Reforestation & Nurseries Tech Tips

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Evaluation of Affordable Battery-Operated Weather Stations for Remote Sites

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Some weather stations are expensive and require so much computer programming that they are unaffordable for field units of natural resource agencies. For example, the Remote Automated Weather Stations (RAWS) run by the Forest Service, U.S. Department of Agriculture, and Bureau of Land Management, U.S. Department of the Interior, provide accurate data, but cost $5,500 or more, depending on their configuration.

The Missoula Technology and Development Center (MTDC) was asked to evaluate affordable weather stations for Forest Service nurseries and field locations where relatively simple battery-powered systems (figure 1) can do the job. MTDC purchased three weather stations that cost from $985 to $1,775. They were evaluated for ease of

- Setting the station up
- Programming the data logger and sensors
- Downloading the data
- Transferring the data into a graphing program, such as Excel

Highlights...

- Forest Service units often need to gather weather data at remote locations.
- Sophisticated weather stations for remote locations may cost $5,500 or more.
- Relatively simple battery-operated weather stations can be purchased for $1,000 to $2,000.
- This tech tip reports the results of evaluation of three such weather stations.

Figure 1—Three affordable battery-powered weather stations were evaluated for use at remote sites: the WatchDog 700, the Vantage Pro, and the HOBO Micro Station.

For additional information, contact: *Mary Ann Davies or Gary Kees, project leaders; USDA Forest Service, MTDC; 5785 Hwy. 10 West; Missoula, MT 59808–9361. Phone: 406–329–3900; fax: 406–329–3719; e-mail: mdavies@fs.fed.us or gkees@fs.fed.us.*

Weather Stations Evaluated

The temperature/relative humidity sensors on these three weather stations require a solar radiation shield to prevent direct exposure to sunlight.

HOBO Micro Station

The HOBO Micro Station (figure 2) is a four-sensor data logger designed to monitor weather information. The Micro Station operates on four AA alkaline batteries or lithium batteries (optional for colder temperatures). The Micro Station uses a network of smart sensors that have all the programming parameters stored internally, automatically communicating information to the data logger. Key features of the smart sensors include:

- Automatic detection—No extensive programming, wiring, or calibration is required to set up the sensors.
- Easy expansion—Up to four sensors of any type or combination, including multiple-parameter sensors, can be added simply by plugging them in before data logging begins.
- Digital network—The connection between the smart sensors and the data logger uses a modular plug similar to that used by digital phones.

