NEON FSU Field and Lab Protocol for Ops CPER 2011: Leaf Area Index

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See Configuration Management System for approval history.

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1 INTRODUCTION

1.1 Purpose

The primary purpose of this document is to provide a change controlled version of Observatory protocols, and is the version used for external review by subject-matter experts. This document provides the content for training and field-based materials for NEON staff and contractors. Content changes (i.e. changes in particular tasks or safety practices) occur via this change controlled document, not through field manuals or training materials.

This document is a detailed description of the field data collection, relevant pre- and post-field tasks, and safety issues as they relate to this procedure and protocol.

1.2 Scope

This document relates the tasks for a specific field sampling or laboratory processing activity and directly associated activities and safety practices. This document does not describe:

- general safety practices (i.e. how to drive a boat)
- site-specific safety practices (e.g. how to safely walk in a stream)
- general maintenance (i.e. fill the car with gas)

It does identify procedure-specific safety requirements such as safe handling of small mammals or safe use of required chemicals and reagents.

1.3 Acknowledgements

If a protocol is based closely on the work of another program or author, note that here.

2 RELATED DOCUMENTS AND ACRONYMS

2.1 Reference documents

If you want to reference other procedural documents (e.g. associated Protocol document), drawings, etc. then include filenames in the following sections.

RD[01]	NEON.NPR.000008 NEON Acronym List
RD[02}	EHS Safety Policy and Program Manual
RD]03…]	<primary science design docs explaining/justifying this protocol/these procedures>
RD[04]	NEON Sampling Design Document
RD[05]	Training Plan
	QA/PA Plan
	DOORS requirements
	ATBD
	NEON.DOC.000243 NEON Glossary of Terms

2.2 Acronyms

NEON	National Ecological Observatory Network
FSU	The NEON Fundamental Science Unit at Headquarters
P&P	Procedure and Protocol
EP	Ecosystem Productivity [plot]
LAI	Leaf area index
CPER	Central Plains Experimental Range

3 BACKGROUND AND OBJECTIVES

3.1 Background

This document describes the required protocols for conducting field sampling, making a human-mediated field observation, or operating an instrument to make measurements in the field, or any other activity that generates a Level 0 data product.

Briefly describe science rationale for selecting protocol. Specific details of methodology are described in standard operating procedures (SOPs) included as appendices. Recommended length <1 page.

3.2 Science requirements

This protocol fulfills the following Observatory science requirements:
List science requirements from DOORS that are met by this protocol.

3.3 Data products

List Level 0 data products measured by protocol.

Table 1. A summary of field and related lab measurements and the associated NEON Data Products.

Measurement	Data Product

4 PROTOCOL

Leaf area index (LAI) is a useful proxy variable for numerous other variables of ecological interest, including plant biomass, plant productivity, forage quality, carbon balance, ecosystem energy flux, plant density, and the heterogeneity of plant cover. LAI is also used widely as a key input variable to models that seek to predict ecological processes such as carbon cycling. Regional to continental scale estimates of LAI are typically derived from satellite data, but calibration of satellite data with aircraft and ground-collected data is rare. By leveraging NEON's aircraft and ground-collected estimates of LAI, it will be possible to rigorously develop calibrated, ground-truthed estimates of LAI at the continental scale.

Collecting quality LAI data with the LiCOR LAI-2200 is highly dependent on properly using the equipment, and on choosing appropriate times for measurement. This protocol is meant to serve as a continual reference point throughout the data collection procedure so that data are collected consistently and with a high degree of accuracy and repeatability.

Leaf area index should be measured when vegetation is at peak greenness – that is, before the dominant plants have begun to turn brown and senesce. Leaf area index is measured every 10 m along

the length of the four Ecosystem Productivity (EP) plot center-lines. See Figure 1 for a general layout of of the EP plots. In Figure 1, green lines correspond to the locations of LAI measurements, and concentric circles indicate points spaced every 50 m along the EP plot center-line that are associatd with high-resolution GPS coordinates. The red concentric circle is the start of the EP plot, and marks the starting point for LAI measurements along the EP plot center-line.

Placeholder for Figure 1: General layout of Ecosystem Productivity (EP) plot, and associated leaf area index measurement locations at CPER.

