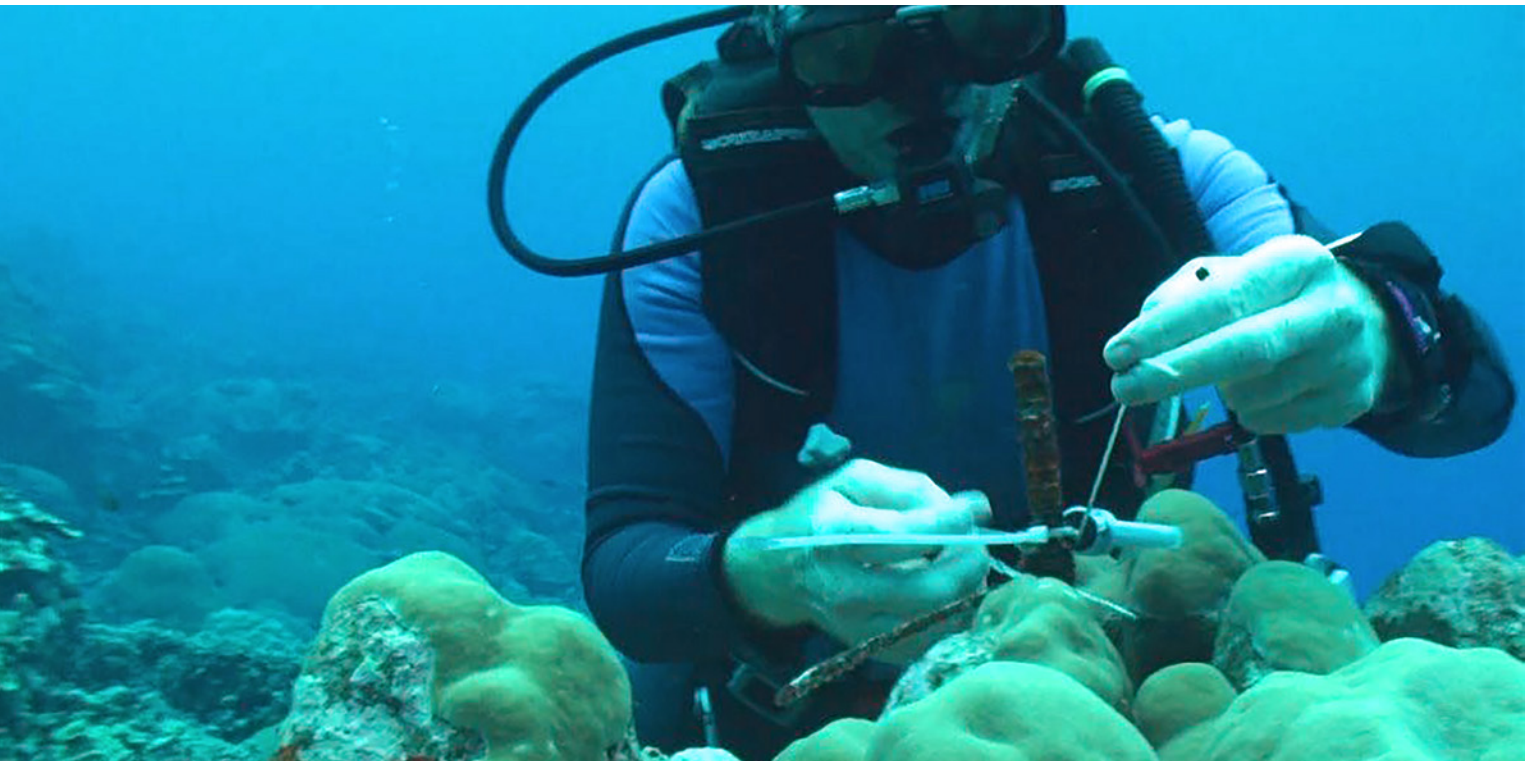
onset®
HOBO® Data Loggers



Underwater Temperature Loggers

Considerations for Selection and Deployment

Introduction

Researchers and resource managers working in the world's rivers, lakes, and oceans often need to monitor water temperature over time. Whether they are studying coral reef bleaching, assessing industrial thermal loading in lakes, modeling freshwater fish populations, or developing marine technology, users must have temperature data collection methods that are accurate, reliable, and practical for their particular field sites and studies.

