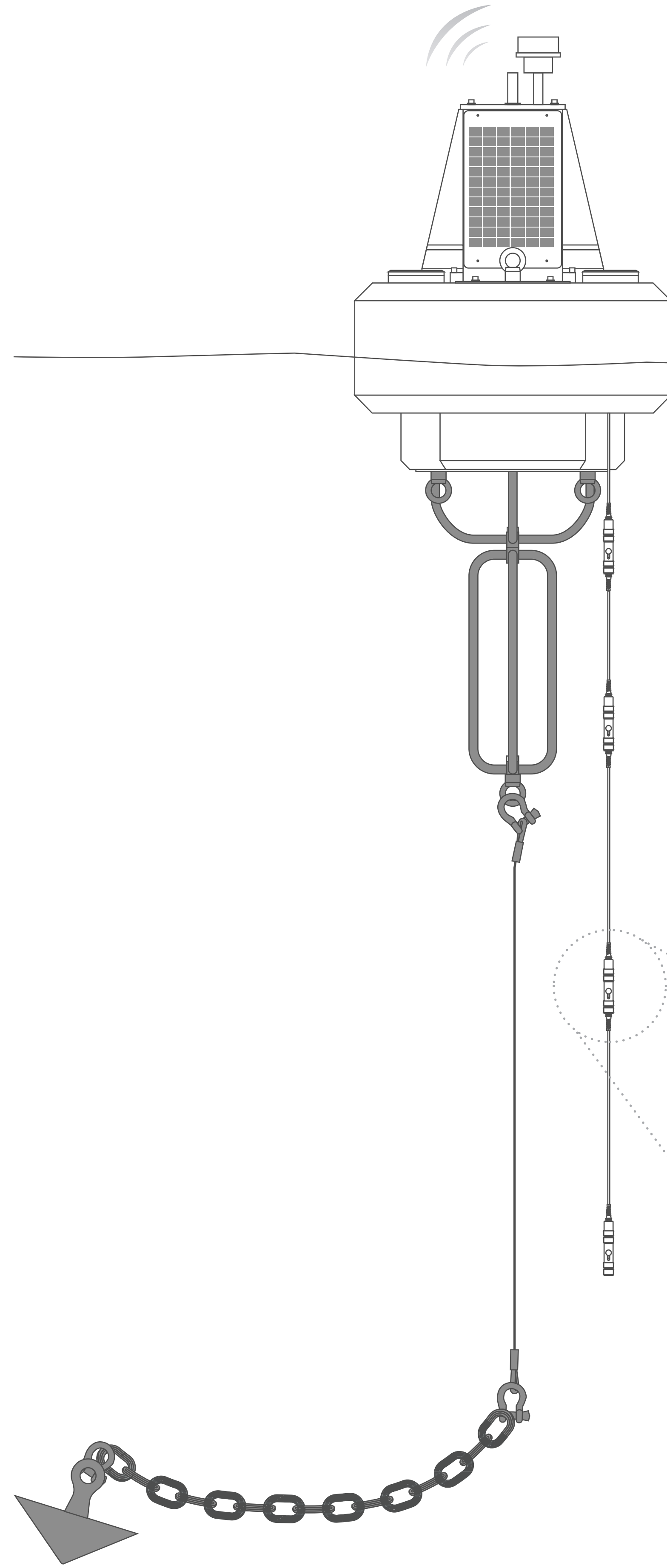
Telemetry

Telemetry provides temperature monitoring data in real time by sending the data to a central computer or web-based datacenter. The wireless communication can be radio-to-shore, cellular or satellite based.



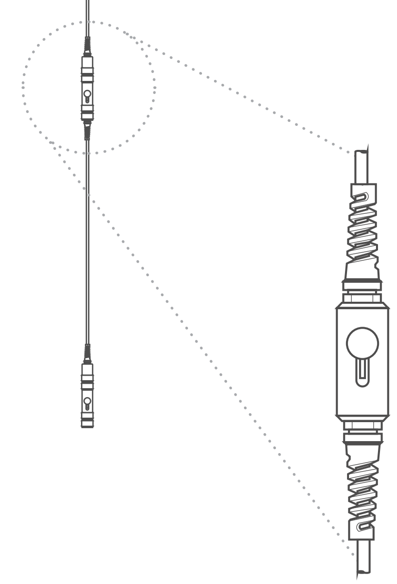
Data Buoy

A data buoy is a floating platform that supports real-time monitoring instruments such as sensors and data loggers. In addition to housing the monitoring equipment, the buoy supplies all power and can transmit sensor data in real time.



