# Arcata Fish and Wildlife Service's 2006 Multiprobe Maintenance and Deployment Protocol

By

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## PURPOSE STATEMENT

The challenge associated with water quality monitoring is to collect data that consistently represents the environmental conditions. To be able to best represent these conditions, it is important to develop a thorough protocol to obtain comparable data. To ensure the collection of good data, a quality assurance/quality control (QA/QC) program must be incorporated into the plans.

This document is part of a continuing effort for the Arcata Fish and Wildlife Office (AFWO). Based on information learned from the literature, during trainings and in the field, our project has made efforts to continually improve our protocol based on the latest industry trends and most applicable field techniques. Our database development has driven our QA/QC practices and has yielded important information regarding the effectiveness of field techniques. This document was largely put together to assure that the different persons involved with the Water Quality Monitoring Project are consistent in the protocols that they use in the field. Specifically, this document covers protocols for the calibration and collection of continuous and spot data with multimeter probes (e.g. Hydrolab DataSondes and Quanta's).

## QUALITY ASSURANCE/QUALITY CONTROL

Two major components of QA/QC are accuracy and precision. Accuracy is how close the results are to a true or expected value. Instrument calibration is the necessary first step to assure accurate performance in the field. Precision, on the other hand, is the amount of agreement (or random error) among repeated independent measurements of the same parameter. Comparisons between instruments, whether in the field or laboratory, allow for an understanding of instrument precision. The protocol identified herein, describes techniques used to obtain accurate and precise data.

If you have not operated these instruments before, it is necessary that you spend some time reading the users guide, past reports, and practicing the calibration of the instrumentation. Demonstration of the instrumentation by veteran users is valuable and should be sought where available. As with any equipment, the knowledge you attain with the instrumentation will translate to collecting better quality data. Attention to detail with the calibration procedures is required in order to obtain good data quality and defensible results.

## DATASONDE AND QUANTA UTILIZATION

### Step 1: Is Your DataSonde Ready To Be Used?

Many things are necessary to consider before the start of the field season, upon receiving a DataSonde from the manufacturer, or pulling one out of storage. For example, how long since the pH reference solution was changed? Will the calibration solutions expire during the season? These are but a few questions you must ask yourself before using the instrumentation. A thorough examination of the manufacturers recommended

maintenance schedule will generally supply you with a list of things to consider. In some cases, previously collected data may provide some evidence as to where probes are starting to fail, allowing you to obtain a replacement probe early in the season. Making sure the instruments have met the maintenance schedules and are running correctly before the season starts serves as a first line of defense to help assure that data collection efforts are successful. AFWO regularly conducts a preseason comparison study that allows us to compare instrumentation together under the same conditions, prioritize probes needing replacement and promote general sonde maintenance. The preseason instrument checks further limits instrumentation failures in the field and prevent excessive bias from being introduced into the data. (Some preseason work has been done to evaluate the new sondes but 8 of our 10 sondes are currently backordered, restricting any testing we can do at this time.)

## Step 2: Preparation of the Instrument for Deployment

***Study Sites, Housing and Security***

The monetary value of the instruments and the importance of the data collected require that water quality instruments be secure when in the field. Study locations are chosen at the discretion of the researchers and must meet the study's objectives. In many cases, instrument placement includes considerations of vandalism, ecological effects, access, etc. An ideal site is one that is representative of the section of water being measured and has some object such as large riparian trees, bedrock or pilings that can provide a secure point of attachment for the equipment. With bedrock, boulders, or old bridge pilings, a hole can be drilled and an eyebolt glued into place to ensure a permanent anchor that is more secure than a riparian tree. Plan to drill the hole as close to the water level during low flows to reduce the visibility of the eyebolt. Place the DataSonde in a 4- 6" ID perforated aluminum housing to protect the sonde during unattended monitoring. Attached to the housing should be a section of chain which is locked to the anchor. Another lock will be used to ensure the sonde is not removed from the housing. Where possible, avoid sites that have frequent visitors and try to conceal it to avoid unnecessary attention. Care should be taken to prevent placement of the probe-end of the sonde in areas with silt or algae. Housings that include "legs" to raise the sensor end above the substrate are useful in these situations. Additionally, wading upstream of a deployed sonde disturbs sediments or algae and should be avoided prior to the sonde recording to prevent erroneous readings.