Most researchers today rely on electronic underwater temperature logging devices for their monitoring needs, rather than on human data collection. The latest of these loggers are small, rugged, inexpensive, and easy to use. These battery-powered devices can be programmed to gather data for months or years at a time and can withstand an extensive range of environmental conditions, including wide temperature fluctuations, rushing rocky streams, and ocean storms.

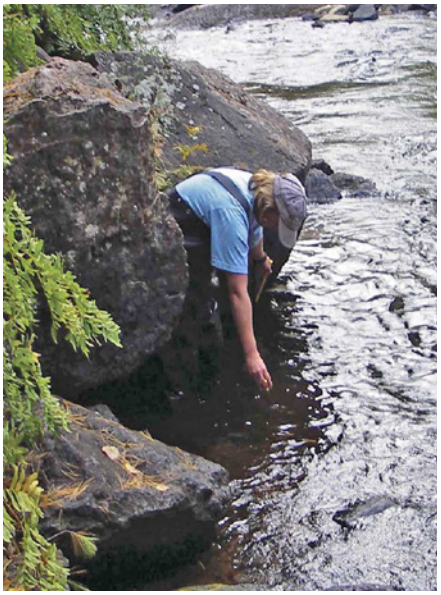
This report provides general information about monitoring water temperature, and serves as a guide to selecting underwater temperature loggers. It also identifies some of the challenges specific to particular field sites, and provides tips on deploying loggers in such environments.

Data loggers for monitoring

Most researchers turn to underwater temperature data loggers to address their monitoring needs. These devices are low-cost, compact instruments with built-in processors, high-accuracy temperature sensing, and battery power in a rugged enclosure designed for long-term underwater deployment. They range from cigar-sized units to units the size of a short stack of quarters, typically with anchoring holes at one end.

The latest models feature precision sensors that can measure water temperatures ranging from 0°C to 50°C (32°F to 122°F) in plastic housings and from 0°C to 125°C (32°F to 257°F) in stainless steel or titanium housings. Typically, underwater data loggers are deployed for months at a time, collecting temperature data at user-defined intervals and storing it digitally into logger memory. By operating in a continuous, 24/7 monitoring mode, underwater loggers eliminate many of the hassles of traditional monitoring methods. And, because the devices are typically inexpensive, users are often able to deploy loggers at more points in a water body.

Underwater data loggers also simplify the process of reporting data. Instead of having to manually record times and temperatures, users can simply offload the logger data to a laptop computer and create detailed graphs or tables with the click of a mouse button. The charts can be easily printed or the data can be exported to other software applications as necessary.