Thermistor String

A thermistor string can also be referred to as a thermistor chain, temperature string, or temperature chain. Regardless of the nomenclature, it can be defined as a series of thermistors or temperature elements embedded along a single cable assembly.



Live Data

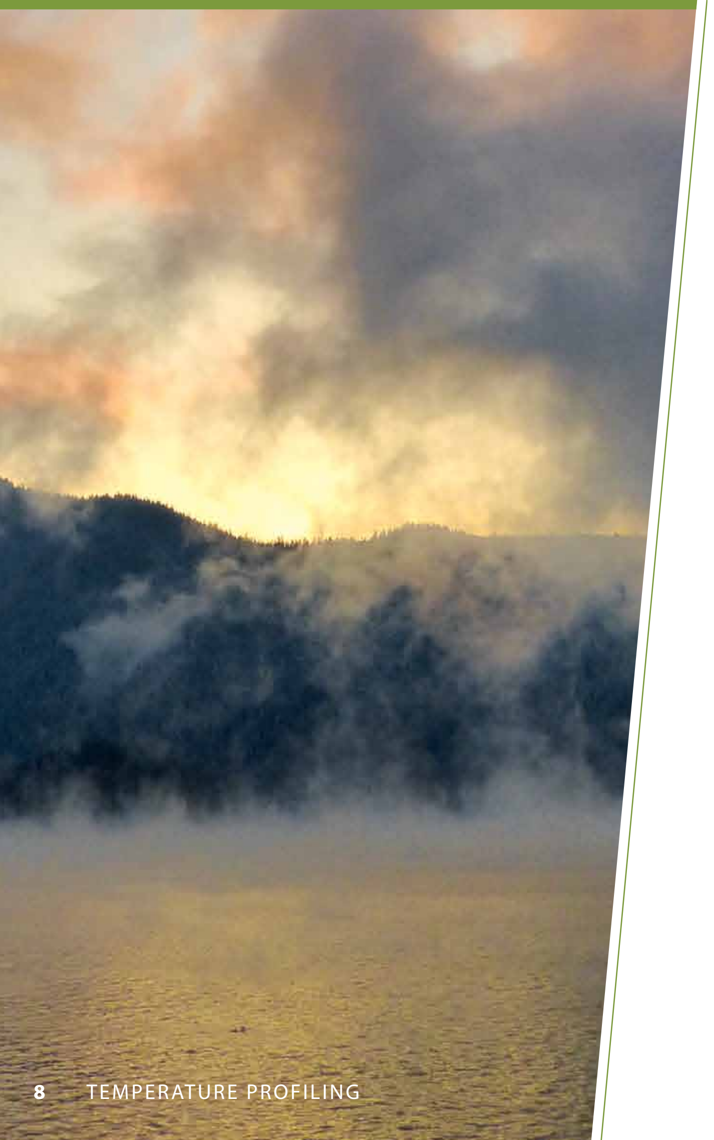
Temperature data can be viewed instantly at any time 24/7 through an online datacenter. This data can be viewed in real time, or as a graph to see trends. Automated alerts can be sent in real time via text or email when temperature exceeds or falls below predefined thresholds.

Thermistor

Each temperature node consists of a titanium thermistor and circuit board housed in a waterproof body. Measured data is converted into a digital signal and transmitted through the string.

MONITORING LOCATION

Where a temperature profiling monitoring system should be located will depend largely on the site conditions of the lake. Careful planning is needed to select the location, determine depth and water level fluctuation, and design a mooring solution that will effectively hold the system in place without damaging the instruments.



Selecting the Location

As suggested by the name, stationary systems are set at fixed locations. These systems can be placed on structure or on an anchored buoy in the water. However, site conditions often make it difficult or impractical to mount the monitoring equipment along the shore. In addition, relying solely on shoreline solutions may not accurately represent thermal stratification. For these reasons, buoy-based systems offer the most comprehensive and cost-effective solution. Data buoys provide a stable platform for temperature profiling, with the ability to house multiple sensors at different depths in the water column. In addition, they can carry a data logger, solar-powered battery pack, and telemetry (wireless communications) systems for extended deployments.