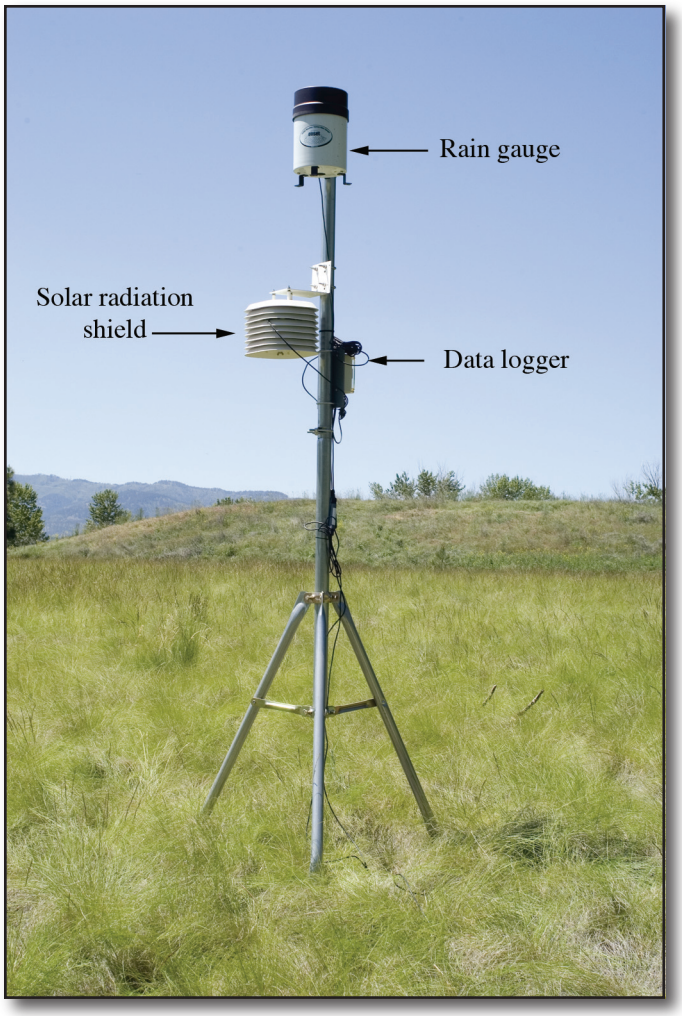


Figure 2—The HOBO Micro Station manufactured by Onset Computer Corp.

Logging and Downloading Data

The sampling interval for recording data measurements ranges from 1 second to 18 hours. The data logger's capacity is 512 kilobytes. The data logger software automatically estimates how long the data logger will record until the memory is full, based on the logging time interval and the number and types of sensors connected. In the evaluation, the Micro Station with one soil temperature sensor, one rain gauge sensor, and an air temperature/relative humidity sensor was set to log 5-minute intervals, allowing it to collect data for about 250 days.

Setting up parameters for the Micro Station, downloading the data, or checking a sensor's status requires a PC (personal computer) with BoxCar Pro or Remote Site Manager software. Once the Micro Station is set up, data can be downloaded with a handheld PDA (personal digital assistant) using HandCar EX software and a compatible HotSync cable. Later, the data on the PDA can be transferred to a PC.

Observations

Determining which of the serial communication ports is available on a PC requires opening each communication port and attempting to communicate with the data logger. Exporting downloaded data into Excel is straightforward with little manipulation.

Subzero temperatures did not affect the operation of the HOBO Micro Station. The HOBO Micro Station does not have a real-time display screen and does not provide a National Oceanic and Atmospheric Association (NOAA) weather report.

The WatchDog 700

The WatchDog 700 weather station (figure 3) comes with an integrated suite of sensors to measure windspeed and

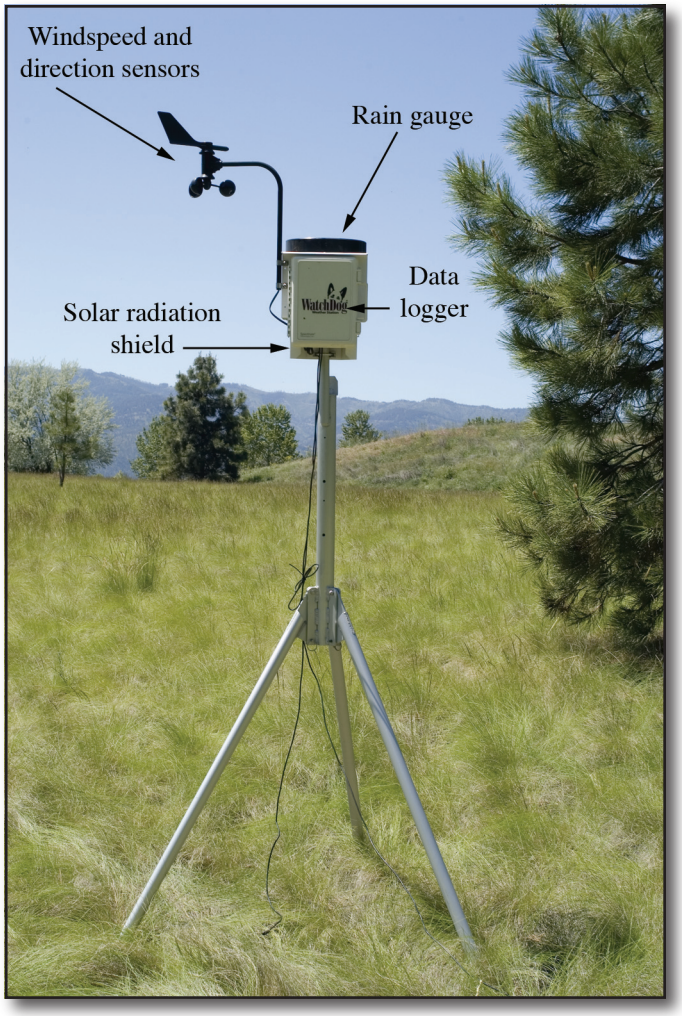


Figure 3—The WatchDog 700 weather station manufactured by Spectrum Technologies, Inc. The WatchDog 700 has been replaced by the WatchDog 2700.