***Sampling Intervals***

Based on previous experience and protocols developed by the USGS, our water quality instrument will be deployed for two weeks intervals in 2006. Based on the expected resistance to fouling of the new instruments, this interval should be adequate to obtain readings that will portray in river conditions. Due to the highly productive nature of the Klamath River, if fouling is causing an unaccountable level of error in the probes, the deployment interval may be shortened or other changes affected to obtain quality data. During previous field seasons, post calibration protocol involved measurements at the end of the deployment that attempted to estimate the effects of biofouling. Through this recovery, biological fouling was not shown to consistently bias any of the probes,

regardless of the site or season sampled. Because two week deployments are near both the limit of the desirable deployment interval and the expected battery life, it is important to be able to service the sonde on the two week schedule and not allow for longer deployments.

***Parameter Set-up***

The Surveyor® data logger and display, used in conjunction with the DataSonde multiprobe, allows the user to set the DataSonde to record the desired parameters, calibrate the instrument, and download the sonde files. For specific methods on using the Surveyor, refer to the Surveyor 4 Water Quality Data Display User's Manual (Hydrolab, 1999).

When first hooking up the DataSonde to the Surveyor, set the date and time on the DataSonde. This step is crucial to maintaining consistent data throughout the season. Make sure to check the DataSonde clock against a watch or cell phone clock that is known to be correct every field visit to maintain accuracy of the sonde recording time.

All parameters and units to be measured should be set through the Surveyor to record in the following sequence. Enter each of these parameters separately and in the order they are to be displayed on the screen (from left to right). Parameters include: Date, Time, Temp ($^{o}$C), Specific Conductivity (µS/cm), pH, Luminescent Dissolved Oxygen, (mg/L), Luminescent Dissolved Oxygen (% Saturation), I Batt (internal battery level) and other optional parameters such as depth (meters) and salinity (pss). This sequence provides all the data necessary for the database in an easily importable format.

***File Creation***

The creation of a file describes where an instrument will be placed, the time frame in which it will be deployed and extracted, and its recording interval. Define the file name by using the site abbreviation followed by the underscore symbol then the deployment date. For example, TR_070305 is a file that was deployed in the Trinity River on July 3$^{rd}$, 2005. This pattern is important for accurate tracking and management of files. Specific site abbreviations for the Klamath River are as follows, OR= Orleans Gage, SV= Seiad Gage, IG= Iron Gate Hatchery Bridge. For situations where multiple sondes are located in an area, other naming conventions such as numbers (MT1_072406, MT2_072406, etc.) may be used but be certain to record such information and not mix up which sonde is placed where.

When setting the start time, make sure it is set on the half hour and there is enough time to get the unit in the water to stabilize before the recording starts. The stop date should be set for at least a week past the date you expect to extract the unit. This gives the user time to reschedule an extraction in case of unforeseen circumstances. Stop time should be set for sometime after dark so that an extraction audit is not missed in the middle of the last day of the file. Set the instrument to record every 30 minutes; on the Surveyor this is an interval time of 003000. Set sensor warm up for 000030 to give the instruments thirty seconds to warm up before taking the recording. The circulator in not necessary and the warm up time is reduced this year due to improved technology of the LDO probe.

At this point, the file setup is complete but be sure to go back through the menu to double check and make sure the file has been created correctly. Because of the difficulties with the Surveyor buttons, the dates and times for the deployment and extraction should be reviewed. In addition to the file being created make sure that the DataSonde is also set up in the Autolog format so that in the case of a file problem, hourly data will still be recorded.