The following protocol outlines a multi-day method for collecting high-quality LAI data. The draft sampling design for measuring LAI for the D10 2011 Field Operations prototype is based on LAI studies conducted in similar short-grass steppe ecosystems (Weiss et al. 2004, He et al. 2007). It is NEON's desirement to estimate leaf area index to within 10% of the mean, and to adequately capture the range of variability of LAI within the tower airshed. However, at present it is unclear whether the current design will accomplish this goal.

5 QUALITY ASSURANCE AND QUALITY CONTROL

The NEON QA/QC plan for these measurements is under development and TBD.

6 DECISION TREE

Table 2. Decision tree associated with the plant leaf area index measurements, indicating how to respond to unanticipated delays in field or lab work, and consequences of these delays.

Delay	Action	Adverse outcome	Outcome for Data Product
Hours	If 1) Delay interrupts data collection mid-transect: a) stop data collection for the transect; b) when able to resume, make sure light conditions are favorable for data collection from an entire transect; and c) repeat data collection for entire transect on the same day if possible.	A delay of hours can lead to unfavorable light conditions for collection of LAI data.	Overestimation or imprecise estimation of LAI.
	If 2) Delay occurs between transects: a) Ensure light conditions are favorable for data collection from an entire transect; and b) resume data collection for next transect.	A delay of hours can lead to unfavorable light conditions for collection of LAI data.	Overestimation or imprecise estimation of LAI.
Day	If 1) Delay interrupts data collection mid-transect: a) stop data collection for the transect; b) next day, ensure light conditions are favorable for data collection from an entire transect; and c) repeat data collection for the transect.	None	None
	If 2) Delay occurs between transects: a)	None	None

Delay	Action	Adverse outcome	Outcome for Data Product
	Return to the field the next day; b) ensure light conditions are favorable for data collection from an entire transect; and c) resume data collection for next transect.		
2-7 days	If 1) Delay interrupts data collection mid-transect: a) stop data collection for the transect; b) return to the field asap and ensure light conditions are favorable for data collection from an entire transect; and c) repeat data collection for the transect.	None	None
	If 2) Delay occurs between transects: a) Return to the field asap; b) ensure light conditions are favorable for data collection from an entire transect; and c) resume data collection for next transect.	None	None
8-13 days	If 1) Delay interrupts data collection mid-transect: a) stop data collection for the transect; b) return to the field asap and ensure light conditions are favorable for data collection from an entire transect; and c) repeat data collection for the transect.	LAI may change over a delay of this length.	Imprecise estimation of LAI.
	If 2) Delay occurs between transects: a) Return to the field asap; b) ensure light conditions are favorable for data collection from an entire transect; and c) resume data collection for next transect.	LAI may change over a delay of this length.	Imprecise estimation of LAI.
2 or more weeks	If 1) Delay interrupts data collection mid-transect: a) stop data collection for the transect; b) return to the field asap and ensure light conditions are favorable for data collection from an entire transect; and c) repeat data collection for the transect.	LAI may change over a delay of this length.	Imprecise estimation of LAI.
	If 2) Delay occurs between transects: a) Return to the field asap; b) ensure light conditions are favorable for data collection from an entire transect; and c) resume data collection for next transect.	LAI may change over a delay of this length.	Imprecise estimation of LAI.

7 SAFETY

Personnel working at a NEON site should be familiar with and practice safe field work as outlined in the EHS Safety Policy and Program Manual. Additional safety issues associated with this field procedure are outlined below. The Field Operations Manager and the Lead Field Technician have primary authority to stop work activities based on unsafe field conditions; however, all employees have the responsibility and right to stop their work in unsafe conditions.

There are no specific safety issues associated with collection of LAI data in the field, or operation of the LAI-2200 equipment. However, if LAI data are collected in the field at dawn or dusk, it is advisable to bring a headlamp to aid navigation – though the lamp should remain off during data collection to avoid influencing the measurements.

8 PERSONNEL REQUIREMENTS

A team of two field technicians is required for LAI measurements. One person is responsible for logging LAI data with the LAI-2200; the other person is responsible for guiding the location of measurements with GPS and compass, and for recording LAI QC data.