Using underwater temperature data loggers

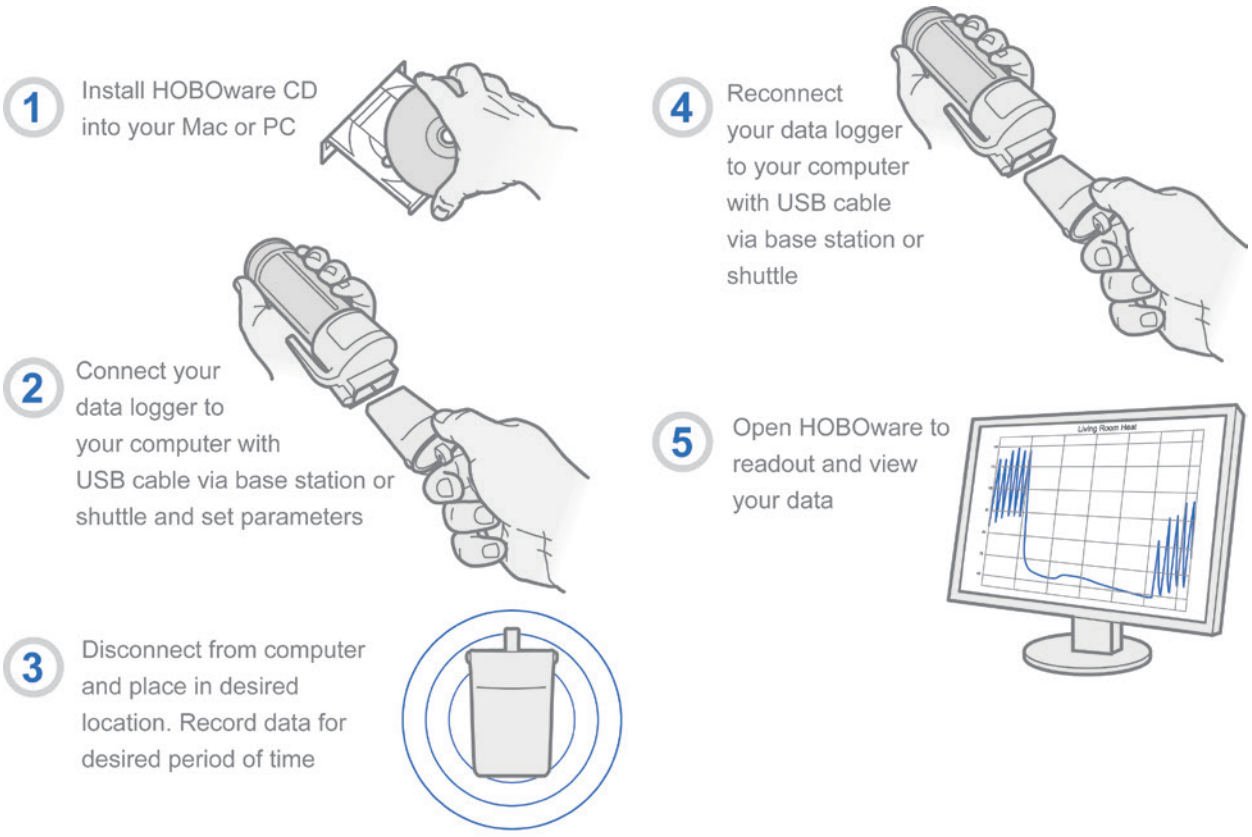
While specific logger operating procedures vary among manufacturers, the process of using underwater temperature loggers is relatively straightforward and involves three main phases: logger configuration and launch; deployment; and data processing (data retrieval, QA/QC, integration into a database, and analysis).

Configuration and launch

A logger is typically configured by connecting it to a computer (with a cable or base station) and making a number of selections:

- Logging interval – This indicates how often the logger will take a water temperature measurement. The frequency of this interval will determine the maximum deployment time for the device.
- Logger start time – This allows the user to start the logger immediately or postpone it until a specific date and time.

Once these selections are made, the user simply clicks a start button in the logger software and the device is ready to start monitoring.



Basic deployment of a HOBO Pendant series water temperature data logger

Deployment

Several steps are involved in deploying an underwater data logger, including site selection, anchoring the logger, documenting logger location, and retrieval. See following pages for specific field tips.

- Site selection – This refers to the particular location in a body of water where temperature sampling is needed. Choose a site with good mixing, such as the turbulent area below a rock. Also make sure that the location will still be submerged at the low water point, and consider potential impact from moving debris.
- Anchoring the logger – There are a number of ways to secure underwater data loggers in still, flowing, and marine waters. Some users tether a logger to a cement block or brick using nylon cord, whereas others choose to drive a rebar stake into the streambed or shoreline and tie or clamp a logger to the stake. For deepwater deployment, users usually use plastic cable ties to attach a logger to a mooring line or sand screw. See following pages for more tips specific to certain environments.