## Step 3: DataSonde Field Timeline

Upon arrival at each monitoring site, numerous tasks must be performed to successfully meet the QA/QC protocol and service the DataSonde. Properly filling out the calibration sheet is critical to collecting all the data that is needed for the evaluation of the sonde file. Here is an overview of a typical field tour consisting of extracting the sonde, performing scheduled maintenance, redeploying and returning the next day to calibrate for dissolved oxygen.

1. Arrive on site and acclimate pH and conductivity standards to ambient stream temperature in order to accurately post calibrate/calibrate the DataSonde. There are two possible methods to do this.
    - Method One: Collect water from the stream that is representative of the ambient stream temperature. Place the stream water, pH and conductivity buffers, as well as jugs of deionized water in a cooler to equalize the standards to ambient stream conditions. This acclimation procedure can take 15-30 minutes. Be very careful to have all lids properly capped so that buffers are not contaminated by stream water. Water from another reach of the river may be used so that the buffers can be acclimating during the drive to the next site.
    - Method Two: place the standards and deionized water in a durable mesh laundry bag and secure it in the stream. This will allow for a more rapid heat transfer and more precise acclimation to the site specific stream temperature.
2. Record current barometric pressure at the site along with other environmental conditions, such as, weather, changing water levels, etc. Calibrate the Quanta if it has not been calibrated already. If it has been calibrated, adjust the dissolved oxygen (percent saturation) for current site barometric pressure and deploy next to the sonde at least five minutes before the half hour. This will give the Quanta time to stabilize while also allowing it to be recorded at the same time as the sonde.
3. As close to the half hour as possible, but always within +-5 minutes, record the Quanta information. Only after the sonde has recorded on the half hour (preferably wait five minutes), carefully remove the sonde from the housing trying not to disturb any fouling on the probes.
4. Place the sonde and the Quanta within a bucket or cooler filled with stream water. Connect the sonde to the Surveyor and once both probes are stabilized, record both values. This will provide a comparison within the same parcel of water before cleaning the sonde.

5. Clean the sonde probes with a mild soap (Dr. Bronners, or alternative) and Q-tips or Kim wipes being especially careful with the probes and sensor area.
6. Replace the cleaned sonde back into the bucket with the Quanta and allow them to stabilize before taking readings from the two instruments again. This will act as a post cleaning comparison to determine the amount of fouling associated with the sonde probes.
7. Remove the sonde from the bucket and begin the post calibration of the DO probe. See the post calibration section for a detailed description of techniques. While the DO probe is stabilizing, this is a good time to perform file maintenance by downloading the old file and creating a new file. Make a note of the DO level so you can track how quickly the probe is stabilizing.
8. Perform post calibration on the specific conductivity and pH probes using stream acclimated standards.
9. Change batteries before every deployment making sure to grease the o-rings with silicone. Old batteries can be reused for flashlights, etc. before being recycled. Check sonde clock against verified watch and recalibrate if off by more than 1 minute. Make sure that a single watch is used week after week to maintain the same time comparisons. Set the watch using a computer's clock, and check it and reset if necessary regularly.
10. Redeploy the DataSonde and obtain Quanta information at the time of the first half hour recording of the sonde.

## Step 5: Post Calibration/ Calibration

Calibration of the instrumentation in the field to a standard of known value is critical for accurate and precise measurements of the multiprobes. Post calibration of the instruments is similarly necessary to understand how the instrument is performing at the end of the deployment period. The post-calibration check is vital to the QA/QC process and provides a necessary evaluation of the instrumentation for the previous deployment. This check is required to estimate the electronic drift and for dissolved oxygen only, the effects of biofouling, of a dataset after instrument extraction. In the case of pH and specific conductivity, because the instrument has already been cleaned, the post-calibration also calibrates the instrument for the next deployment. Temperature probes do not undergo a weekly post-calibration process.

Consistently following the post calibration/calibration procedures outlined below will help ensure the data is of good quality. In addition, inconsistent application of a rigid protocol weakens the confidence of the data that in turn may inhibit the ability to draw any conclusions from the study. In general, when waiting for a parameter to stabilize, write down on the side or make a mental note of what the value is and when you check periodically, see whether it is still drifting one way or another. When the parameter stops drifting in one direction, it is a good sign that it is beginning to stabilize. This method works for any parameter you are calibrating for.