- Ability to perform field work at dawn or dusk

9 TRAINING REQUIREMENTS

The NEON training plan associated with these activities is under development and TBD.

10 FIELD STANDARD OPERATING PROCEDURE

This field procedure is designed to collect LAI data with a LiCOR LAI-2200 in a short-stature mixed grassland, such as is the dominant vegetation type within the tower airshed at the D10 CPER site.

10.1 Sampling frequency and timing

As mentioned above, LAI should be measured when the vegetation is at peak greenness. One method for determining the average dates of peak greenness at a given site is to use data from the MODIS satellite (specifically the NDVI data product from MODIS). Based on MODIS NDVI data, peak greenness occurs at the CPER site between the 20th May (Julian day 140) and the 9th of July (Julian day 190), and LAI measurements should take place within this timeframe.

Two additional constraints apply with respect to collecting high-quality LAI data: 1) it is not possible to measure LAI with the LiCOR LAI-2200 when it is raining – check the local weather forecast prior to initiating field work to ensure that data collection will be possible; and 2) LAI data must be collected when light conditions are appropriate – i.e. dawn, dusk, or when direct sunlight is not visible on the foliage. See “Determining appropriate light conditions” section for more details.

We have estimated that it will take a team of 2 technicians approximately 2.5 hours to collect LAI data along the center-lines of each of the EP plots. Given that there are four EP plots in the tower airshed, and that sampling times are restricted to either dawn or dusk for optimal data collection, it follows that 2 technicians can collect LAI data from one EP plot per day, and all four EP plots can be measured in 4 ×

2.5-hour bouts spread over 4 days (not including travel time). Ideally, measurement days should be consecutive so that the effect of time on the measurements is negligible.

Table 3. The acceptable sampling date range for leaf area index data collection at the NEON CPER site.

Domain, Site	Date range	Frequency
D10, CPER	20th May – 9th July	1X per year

10.2 Contingency decisions

Please see the Decision Tree in Section 6.

10.3 Field procedure

The following procedure illustrates how to acquire both above-canopy (**A**) and below-canopy (**B**) data using the LAI-2200 console and an attached wand. Data are collected along the center-line of the four 300 m long EP plots, with each EP plot permanently marked every 50 m (Figure 1). Permanent markers are associated with a set of high-resolution GPS coordinates. EP plot markers are labeled according to the scheme "X-000", where "X" is the EP plot number, and the three digits correspond to the position along the plot center-line; for example, a marker labeled "3-150" would mark EP plot 3 at the 150 m point.

10.3.1 Equipment and materials

The following equipment is sufficient for a team of 2 field technicians to collect LAI data in an ecosystem with vegetation < 2 m in height.

Table 4. Materials and supplies required for measuring leaf area index in vegetation with a maximum height of less than two meters.

Item Description	Quantity per sampling event	Hazardous Chemical
LiCOR LAI-2200	1	NA
Brünton compass w/ mirror sight	2	NA
Juno SB GPS unit	1	NA
LAI QC datasheet	1	NA
Mechanical pencils	2	NA
Headlamp, LED	2	NA

10.3.2 Preparation

Two days before the anticipated field work, the LAI-2200 equipment must be checked to make sure it is in full working condition, and field technicians need to calibrate their pacing with a meter tape to speed measurements in the field.

10.3.2.1 LAI-2200 equipment check

There are several important weather and light constraints that dictate when it is possible to collect high-quality LAI data; please see the "Sampling frequency and timing" section of this document for more

details. Assuming weather and light conditions allow collection of LAI data, perform the following checks on the LAI-2200 equipment two days prior to the planned field work:

1. Use the ZTS Mini Multi Battery Tester to test all batteries (console and wand batteries) under load. Replace and/or charge batteries as necessary.
2. Check that the time on the LAI-2200 console is set correctly, and that the time is set in Coordinated Universal Time (UTC) using 24-hour notation.
    a. For Colorado, UTC = MST + 7 hours. The correct UTC time can be found at http://www.time.gov/timezone.cgi?UTC/s/0/java
    b. Clocks on the LAI-2200 consoles should be pre-set, but if the time on the console is incorrect, do the following to properly set the clock:
        i. Press the **Power** button on the console located near the lower-left corner of the screen (see Figure 2). Press **Menu > Console Setup > Set Time** and press **OK.**
        ii. Use the ↑ and ↓ arrow keys to select the correct values for the time and date fields, and use the ← and → arrow keys to switch between fields.
        iii. Press **OK** to implement the new time/date, or press **Exit** to abandon changes.