These buoys can come in different sizes based on the environmental conditions and the number of sensors suspended from the buoy. Data buoys with 150- to 450-lb. net buoyancy are generally adequate for monitoring projects on rivers, inland lakes and protected waters. Larger platforms may be required in coastal and Great Lakes deployments that are subject to more extreme conditions and wave action.

Pre-Deployment

For accurate data, all sensors should be checked in a water bath shortly before the project begins. If using a buoy-based system, the platforms should be fully assembled on shore prior to deployment. This includes attaching any sensors, towers, solar panels and additional ballast weights if needed. Furthermore, the complete temperature profiling system (sensors, data logger, telemetry, software) should be tested before the buoy is put in the water. While this process ensures that all equipment is functioning within specifications, it also gives everyone the chance to familiarize themselves with the system prior to deployment. Issues are always easier to deal with before the buoy platform is deployed in the water.

Buoy Mooring

A buoy-based system must be moored to ensure that it remains stationary. The buoy is usually moored via a stainless steel mooring line, bottom chain and anchor. It is recommended to moor the buoy in the deepest part of the waterway to ensure the most inclusive measurements. This allows for multiple measurement depths and will best reflect the characteristics of the water body as a whole.

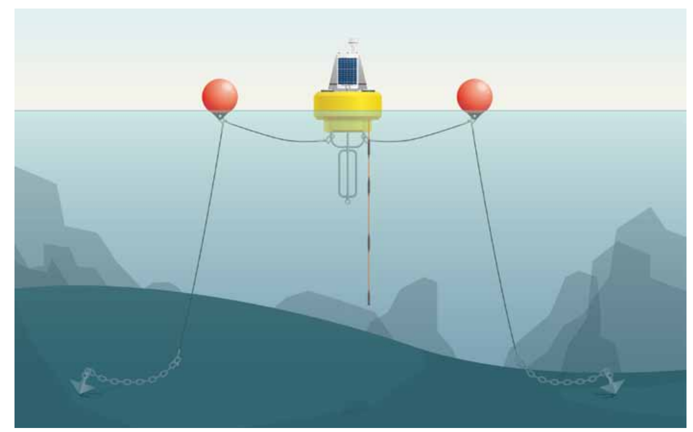
Buoy-based systems are typically moored as either a single-point or two-point mooring, based on environmental and application-specific factors.

Single-Point Mooring

Single-point moorings are not common, but they require the least amount of mooring equipment. This setup can be deployed in very calm waters with minimal instruments. A single-point mooring should only be used when all sensors and equipment are housed within an instrument cage or deployment pipe. Hanging sensors risk getting damaged or entangled with the anchor line. A cage or pipe protects the instruments from entanglement, subsurface debris and currents without affecting sensor readings.

In a single-point configuration, a mooring line connects the buoy directly to a bottom chain and anchor. The sensors are typically housed within a central deployment pipe or attached to a rigid instrument cage. The anchor, bottom chain and mooring line are assembled and attached to the buoy prior to deploying the system.

Two-Point Mooring



Two-point moorings are the most common deployment configuration. This is the recommended setup if sensors will be hanging at multiple depths in the water column. In a two-point setup, the mooring lines are pulled away from the data buoy by two smaller marker buoys. This configuration leaves the water column below the buoy available for sensors, without risk of entanglement with anchor lines. It also offers greater stability if there are currents or wave action at the location.

A two-point mooring requires a larger deployment area than a single-point mooring, as the marker buoys are typically set about ten feet away from the data buoy. Additional mooring lines run from the marker buoys to bottom chains and anchors at the seafloor. The increased system stability from the two anchor setup is well worth the extra equipment, as is the expanded area for hanging sensors. If there is significant subsurface debris or other risks present, deployment pipes or instrument cages can still be used.

DATA MANAGEMENT

A major part of any monitoring project is collecting and accessing the data. While it is possible to simply record measurements onsite, the ability to log, send and view monitoring data in real time is far more efficient.