For any deployment, users should think about potential natural and human factors that might dislodge or damage a logger, and consider protecting or camouflaging the device as necessary. Also consider whether you want to read out the logger's data during deployment. In that case, you can attach the device with a tether line so it can be pulled up.

- Documenting logger location – To ensure successful retrieval of underwater data loggers, it is important to document the specific location of each one during deployment. This is especially important if more than one person is working with the loggers. Documenting location in at least two ways is recommended, and can be done by taking a photograph of each monitoring site, marking the location on a map or aerial photograph, entering GPS coordinates, and using words to describe the location in a data book. Affixing a "please return to" label to the logger is also a good idea, in the uncommon event that a logger becomes dislodged.

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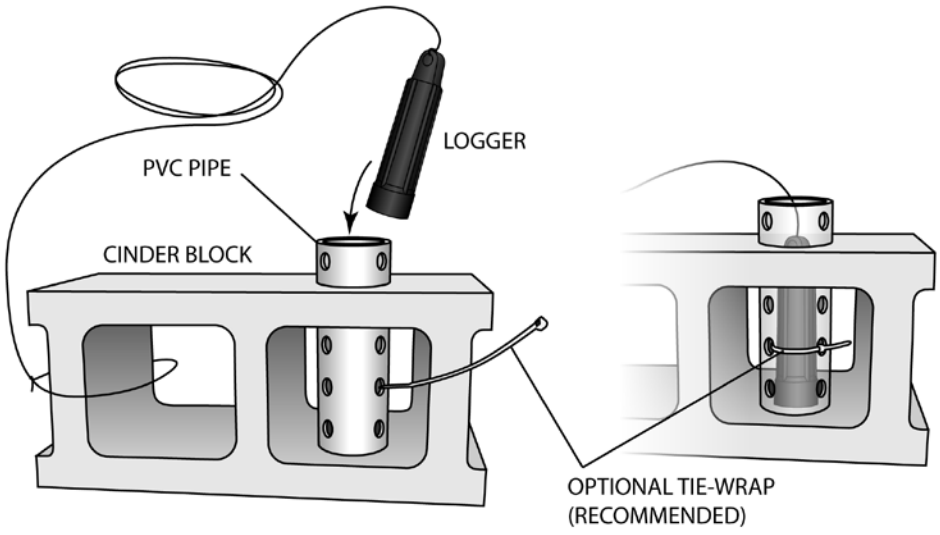


Cinder block data logger anchoring method

From the field: Tips for deploying underwater temperature loggers

Flowing waters are variable throughout the year and can change even on a daily basis. A logger must be positioned at an adequate depth so that it is always underwater.

Loggers have been launched in a wide variety of field conditions worldwide, and researchers have gained experience in making sure their devices stay put. Here are some notes from the field and factors to consider when deploying loggers in specific environments:

Stream/river/or other shallow deployment

Flowing waters are variable throughout the year and can change even on a daily basis. A logger must be positioned at an adequate depth so that it is always underwater. When choosing sites, take into account incoming tributaries, human-generated thermal pollution (measure upstream and downstream of inlet), and shading (for sunny sites that are shallow it may be necessary to use a white protective boot or paint on the logger in order to minimize solar heating). In rocky streams and rivers, heavy-duty garden tools are useful for shifting rocks during logger deployment and retrieval.