Placeholder for Figure 2: Front view of the LAI-2200 console.

3. Synchronize the clock on the optical sensor wand with the clock on the LAI-2200 console unit.
    a. Using the supplied cable, attach the wand to the "X" position on the bottom-left of the console (see Figure 2 and Figure 3). ***Attach the cable carefully, as the pins bend easily; line up the screw guide and slowly push the cable over the pins. DO NOT TWIST the outer screw to tighten until the cable is seated on the pins.***

Placeholder for Figure 3: View of LAI-2200 console ports (left) and wand port (right).

    b. The sensor wands are identified by the console software according to the unique serial number printed on the wand head near the lens.
    c. To choose a wand and set its clock, go to **Menu > Wand Setup > Select wand > Clock** and press **OK.**
    d. Select **Sync Time** to synchronize the wand clock with the console clock. The time is updated after you select **Yes**. Verify the time and press **OK**.

10.3.2.2 Calibrate field technician pacing

To measure LAI at the CPER site, it is necessary to record data in a repeatable manner at 1 m and 3 m to the right of the EP plot center-line, and at 1 m and 3 m to the left of the plot center-line. It is therefore important for field technicians to calibrate their individual paces so that a certain number of steps can be accurately equated with 1 m and 3 m distances.

Prior to performing field work, use a meter tape to determine how many paces are equivalent to 1 m and 3 m. Being able to repeatably pace off accurate distances in the field will speed collection of LAI data considerably.

10.3.3 Collection of LAI data in the field

Collecting high-quality LAI data in the field requires two steps: 1) quantitatively determining whether light conditions are appropriate immediately prior to collecting data; and 2) if light conditions are appropriate, repeatably measuring LAI at specified points along the EP plot center-lines.

10.3.3.1 Determining appropriate light conditions

Measurement of LAI with the LiCOR LAI-2200 requires one of the following conditions: 1) crepuscular light conditions – i.e. dawn or dusk; 2) even overcast skies with cloud cover such that the sun does not cast a shadow; or 3) a large shade to ensure that the sun does not shine directly on either the plants being measured, or the LAI-2200 lens.

Two rules of thumb can help determine when light conditions are suitable for measurement of LAI with the LAI-2200:

1. Direct sunlight is NOT visible on the foliage, and the sun does not cast a shadow.
2. The signal:noise ratio from the LAI-2200 wand is >100 for at least 1 of the first 4 detector rings. This is typically only an issue when measuring LAI in low-light conditions at dawn or dusk. Do the following to determine whether the signal:noise ratio is > 100:
    a. Attach the cable to the wand and to the "X" port on the console (see Figure 2 and Figure 3), and power on the console.
    b. On the main screen of the console (see Figure 2), use the ↑ and ↓ arrow keys to highlight the "X" field on the display – choose "X" because the wand is attached to this port.
    c. Configure the wand for overhead, above-canopy measurements (i.e. **A** measurements; see Figure 4), and hold the wand overhead such that the lens is looking straight up.

Placeholder for Figure 4: The LAI-2200 wand configured for overhead, above-canopy **A** data recording.

    d. Then use the ← and → arrow keys to scroll through the signal associated with rings 1 through 4. That is, for a wand attached to the "X" port, X1 = ring 1 data, X2 = ring 2 data, etc.
    e. Record the readout for rings 1 – 4 on the "LAI QC" checklist.
    f. The level of signal associated with "noise" can be determined by placing a solid view cap over the lens, and checking the read-out on the console screen again. The read-out should be approximately 0.001.
    g. Record the "noise" readout on the "LAI QC" checklist.
    h. Divide the "signal" by the "noise" and you will have an approximation of the signal:noise ratio. If the value is > 100 for at least 1 of the first 4 rings, it is possible to proceed with measurements.