*Dissolved Oxygen*

Dissolved oxygen sensors are sophisticated electronic instruments that require frequent calibration and delicate handling. While the newer technology LDO sensors do not require regular maintenance, the Clark cell DO probes on the Quanta do require regular changing of the membrane to maintain accuracy. Protect the instruments from sudden impacts, drastic temperature changes, and extremes of heat and cold.

Maintenance issues of the Quanta dissolved oxygen probe generally are associated with the membrane. The thin Teflon membrane is affected by biological fouling changing the permeability rate of oxygen through the membrane. Replacing the membrane and electrolyte solution every deployment should eliminate or limit any bias due to a change in oxygen permeability. Accuracy and precision of dissolved oxygen data is not only dependent on the frequency of sampling and environmental conditions where the samples are being taken (e.g. eutrophic water), but also on the extended use of the instrument. It is necessary to regularly calibrate the DataSonde for dissolved oxygen. Calibrate for dissolved oxygen in mg/L based on DO % saturation at 100%. The US Fish and Wildlife Service recommends using the Air saturated water method for calibration of the LDO probe and the modified wet towel method for calibration of the Quanta. According to Hach, the air saturated method does not work effectively for the membrane style probes. The methods are described below.

*Air Saturated Water*: DATASONDE 5 with LDO probes

Remove the field cup of the sonde and replace it with the calibration cup.

1. With a 1-2 liter bottle, fill it with ½ Liter of water that has been at equilibrium with atmospheric pressure for at least 12 hours. This would be water that has been sitting in an uncapped container, at least overnight.
2. Make sure the water in the bottle is close to temperature equilibrium with the calibration environment.
3. Seal the bottle and shake it vigorously for 1 minute.
4. With the sensors facing upright, pour the water into the calibration cup until it is within 1/2" of the top. Cover the calibration cup with the cap upside down to stop the exchange of air without pressurizing the cup. Keep the sonde out of direct sunlight, or wrap the sonde in a wet towel to prevent the sonde and sensors from changing temperature.
5. Determine the barometric pressure using a calibrated handheld barometer.
6. Wait 3-5 minutes to assure the LDO sensor has reached the same temperature as the water bath.
7. Record the DO mg/L reading.
8. Enter the BP into the sonde to calibrate for DO % saturation.
9. Once it has stabilized to the new calibration, record the final calibrated value in mg/L.

*Modified Wet Towel Method:* QUANTA with Clark cell DO probe

Remove the field cup of the DataSonde or Quanta. Use the corner of a non-abrasive tissue such as Kim-wipe to absorb any water on the surface of the

membrane. Be careful not to remove any fouling material from the membrane at this time. Alternatively, allow the membrane to air dry if hot and dry conditions are present. Air drying may only take a few minutes and improves the accuracy of the biofouling estimate.
Place a small wet sponge in the bottom of the sensor area, wedging it between the probes while avoiding direct contact with both the DO membrane and the temperature probe. Replace the field cup and wrap the sonde in a white towel that has been soaked in water and gently wrung out so it is not dripping wet. The towel should cover the entire sonde and go around the sensor area at least twice. Make sure the field cup is completely covered with the towel to make sure the probe is in a 100 percent saturated environment. Allow the dissolved oxygen mg/L readings on the Surveyor to stabilize (about 10-15 minutes) and record the mg/L value as the initial reading. After you record the initial reading calibrate for Dissolved Oxygen % saturation by entering the current site barometric pressure from the Surveyor or a handheld barometer. Wait for the new value to stabilize then record the value in mg/L as the final reading. The difference between the initial and final reading will incorporate the effects of bio-fouling and electronic drift over the course of the deployment.