Data Logger

As the name implies, a data logger is an instrument that stores data. In environmental monitoring applications, data loggers can be used not only to collect data from sensors and sondes, but to control sampling rates and transmit data to a central location in real time.

Most thermistor strings simply measure and output data when a power source is applied, which dictates the need for a data logger to control sampling rates and log data. If telemetry (wireless communication) is available, the logger can remotely control sensor sampling rates and transmit collected data to a central project computer. Data loggers with telemetry technology can provide real-time temperature profile data and remote access via a cellular modem, radio transmission or satellite modem.

When housed in a data buoy, a data logger is charged by the buoy's solar power system. If a solar panel system or external battery is not available, the logger can be self-powered using alkaline batteries. Data loggers can be configured with a number of sensor ports for connection to industry-standard digital and analog interfaces, including RS-485, SDI-12 or 0-2.5 VDC. A data logger can also support water quality sensors and sondes, weather stations, and other instruments to complement the temperature profile data.

Telemetry

Telemetry, or wireless communication, is a useful tool for monitoring temperature in real time. Common telemetry options are cellular and radio, though satellite telemetry can be used in more remote locations. The deciding factor when determining the most cost-effective telemetry option should be the local site conditions and proximity to a project computer. All three of these options permit real-time updates for temperature profiles.

Radio telemetry is recommended when all equipment is in close proximity. If equipped with a license-free spread-spectrum radio, a data logger can communicate with a shore-side or dam-mounted radio base station. This range may vary depending on the logger and base station used. Spread-spectrum radio technology may allow a range as far as five miles (line-of-sight) or a few hundred feet (non-line-of-sight). The radio base station serves as a central hub for any compatible data logger in range, with the ability to send the collected data to a project computer.

Cellular telemetry offers more geographic flexibility than radio, though it does require a cellular data plan. This small, additional cost permits data transmissions from anywhere that receives a cellular signal. With cellular telemetry, monitoring stations do not need to be in close proximity, nor is a base station required. If multiple monitoring stations are required, each data logger can send information individually to a central database. All the data can then be accessed wirelessly from any computer via the Internet. Data loggers may be equipped with cellular modems from different providers, including AT&T, Verizon and Sprint.

For remote applications where radio and cellular telemetry are not feasible, satellite telemetry can be used. The Iridium communications network maintains a dynamic, cross-linked constellation of Low Earth Orbiting (LEO) satellites, providing coverage all over the world. This means that data loggers with an Iridium satellite modem can transmit data in real time from anywhere on Earth. As with cellular networks, the data are sent to a central gateway, which then transfers the data over the Internet to any project computer or cell phone.