10.3.3.2 Measurement of LAI

When light conditions are favorable, LAI measurements are made every 10 m along the EP plot center-line (measurement points are marked with green lines in Figure 1). LAI measurements are easily made

with a two-person team, with one person recording LAI data with the LAI-2200, and the other person using a compass, GPS, and steel meter tape to determine where measurements should be made, as well as performing data quality control (QC) tasks.

1. Use a GPS unit pre-loaded with the appropriate waypoints to locate the origin of the EP plot for which LAI will be measured.
    a. The EP plot origin is marked with a red concentric circle symbol in Figure 1, and is marked in the field with a large, labeled aluminum disk.
    b. Record the start-time in UTC in the "LAI QC" checklist.
2. Connect the LAI-2200 wand port to the "X" port on the console using the supplied cable (see Figure 2 and Figure 3). ***Attach the cable carefully, as the pins bend easily; line up the screw guide and slowly push the cable over the pins. DO NOT TWIST the outer screw to tighten until the cable is seated on the pins.***
3. Remove the solid lens cap, and place the 90˚ view-cap over the lens. Orient the view-cap as in Figure 5. The opening in the view-cap should face away from the operator.

Placeholder for Figure 5: Proper placement and orientation of the 90˚ view-cap over the LAI-2200 wand lens.

4. Turn on the LAI-2200 console and wand by pressing the **Power** button. Note that if the blue "Above" LED on the wand handle is on, the unit tags measurements as above-canopy **A** measurements, and if the light is off, data are tagged as below-canopy **B** measurements (see Figure 6).

Placeholder for Figure 6: LAI-2200 wand handle, showing the blue "Above" LED lit for **A** data collection (left), and off for **B** data collection (right).

5. Press the **START|STOP** button on the console, select **New File**, press **OK**, and enter a file name into the file name field using the keypad (up to 8-characters).
    a. The file name should include a two letter abbreviation of the site name, the unique EP plot number, and the month and day of the measurement date. For example, "CP010625" would be an acceptable file name for LAI data collected at the D10 CPER site, EP plot #1, on the 25th of June.
    b. Record the file name you have created in the "LAI QC" checklist.
6. Press **OK** again.
7. When prompted, again enter the unique number associated with the EP plot you are about to measure (e.g. "CP01"). Then use the ↓ arrow key to move to the "initials" field, and enter the initials of the person making the measurements.
8. Press **OK** one last time.
9. Beginning at the "X-000" marker, the person carrying the LAI-2200 holds the end of a 100 m steel measuring tape at the marker, and the other team member uses a compass and GPS unit to extend the tape to the "X-050" marker.
10. Still standing at the "X-000" marker, the person with the LAI-2200 next uses a compass to sight a line at a right-angle to the direction of the EP plot center-line. This right-angle line need not be

marked with a meter tape, but will be used as a mental guide for proper placement of LAI measurements (see Figure 7).

Placeholder for Figure 7: Leaf area index data collection scheme at a given point within the Ecosystem Productivity plots.

a. Figure 7 illustrates how LAI data are recorded at each of the green lines depicted in Figure 1. In Figure 7, the orange line represents the 100 m steel tape used to mark the EP plot center-line, the dashed line represents the line sighted with the compass that is used to place individual LAI data log events, and the gray arrow indicates the direction of travel along the EP plot center-line. Below-canopy **B** data are recorded at each of the green circled "X" symbols. Above-canopy **A** data are recorded at the concentric circle symbol. The short black line at the left of the figure, and the blow-up illustration of the LAI-2200 wand, show how to place and orient the wand for each data log event.

11. Along the dashed line depicted in Figure 7, six (6) LAI measurements are recorded. ***Take care not to walk on, trample on, or disturb the vegetation that the LAI-2200 will be measuring.*** Facing in the direction of the arrow in Figure 7, the measurement sequence is as follows:

    a. Data log 1: First **A** reading.
    Location: EP center-line.
    Wand position: Overhead (see Figure 4).

Placeholder for Figure 4 (repeated): The LAI-2200 wand configured for overhead, above-canopy **A** data recording.

    b. Data log 2: First **B** reading.
    Location: 1 m to right of EP center-line.
    Wand position: As close to the ground as possible (see Figure 8).