direction, air temperature/relative humidity, and rainfall. The weather station has four external ports for additional sensors to measure solar radiation, soil moisture, soil temperature, or other variables. A computer with SpecWare 6.02 software is needed to set parameters, launch the weather station, or view and download data from the WatchDog 700. The station is powered by four AA alkaline batteries.

Logging and Downloading Data

Data can be viewed as a graph or as text using the SpecWare software. Reports can be generated for each sensor, including high, low, and mean readings for most sensors. An approved NOAA weather report summary can be generated. Each channel can store 3,100 measurements. This capacity is equivalent to a 30-minute logging interval for 64 days.

Observations

The WatchDog 700 with SpecWare 6.02 software is now discontinued. The WatchDog 2700 with Spec 8 Pro software replaces the WatchDog 700. SpecWare 6.02 cannot be upgraded. SpecWare 6.02 data files must be converted before they can be read by the most current version of the software.

The WatchDog 2700 with Spec 8 Pro software offers wireless options that can reach a PC up to 2 miles away. Each sensor needs to be configured to its corresponding port to record the data. The data logger's capacity is less than the other stations evaluated.

A portable device is available to download data from the weather station to a PC. During the evaluation, the LCD (liquid crystal display) screen couldn't be read at temperatures below 15 degrees Fahrenheit.

The Vantage Pro

The Vantage Pro weather station (figure 4) comes with an integrated suite of sensors to measure air temperature/relative humidity, windspeed and direction, and a rain gauge. Additional sensors are available for measuring soil moisture, soil temperature, leaf wetness, and solar and ultraviolet radiation. The weather station's sensor suite transmits real-time data to an external console. The consoles are available in cabled and wireless versions.

With the cabled version, sensor data is transmitted to the console over standard four-conductor cable that may be up to 1,000 feet long. The console of the cabled version should be powered by an AC power source.

The wireless version transmits data up to 400 feet to the console (figure 5) using a low-power radiofrequency. The console of the wireless version can be powered by three C alkaline batteries for 1 year. The console records and displays real-time data, graphs the weather data, and displays a weather forecast.

Figure 4—The Vantage Pro weather station manufactured by Davis Instruments. The Vantage Pro has been replaced by the Vantage Pro2.

Logging and Downloading Data

WeatherLink software is loaded on a computer to configure the weather station's communication port and to set date, time, elevation, units of measure, logging intervals, and sensor parameters. Depending on the logging time interval, the data logger can store up to 6 months of data. The console's LCD screen and keyboard provide access to past and current weather information, future forecast conditions, graphs, and sensors.

Observations

Hooking up sensors is very easy (plug and play). Building walls reduce the distance that data can be

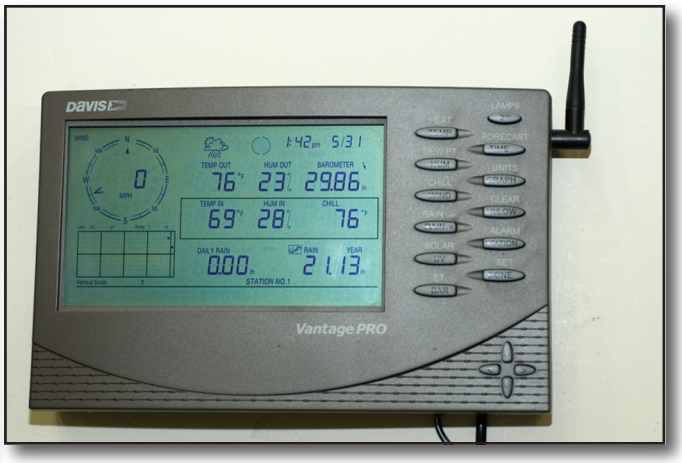


Figure 5—The wireless remote console for the Vantage Pro.

transmitted wirelessly to the external console. Sensors continued recording data during subzero temperatures.