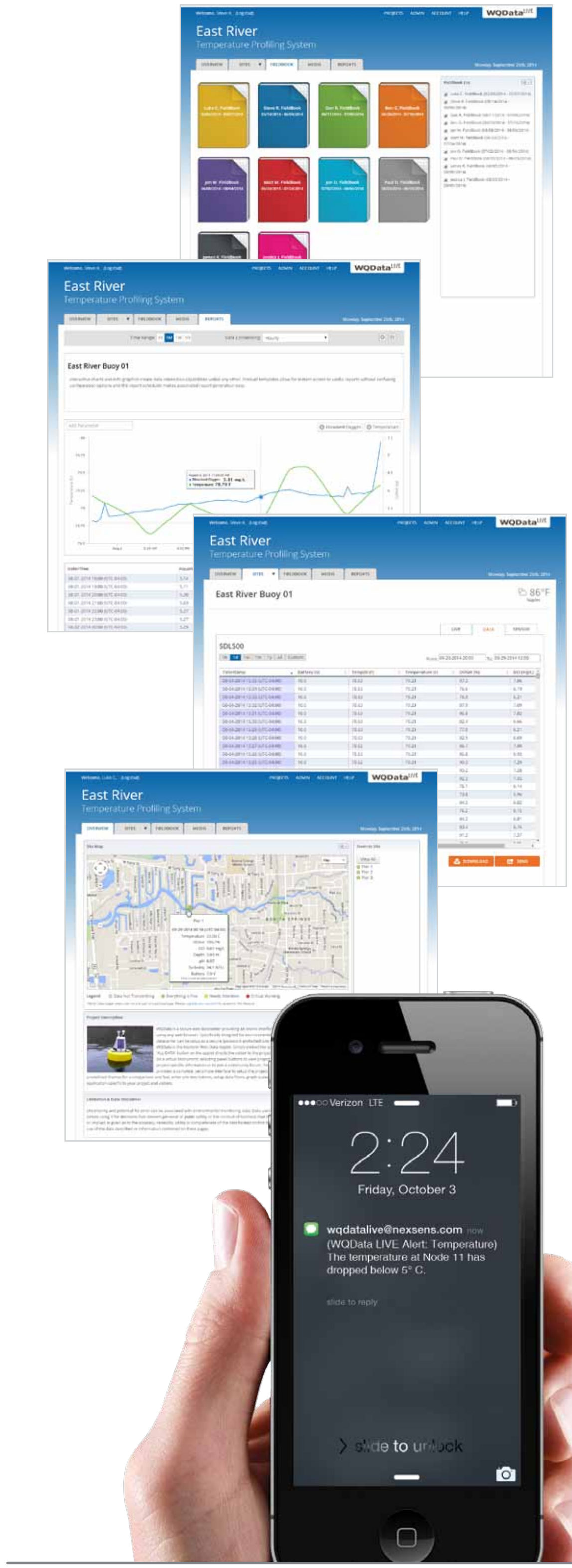
Real-Time Online Datacenter

The easiest way to share and view temperature profiling data is through a web-based datacenter. An online datacenter offers 24/7 instant access to project data via any web browser. Temperature and other data can be exported into the datacenter directly from the data logger, or through the project software.

This project management service can be password protected or public, and allows users access to the collected data in real time. In addition to any profile-specific information, the online interface can provide dynamic area maps, overlaid with weather information, recent and historical data, time series graphs and statistical summaries. Visitors can interact with the project maps and view real-time monitoring data or temperature trends over time.

But these cloud-based datacenters are more than just a pretty face. Many can be programmed to send out automated alarm notifications when temperatures exceed pre-defined limits. Once an allowable range has been set, the data are entered into the online database. If temperatures exceed or fall below these recommended ranges, the datacenter will immediately issue an alert (text and/or email) to the appropriate project manager or interested party.

With the availability of real-time data and the datacenter's auto-alert system, lake managers can be notified immediately when interesting or action-oriented events may exist. This can be thermal pollution, eutrophication, stratification, etc. The online datacenter can also transmit this alert back to the data logger in order to respond to the exceeded temperature range. Automated responses may include taking more frequent readings high or low temperature periods, then resuming regular log intervals when levels return to normal.



QUALITY ASSURANCE

Accurate data help lake managers remain in compliance with set regulations, respond to potential quality concerns and adjust treatment regimes. The same standard of accuracy ensures that researchers are able to conduct valid analyses and draw useful conclusions.

Thermistors are very sensitive to temperature changes, and in regular use conditions, will rarely require calibration. However, they exhibit an aggressively nonlinear characteristic, that is, the relationship between electrical resistance and temperature. Generally, this will manifest in the form of reduced measurement resolution only at very high temperatures. Manufacturers may provide curve forms to help users compensate, or users can calibrate their own response curves with the help of an accurate temperature measurement standard.

System Maintenance

Regardless of the temperature profiling equipment chosen to monitor a lake, periodic maintenance and calibration is required. Instrument maintenance includes cleaning the thermistors and replacing any deteriorating o-rings to prevent water ingress. If using additional water quality sensors, further field servicing may be required. Maintenance intervals are largely dependent on site conditions and other variables, such as the potential for biofouling. A system where the only deployed instrument is a thermistor string can likely go a full season without any maintenance requirements.

In case of sensor failure or damage, it is useful to have spare sensors or thermistor strings on hand. These can be field swapped during routine maintenance checks. Having a spare thermistor string available will reduce downtime due to unforeseen sensor failure, which could cause critical and costly interruptions to a temperature profiling system.

For greater details regarding maintenance requirements and sensor calibration, the manufacturer's user manual should be referenced.

Performance Verification

Thermistors cannot be calibrated by the user, but they should be checked periodically against a precision thermistor to ensure readings are still within specification. Given the number of thermistors on a string, it is generally recommended to send the string back to the factory for a performance check. This can be done on an annual or bi-annual basis.