Ocean and lake deployment (deep water)

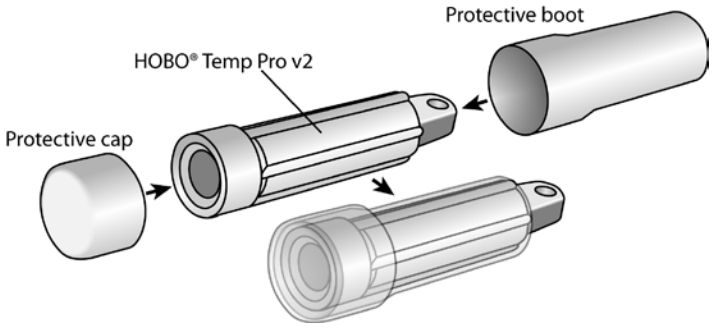
Wave action, currents, and storms are important considerations when securing data loggers in deep waters. Some users have been successful in anchoring loggers to mooring lines on sand screws or pins (widely available at boating equipment suppliers) driven into solid substrate. Some users attach the logger to the screw or pin itself, and recommend using more than one cable tie in case one breaks loose. In marine environments, a scraping tool is useful if encrusting organisms colonize the logger. In particularly rough conditions, it is wise to secure the entire body of the logger, rather than just one end.

Intertidal deployment

Intertidal environments are alternately submerged in seawater and exposed to the air. They are also subject to wide temperature fluctuations, so logger anchoring materials must be able to withstand such varying conditions. Putty epoxy that cures underwater and in air has been used successfully to anchor loggers to rocks in the intertidal zone.

Areas of heavy human use

Humans use water bodies commercially and recreationally, and having curious people around field sites can be a challenge. In addition to boating and fishing activity, vandalism can potentially damage or dislodge a temperature logger. Camouflage is a necessity, and can be achieved by burying the logger under rocks or gravel, buying and painting a protective boot for the logger (boots are available from most manufacturers), or enclosing the logger in a secure wire cage. Also, avoid using mounting stakes or posts in areas where they could be dangerous to boats and people. Labeling the logger with the title of your project or posting signs in the area can inform the public about the study.



Tips

- Develop your anchoring protocol carefully, and be sure to take into consideration such factors as how you might get a dozen cinder blocks out into a lake or up a mountain stream.
- Consider deploying more than one logger per location for data quality purposes, or if you suspect you might lose one in a storm or flood.
- Keep in mind that some metal fasteners can corrode quickly, especially in marine environments.
- Think about sending two people, instead of one, into the field to locate deployed loggers as this can save time over one person searching alone. This is especially true if a third party deployed the loggers, if they have been deployed for a few months, or if vegetation is heavy or the substrate is rocky.

Useful equipment

Following is a list of items that researchers have found useful during logger deployment and retrieval:

Written deployment protocol
– note any modifications at field sites

Securing materials
– cable ties (zip ties), wire, cable, wooden stakes, epoxy, nylon cord

Anchors
– cinder blocks, bricks, dive weights, metal stakes, rebar, sand screws, sand pins, mallet or sledge hammer

Tools for removing debris
- ax, machete, rake, hoe, diving knife, wire cutters, heavy-duty scissors, knife

Surveyor flagging

Digital or film camera

Laptop computer

Data shuttle (available from some logger manufacturers)