More than one external console can be used with a weather station. NOAA weather reports are available and well formatted. WeatherLink software was easy to use and has many options for manipulating data. Finding the correct computer communication port was straightforward.

A solar panel is available to power the unit. The 6.5 amp-hour lithium battery is not a standard size.

Conclusions

The three weather stations we evaluated in the field included the HOBO Micro Station, the WatchDog 700, and the Vantage Pro. Setting up the station and sensors using the supplied software was easiest with the HOBO and Vantage Pro. Data could be downloaded from the HOBO Micro Station and the WatchDog 700 using a handheld device, a convenient feature when stations are in remote locations. The Vantage Pro's external console was located in a building that allowed data to be viewed and downloaded comfortably during inclement weather.

Two of the three weather stations have been upgraded since the field evaluations. The newest models were not evaluated.

The WatchDog 700 has been replaced with the WatchDog 2700, which requires new software, Spec 8 Pro.

Weather Stations at a Glance			
	HOBO Micro Station	**WatchDog 2700** replaces WatchDog 700	**Vantage Pro2** replaces Vantage Pro
Air temperature	•	•	•
Relative humidity	•	•	•
Dewpoint		•	•
Windspeed	•	•	•
Wind direction	•	•	•
Windchill		•	•
Rain gauge	•	•	•
Solar radiation		•	•
Evapotranspiration			•
Soil moisture	•	•	•
Soil temperature	•	•	•
UHF wireless		•	•
Palm compatible	•		
WatchDog data shuttle		•	

The new software must be purchased separately and the older software (SpecWare 6.02) cannot be upgraded. The WatchDog 2700 updates include sensors that measure a wider range of relative humidity, a new solar radiation sensor, and a 900-mHz UHF wireless option. The Vantage Pro has been upgraded to the Vantage Pro2, which can transmit and receive data wirelessly from 1,000 feet (up from 400 feet).

Manufacturer's contact information, product specifications, and costs for each weather station evaluated follow.

HOBO Micro Station
(Model No. H21-002)

Onset Computer Corp.
470 MacArthur Blvd.
Bourne, MA 02532
Phone: 800–564–4377
http://www.onsetcomp.com

Specifications

	HOBO Micro Station	
	Range	Accuracy
Windspeed (S-WCA-M003)	0 to 99 mi/h	+/-2.4 mi/h (< 38 mi/h)
Wind direction	0 to 358 degrees	+/-5 degrees
Air temperature (S-THA-M002)	-40 to 167 ºF	+/-1.3 ºF
Windchill	n/a	n/a
Relative humidity (S-THA-M002)	0 to 100% at 32 to 122 ºF	+/-3%
Dewpoint	n/a	n/a
Rain gauge (S-RGA-M006)	0 to 5 in/h	+/-1% (up to 1 in/h)
Solar radiation (S-LIB-M003)	1 to 1,280 W/m^2	+/-10 W/m^2
Evapotranspiration	n/a	n/a
Soil moisture (S-SMA-M003)	0 to 0.405 m^3/m^3	+/-0.03 m^3/m^3
Volumetric water content	0 to 40.5%	32 to 122 ºF
Soil temperature (S-TMB-M002)	-40 to 167 ºF	+/-0.36 ºF from 32 to 122 ºF

Costs
HOBO Micro Station

Accessories	Cost
HOBO Micro Station with batteries	$199
BoxCar software	$99
Communication cable	$9
USB adapter communication cable	$49
HandCar EX software with Palm communication cable	$69
Tripod	$165
Sensors	
Air temperature/relative humidity	$135
Temperature	$90
Rain gauge	$399
Solar radiation with mount	$220
Soil moisture	$139
Soil temperature	$90
Windspeed[1]	$199
With wind direction[1]	$499

[1] Windspeed and direction sensors were not evaluated.