RECOMMENDED EQUIPMENT

While there are plenty of thermistors and temperature monitoring instruments on the market, some stand out about the rest. Fondriest Environmental has selected these products as the best in their field for their quality, reliability and value. Together, they provide an advanced and powerful real-time temperature profiling system. The NexSens T-Node FR temperature sensors can be connected in-series and suspended vertically from a data buoy to create a highly accurate, multi-point thermistor string. The rugged NexSens CB-450 offers long-term durability with 30 watts of solar power, 450 pounds of buoyancy and a choice of instrument mounts for multiple sensors. Additionally, the WQData Live web datacenter allows 24/7 remote access to collected data from any computer or mobile device, while incorporating instant alarm notifications and trend tracking.

NexSens T-Node FR

The NexSens T-Node FR Thermistor String provides high precision measurements in a connectorized and addressable architecture for water quality profiling. Each node features an integral titanium thermistor secured and epoxied in a protective housing for underwater deployments. The nodes are connected in-series using marine-grade UW Cables with braided Kevlar core and double O-ring seals.

Each T-Node FR sensor is accurate to +/-0.075 C for high-precision measurements. The exposed titanium thermistor makes direct contact with water, allowing readings to stabilize within 60 seconds. Temperature data is transmitted on a RS-485 Modbus RTU string bus for integration with data loggers and SCADA systems. The string is powered by 4-28 VDC for operation on a 12 or 24 VDC power supply.

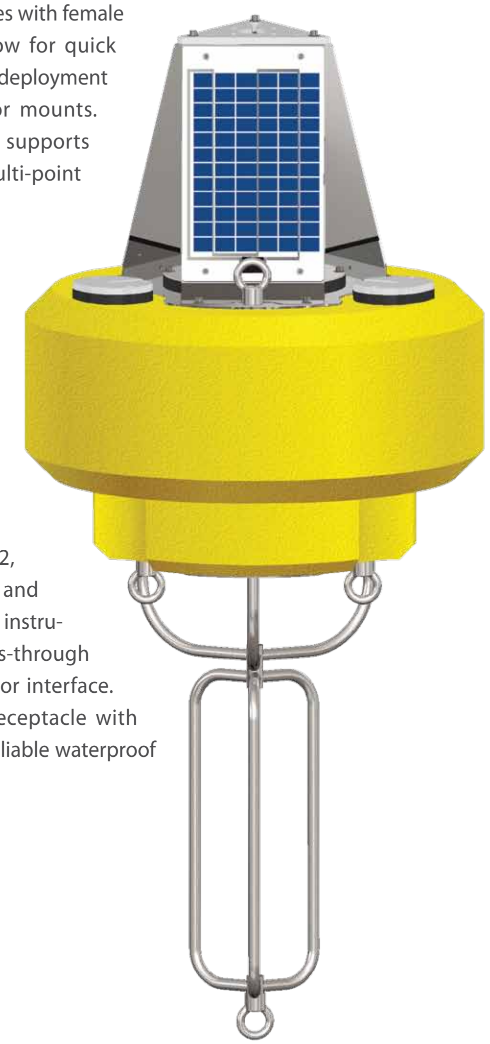
Mating UW Cables are available in lengths from 0.5m to 50m with a maximum 1,219 meters (4,000 feet) or 250 nodes. Strings terminate in a NexSens UW plug and receptacle connector, allowing additional sections or sensors to be added as required. Optional accessories include water quality sensors, pressure sensors, signal splitters, cable clamps, stainless steel mooring line, and communication adapters.