Hand-held GPS

Watch

Maps, aerial photos

Waterproof field notebook

Pencils

Boat, raft, float for holding equipment

Rubber boots, waders, scuba or snorkeling gear

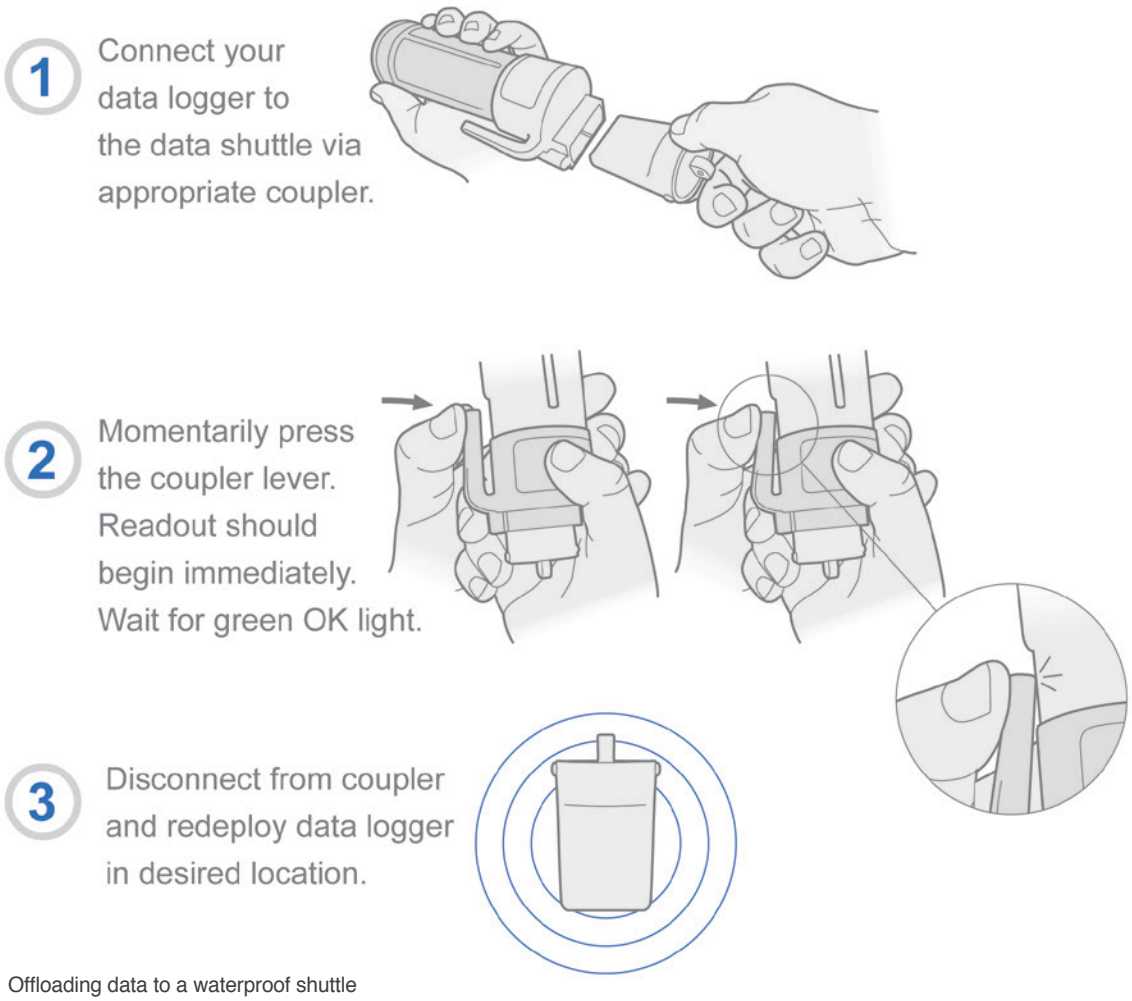
Personal
– warm and dry clothing, sunscreen, insect repellant, appropriate outerwear, cell phone or radio, water and food

Data retrieval and analysis

After temperature data has been collected for a period of time, the next steps involve retrieving, offloading, and analyzing the collected data.

In the past, retrieving data from underwater temperature loggers meant bringing the loggers back to an office computer, or taking a laptop into the field and risking water damage. Today there are loggers available that can transmit data optically to a waterproof pocket-sized data shuttle. Shuttles provide safe, easy offload and transfer of data, while allowing loggers to remain in their deployment location where they can be re-launched, without any data gaps.

Once the data is uploaded to a computer, it can be QA/QC'd, combined with other data, and then analyzed using the data logger software, or exported into another program, such as Excel. Typically, logger software applications allow the user to quickly and easily generate graphs over the given data collection period.



Offloading data to a waterproof shuttle

Capabilities to look for

There are a number of features and capabilities to look for when evaluating underwater temperature loggers.

First, it is important to make sure that the logger has a rugged, fully-sealed enclosure that will withstand years of use in challenging conditions. Check device temperature and depth ranges, and ask about saltwater deployment, if applicable. For example, stainless steel will corrode when used for long-term saltwater deployment. Protective boots are available from some manufacturers.