WatchDog 700 and 2700

WatchDog 2700 not tested, replaces WatchDog 700

Spectrum Technologies, Inc.
23839 West Andrew Rd.
Plainfield, IL 60544
Phone: 815–436–4440
http://www.specmeters.com

Specifications

	WatchDog 700	
	Range	Accuracy
Windspeed	0 to 175 mi/h	+/-5%
Wind direction	2-degree increments	+/-7 degrees
Air temperature	-22 to 182 ºF	+/-1 ºF
Windchill	-40 to 140 ºF	+/-4 ºF
Relative humidity	20 to 100% at 41 to 122 ºF	+/-3%
WatchDog 2700 upgrade	10 to 100% at 41 to 122 ºF	+/-3%
Dewpoint	-99 to 140 ºF	+/-4 ºF
Rain gauge	0.01 in	+/-2%
Solar radiation	1 to 1,250 W/m^2	+/-5%
Soil moisture (6452-20)	0 to 0.405 m^3/m^3	+/-0.04 m^3/m^3
Volumetric water content	0 to 40%	-40 to 140 ºF
Soil temperature (3667)	-22 to 212 ºF	+/-1 ºF

Costs
WatchDog 700 (Discontinued)

Accessories	Cost
The WatchDog 700 with integrated sensor suite: windspeed and direction, air temperature, windchill, relative humidity/dewpoint, rain gauge	$1,095
SpecWare 6.02	$99
Tripod	$70
Sensors	
Soil moisture	$150
Soil temperature	$170
Solar radiation	$269

Costs
WatchDog 2700 (New Model)

Accessories	Cost
The WatchDog 2700 with integrated sensor suite: windspeed and direction, air temperature, windchill, relative humidity/dewpoint, rain gauge	$1,195
Spec 8 Pro software	$274
Tripod	$70
Sensors	
Soil moisture	$150
Soil temperature	$170
Solar radiation	$269

Vantage Pro (Model No. 6150-Wireless) and Pro2 (Model No. 6152-Wireless)

Vantage Pro2 not tested, replaces Vantage Pro

Davis Instruments Corp.
3465 Diablo Ave.
Hayward, CA 94545
800–678–3669
http://www.davisnet.com

Vantage Pro Specifications

	Vantage Pro	
	Range	Accuracy
Windspeed	2 to 150 mi/h	+/-5%
Wind direction	1-degree increments	+/-4 degrees
Air temperature	-40 to 150 ºF	+/-1 ºF
Windchill	-110 to 130 ºF	+/-2 ºF
Relative humidity	0 to 100%	+/-3 % (0 to 100%)
Dewpoint	-105 to 130 ºF	+/-3 ºF
Rain gauge	0.01 in	+/-4%
Solar radiation (6450)	1 to 1,800 W/m^2	+/-5%
Soil moisture (6440) electric resistance	0 to 200 centibar	n/s*
Soil temperature (6470)	-40 to 150 ºF	+/-1 ºF
Evapotranspiration-UV (6490)	0.01 in	+/-5%

* not specified

Costs
Vantage Pro (Discontinued)

Accessories	Cost
The Vantage Pro Weather Station with integrated sensor suite: windspeed and direction, air temperature, windchill, relative humidity/dewpoint, and rain gauge)	$595
WeatherLink software	$90
Tripod	$45
Sensors	
Soil radiation	$160
Soil moisture	$50
Soil temperature	$40
Evapotranspiration	$350