NexSens CB-450 Data Buoy

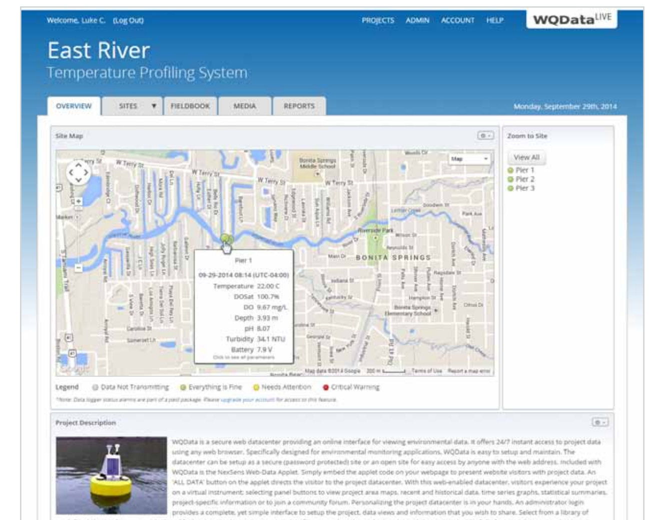
The NexSens CB-450 Data Buoy is designed for deployment in lakes, rivers, coastal waters, harbors, estuaries and other freshwater or marine environments. The floating platform supports both topside and subsurface environmental monitoring sensors including weather stations, wave sensors, thermistor strings, multi-parameter sondes, Doppler current profilers and other monitoring instruments.

The buoy is constructed of an inner core of cross-linked polyethylene foam with a tough polyurea skin. A topside 20" tall stainless steel tower includes three 10-watt 12VDC unbreakable solar panels, and a center 10" ID x 18" tall instrument well accommodates batteries, data loggers, sensors and more. Three 4" pass-through holes with female NPT bottom threads allow for quick connection of instrument deployment pipes and custom sensor mounts. The stainless steel frame supports both single-point and multi-point moorings.

The CB-450 Data Buoy is optimized for use with NexSens data loggers. Wireless telemetry options include Wi-Fi, spread spectrum radio, cellular and Iridium satellite. Compatible digital and analog sensor interfaces include RS-232, RS-485, SDI-12, VDC, mA and pulse count. The top of the instrument well includes 8 pass-through ports for power and sensor interface. Each port offers a UW receptacle with double O-ring seal for a reliable waterproof connection.



NexSens WQData LIVE Web Datacenter



WQData LIVE is a web-based project management service that allows users 24/7 instant access to data collected from NexSens remote environmental data logging & telemetry systems. More than just an online database, WQData LIVE offers the ability to generate automated reports, configure alarms to notify project personnel when data values exceed threshold limits, create FieldBooks to store calibration forms, notes and media and much more. Projects are password protected with the ability to configure a public portal or presentation view to share data with the general public. Project Administrators have the ability to edit project descriptions and information, while users given Collaborator access are limited to data viewing and form entry.

The Google Maps view shows all project sites on a map with zoom, scroll and drag capability. Mousing over a site on the map displays the most recent data values, and clicking on the site navigates to a display showing the last reading or tabular data that can be downloaded to Excel and sent via email or FTP. FieldBooks can be created to store notes recorded during field visits, including forms to store calibration data, which can be submitted from the WQData LIVE mobile app. This eliminates the need for conventional fieldbooks while keeping critical project information in a single, easy-to-access location. Site photos can even be placed onto FieldBook pages or uploaded into the project's Media page.

The WQData LIVE report feature allows data to be shown both graphically and in a tabular format. Report templates can be saved so that specific information can quickly be referenced. Project alarms send email or text messages to project staff for immediate notification of critical conditions. With this unique set of features, WQData LIVE provides everything needed to effectively manage an environmental monitoring application.

PURCHASE OR RENT?

When managing a large or long-term temperature profiling project, purchasing several profiling systems is often the most economical option. However, for short-term monitoring projects on a tight budget, it may not be practical to purchase the necessary temperature monitoring equipment. In these situations, it is much more prudent to rent real-time monitoring systems. With several lease duration and extension options available, the flexibility of renting temperature profiling systems may still be cost-effective for the larger countermeasure applications as well.

Temperature profiling equipment can be rented instrument by instrument, or as an entire system, calibrated and ready to deploy on arrival. Rental equipment can include thermistor strings, data buoys, and web-based datacenter access. Real-time telemetry via radio-to-shore, cellular, and satellite can also be incorporated. A large rental pool also means that most temperature profiling equipment can be shipped same-day for quick deployment and emergency situations.

Just as with Fondriest purchases, rental projects have access to a knowledgeable support staff who will provide personalized service before, during and after the project.

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ABOUT FONDRIEST

Company

Located in the Lower Great Lakes and Ohio River Valley region, Fondriest Environmental is a leading distributor and integrator of equipment for natural resource professionals and outdoor enthusiasts. Our team of specialists can help customers understand the products they are buying and make the correct decisions out in the field. We seek to understand project needs, devise a comprehensive solution, provide the equipment and know-how to implement it and then offer long-term project support for whatever needs arise.