Secondly, make sure the logger offers suitable options for offloading data at field sites. Dedicated data shuttles allow users to conveniently offload data at field sites without having to worry about moisture getting into a laptop computer. Optical data transfer capability means that data can be downloaded even when the logger is wet.

Depending on temperature measurement accuracy requirements and legal requirements, it may be important to choose an underwater data logger from a manufacturer that offers NIST (National Institute of Standards & Technology) testing and certification services. These manufacturers can provide a certificate that indicates the logger's temperature accuracy versus a NIST-traceable standard.

It's also a good idea to look for loggers that use non-volatile memory that retains data even if battery-power is lost.

Finally, the supplied data logger software should enable you to quickly and easily perform tasks such as configuring the logger, and offloading data. If you have multiple loggers to deploy, software features that allow you to batch configure and export data can save a lot of time. The software should also offer powerful data plotting capabilities, and enable you to easily export data to other programs for analysis. Also consider the operating platforms your users have; you may need software that is supported by both Windows and Macintosh operating systems.

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Conclusion

As the demand for water temperature monitoring grows, so too will the need for instruments that make the process faster, cheaper, and more accurate. Underwater data loggers are the instruments of choice among researchers and resource managers because of their 24/7 operation, high accuracy, ease-of-use, and computer-based analysis and reporting capabilities.

About Onset

Onset is the world's leading supplier of data loggers. Our HOBO data logger products are used around the world in a broad range of monitoring applications, from verifying the performance of green buildings and renewable energy systems to agricultural and coastal research.

Based on Cape Cod, Massachusetts, Onset has sold more than 2.5 million data loggers since the company's founding in 1981.

Contact Us

Our goal is to make your data logging project a success. Our product application specialists are available to discuss your needs and recommend the right solution for your project.

Sales (8am to 5pm ET, Monday through Friday)
- Email sales@onsetcomp.com
- Call 508-759-9500
- In US call toll free 800-564-4377
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Other informational resources available from Onset:

Monitoring Wetlands with Data Loggers: A Best Practices Guide

Wetlands act as a natural filter for polluted water and thus play an essential role in water quality protection. They serve as floodwater storage to help minimize erosion, and create a habitat for many fish and wildlife.

While a variety of factors have decreased the number of wetlands in the U.S. by half since 1950, many organizations are restoring wetlands back to their original flourishing ecosystems. To ensure success, it is necessary to monitor wetland factors such as water level, temperature, and rainfall.

This guide shares field-proven best practices for configuring, launching and deploying portable data loggers in wetland monitoring applications. A range of data logger types is covered, and tips are provided on logger installation and maintenance.

Choosing A Water Level Logger: 5 Things You Should Know

This paper provides hydrology, ecology, stormwater, and waterworks professionals with valuable tips on how to evaluate specific water level data loggers, and points out key factors to be aware of during the product selection process.

Access our full resources library at:
www.onsetcomp.com/learning

Choosing a Temperature Data Logger

This paper provides guidance on features to consider when choosing a temperature data logger, including accuracy requirements, data access needs, software packages, and power requirements. It also includes real-world application examples illustrating how users have incorporated portable data loggers into their temperature monitoring projects.

Whether you are an experienced data logger user or just getting started, this guide can help you choose the ideal temperature logger for your application.

Data Logger Basics

In today's data-driven world of satellite uplinks, wireless networks, and the Internet, it is common to hear the terms "data logging" and "data loggers" and not really have a firm grasp of what they are.

Most people have a vague idea that data logging involves electronically collecting information about the status of something in the environment, such as temperature, relative humidity, or energy use. They're right, but that's just a small view of what data logging is.

In the fields of building performance and environmental research, everyone seems to be using data loggers. But what are they, and why are they useful?

This guide will introduce you to the wide world of electronic data loggers and data logging.