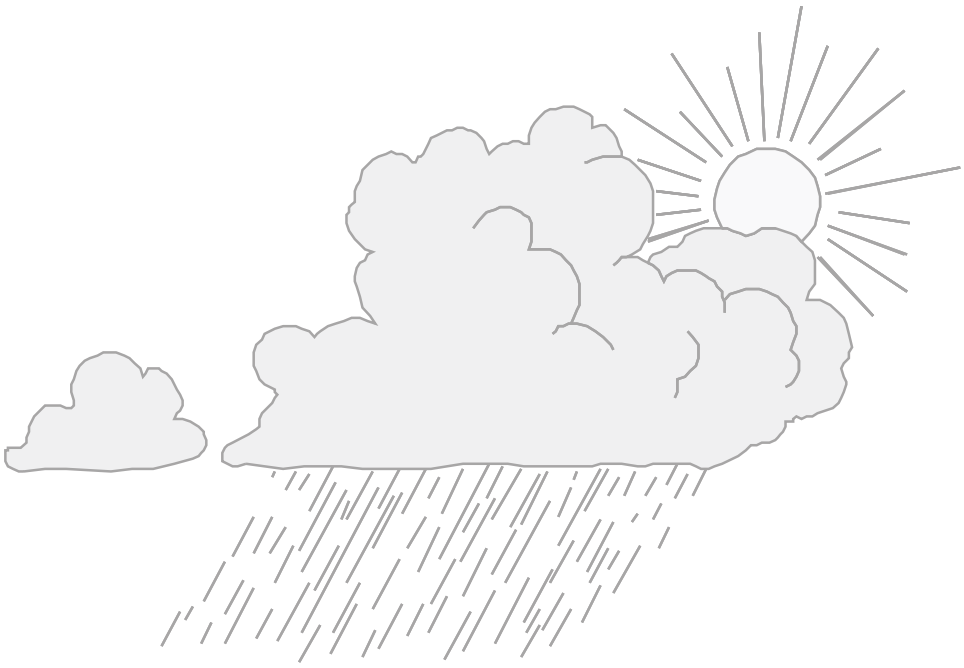
Costs
Vantage Pro2 (New Model)

Accessories	Cost
The Vantage Pro2 Weather Station with integrated sensor suite: windspeed and direction, air temperature, windchill, relative humidity/dewpoint, and rain gauge	$595
WeatherLink software	$165
Tripod	$65
Sensors	
Soil radiation	$160
Soil moisture	$50
Soil temperature	$40
Evapotranspiration	$350

About the Authors

Mary Ann Davies received a bachelor's degree in mechanical engineering with a minor in industrial and management engineering from Montana State University. She worked in the Pacific Northwest Region as a facility engineer and as a tramway engineer. Mary Ann has worked in fire management as a crewmember and as a crewboss. She worked for 5 years with the Rocky Mountain Research Station in the fire chemistry and fire behavior groups before coming to MTDC in 1999.

Gary Kees is a project leader specializing in reforestation and nurseries, facilities, recreation, and GPS projects at MTDC. He received his bachelor's degree in mechanical engineering from the University of Idaho. Before coming to MTDC in 2002, Gary worked for the Monsanto Co. in Soda Springs, ID, as a mechanical/structural engineer and project manager.



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The Missoula Technology and Development Center evaluated three battery-operated weather stations costing from $985 to $1,775. The stations were the HOBO Micro Station (Model No. H21-002), the WatchDog 700, and the Vantage Pro (Model No. 6150). Data could be downloaded from the HOBO Micro Station and the WatchDog 700 using hand-held devices such as a Palm personal digital assistant, a convenient feature when stations are in remote locations.

Keywords: data loggers, dataloggers, instruments, meteorology, sensors, weather

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Additional single copies of this document may be ordered from:

USDA Forest Service, Missoula Technology and Development Center
5785 Hwy. 10 West
Missoula, MT 59808–9361
Phone: 406–329–3978
Fax: 406–329–3719
E-mail: *wo_mtdc_pubs@fs.fed.us*

Electronic copies of MTDC's documents are available on the Internet at:

http://www.fs.fed.us/eng/t-d.php

For additional information about affordable, battery-operated weather stations, contact Mary Ann Davies or Gary Kees at MTDC:

Phone: 406–329–3900
Fax: 406–329–3719
E-mail: *mdavies@fs.fed.us* or *gkees@fs.fed.us*

Forest Service and Bureau of Land Management employees can search a more complete collection of MTDC's documents, videos, and CDs on their internal computer networks at:

http://fsweb.mtdc.wo.fs.fed.us/search/

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