Capabilities

We work closely with NexSens Technology, a company that specializes in the design and manufacture of real-time environmental measurement systems. A variety of sensor, platform and telemetry options are available to fit the unique needs of each project. We can provide complete integrated solutions and support projects from conception to completion. An extensive fleet of rental equipment is also available for short-term project needs.

Certifications

Fondriest Environmental is a Certified Repair Center for YSI, NexSens & Fish-Sens, offering quick turnaround, affordable labor rates and personalized service. Our knowledgeable technicians are available for phone, email and onsite support when the need arises.

Publications

We cover many customer projects in our Environmental Monitor magazine, which is updated daily online and printed quarterly. We also produce Lake Scientist, an interactive online resource providing research articles and news on lake ecology. Informational pages on environmental parameters and applications are available in the Measurement Sciences section of our website. And FishSens Magazine, available online, provides anglers, boaters and fisheries professionals with the latest fish science news.

Commitment

A commitment to integrity and longstanding customer relations are the standard, rather than the exception, at Fondriest Environmental. We support professionals, educators and researchers who continuously work to monitor and protect our global resources by providing them with the products and services needed to face today's environmental challenges. Our team of solution-driven experts has years of field experience and a keen eye for finding the best equipment for each application.

Contact Information

To reach an application specialist, please call (888) 426.2151 or email customercare@fondriest.com

FONDRIEST ENVIRONMENTAL

SYSTEM CONFIGURATION TOOL

Fondriest application specialists will assist with tailoring system configuration and equipment choices on a site-by-site basis to ensure reliability and proper data management. The questionnaire below can help you get started. Once completed, this form can be faxed to (937) 426.1125 or, if completed digitally, emailed to customercare@fondriest.com.

Contact Information

Name: ______________________________

Organization: ______________________________

Telephone: ______________________________

Email: ______________________________

Site Conditions

Describe the site conditions in a paragraph or two. Please include details regarding levels of wind, waves and boat traffic experienced in the area.

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Site Location

The location of a monitoring system can affect what equipment platform best suits the conditions. Please select in what type of water body the system will reside.

☐ Lake ☐ River ☐ Coastal ☐ Other Please Specify ______________________________

Approximate Depth

The mounting hardware and cable lengths used for a deployment depends on the distance to the sea floor. An application specialist can develop the best monitoring plan to accommodate the approximate water depth.

☐ < 5 ft. ☐ Between 5 and 25 ft. ☐ Between 25 and 50 ft. ☐ Between 50 and 100 ft. ☐ > 100 ft.

Water Level Fluctuation

Knowing approximate water level fluctuations will help determine the appropriate mooring strategy and hardware.

☐ <5 ft. ☐ Between 5 and 25 ft. ☐ Between 25 and 50 ft. ☐ Other Please Specify ______________

Water Column Measurements

Thermistor strings are generally built with equal spacing between nodes, but they can be built with custom spacing upon request.

☐ 1m Spacing ☐ 2m Spacing ☐ 5m Spacing ☐ Other Please Specify ______________________

Telemetry

License-free spread-spectrum radio telemetry allows communication with a shore-side NexSens radio base station as far as five miles line-of-sight from the monitoring site. Cellular telemetry allows greater geographic flexibility and is able to transmit from almost anywhere in the U.S., but it includes the cost of a cellular data plan. Satellite telemetry can be used nearly anywhere in the world, but it tends to have the highest data cost compared with cellular telemetry.

☐ Cellular ☐ Radio ☐ Satellite ☐ None

Project Length (Rental vs. Purchase)

Although it often makes sense to purchase systems outright, many short-term projects make it cost-prohibitive. Fondriest Environmental offers real-time temperature profiling systems with weekly and monthly rental rates to accommodate these operations. An application specialist can make recommendations on what choice is most cost-effective.

☐ 1-3 Months ☐ 3-6 Months ☐ 6-12 Months ☐ >1 Year Please Specify ______________________

FONDRIEST
ENVIRONMENTAL

when your **research** demands **quality data**

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TAKE YOUR PROJECT TO THE NEXT LEVEL.

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