*Specific Conductance/ Salinity*

Calibration should occur with a standard that brackets the range of conditions expected in the field. A two-point calibration of zero and a 1000 or 1413 µS/cm is appropriate for most northern California freshwater systems. Higher conductivity solutions should be used for saline or brackish waters. As long as both conductivity and salinity are set to record on the sonde, calibrating for conductivity will act as the calibration for salinity.

With the conductivity and pH solutions acclimated to the stream temperature, calibration can commence. Rinse the probes three times with DI water. Drain the calibration cup and dry the inside of the cell thoroughly with a Q-tip. Calibrate the zero point for specific conductivity by allowing the probe to stabilize in air. Record the initial reading for the air calibration then calibrate the DataSonde for specific conductivity in air by entering in the Surveyor 0.0 µS/cm. It is necessary to perform the air calibration on the instrument even when the instrument may initially read 0.0 µS/cm because this creates the start point for the slope equation to determine conductivity.

Follow this by rinsing sparingly three times with the standard solution. When rinsing, be sure to swirl the solution adequately to remove or continually dilute any residual DI water remaining in the calibration cup. Discard standards appropriately after each use. When in the field, please store any used solutions in a sealed container to be disposed of later into a sewage or septic system. Fill the calibration cup with enough standard to cover the probe and allow a few minutes for readings to stabilize. After stabilization, record the value as the initial reading. Calibrate the DataSonde for specific conductivity by entering the standard solution value. Record the final value once the new reading stabilizes. Rinse the probes three times with DI water.

*pH*

Calibration for pH is also performed after cleaning the probe with alcohol and is performed in the field with buffers that have been allowed to reach ambient stream temperature. Use standards that bracket expected environmental conditions. For the Klamath River, pH standards of 7.0 and 10.0 are appropriate.

Rinse the calibration cup and associated probes three times with DI water. Rinse sparingly three times with pH 7.0 buffer that has been equilibrated to ambient stream temperature. Be sure to swirl the solution adequately to remove or continually dilute any residual DI water in the calibration cup. Fill with pH 7.0 buffer and allow the meter readings to stabilize. Record this as the initial value, which also is the post-calibration check, and then enter the buffer value of 7.0_ (varies based on temperature of the standard) into the laptop. Enter this as the final calibration value once it stabilizes. Now pH 10.0 must be calibrated. Repeat the same process this time switching to pH 10.0 buffer. Be sure to rinse with DI water and buffer three times before calibrating.

As part of regular maintenance, the first field visit of each month should involve changing of the pH reference electrolyte. Following post calibration of the pH probe, unscrew the teflon junction of the pH reference probe and pour out the solution and refill with fresh solution. If the KCl pellets inside have dissolved, replace them with 3 additional pellets. These pellets help keep the KCl solution saturated. Once the solution is replaced, screw the teflon junction back on making sure there is no air trapped within the reference probe. After this is done, recalibrate the pH probe to ensure accurate readings for the next deployment.

*Depth*
Remove water from the calibration cup and point the sensors down. Enter 0 for the standard (air). This calibration should be done following the conductivity calibration (Hydrolab, 2006).

*Water Temperature*
Before and after the field season, it is pertinent to verify that the thermisters of each instrument meet the manufacturer's specifications. Verification builds the researchers confidence that the data that has been or will be collected is of good quality; this may be especially true as the instruments age. The verification process takes place in a water bath and should span a temperature range that is representative of the field setting. This should be done both at the beginning and end of the field season; in multiyear studies this can be accomplished with one experiment. Verification studies conducted by the AFWO following the 2001 through 2003 field seasons found that all multiprobes were within $\pm$ 0.2°C when compared to a NIST thermometer. It is not possible to calibrate for temperature on a weekly basis although it is necessary to verify that the instruments are performing as specified. A check between the DataSonde and auditing Quanta will reveal differences that need further attention. In order to ensure a continuous record of water temperature throughout the season additional calibrated temperature probes (e.g. Optic Stowaways) should be placed at the study sites. These will also act to independently verify the sonde temperature's accuracy.

## CITATIONS

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