Placeholder for Figure 8: The LAI-2200 wand configured for below-canopy **B** data recording.

    c. Data log 3: Second **B** reading.
    Location: 3 m to right of EP center-line.
    Wand position: As close to the ground as possible.

    d. Data log 4: Second **A** reading.
    Location: EP center-line.
    Wand position: Overhead.

    e. Data log 5: Third **B** reading.
    Location: 1 m to left of EP center-line.
    Wand position: As close to the ground as possible.

    f. Data log 6: Fourth **B** reading.
    Location: 3 m to left of EP center-line.
    Wand position: As close to the ground as possible.

12. To acquire data at each position shown in Figure 7, do the following:

    a. Use the bubble-level to keep the wand head as level as possible. Do not spend more than a few seconds doing this – i.e. do not worry about small deviations from level.

b. Press the **Log** button on the wand handle. The wand will beep twice.

c. Check the console to ensure that two **A** logs and four **B** logs have been tallied at the current measurement point.

13. The person responsible for LAI-2200 data collection will then proceed along the EP center-line toward the "X-050" marker, stopping every 10 m to repeat steps (10) – (12) above.

    a. Note: There should be 36 total **A** and **B** data log events by the time data have been recorded at the "X-050" permanent marker.

    b. Check the total number of **A** and **B** data logs against the expected value listed in the "LAI QC" checklist.

14. Next, the team member with the compass and GPS unit extends the meter tape to the "X-100" permanent marker, and the data logging procedure is repeated until data have been collected along the entire EP plot center-line.

    a. At each permanent marker along the EP center-line, check the total number of **A** and **B** data logs against the expected value listed in the "LAI QC" checklist.

    b. At the end of each EP plot, there should be 62 **A** and 124 **B** data logs.

15. At the end of a given EP plot, close the data file on the console. Press the **START|STOP** button to close the file and exit data logging mode. ***Do not record data for more than one EP plot in the same data file!***

    a. Record the stop-time in UTC in the "LAI QC" checklist.

16. At this point there are two choices:

    a. If there is time for measuring another EP plot while light conditions remain favorable, create a new file for the new plot, label the file as previously described, and continue.

    b. Otherwise, press the power button to power down the console and wand. Upon returning to the vehicle, disconnect the wand from the console, and return the instrument to the case.

10.3.4 Sample preservation

Not applicable to this procedure.

10.3.5 Sample shipping

Not applicable to this procedure.

10.3.6 Data handling

Upon returning to the Support Facility lab, enter data from the "LAI QC" checklist into the appropriate MS Access database or Excel spreadsheet. Additionally, consult with the Domain Manager to ensure that the following steps are taken:

- Data files are copied from the LAI-2200 console to a computer, using the supplied USB cable.
- Data files (.txt format) are uploaded to NEON servers the same day they were created in the field.

- After successfully uploading all data files to the NEON servers, the Domain Manager may choose to purge data files from the LAI-2200 console if console memory is limited.

The NEON Plant Ecologist is responsible for performing QA/QC on the LAI data.

10.3.7 Refreshing the field sampling kit

Not applicable to this procedure.

10.3.8 Equipment maintenance, cleaning, and storage

Maintain equipment for the next sampling day/bout by doing the following:

- Use lens tissue to clean the LAI-2200 lens of any water spots, dirt specks, etc.
- Use the ZTS battery tester to check and recharge batteries (if necessary) for the LAI-2200 console and wand
- Use the ZTS battery tester to check and recharge batteries (if necessary) for the GPS unit

Return the equipment to the appropriate storage location in the Support Facility laboratory.

11 LAB STANDARD OPERATING PROCEDURE

There is no laboratory procedure associated with this protocol.

12 DEFINITIONS

Define all protocol specific technical terms in alphabetical format.

13 REFERENCES

He, Y. H., X. L. Guo, and J. F. Wilmshurst. 2007. Comparison of different methods for measuring leaf area index in a mixed grassland. Canadian Journal of Plant Science **87**:803-813.

Weiss, M., F. Baret, G. J. Smith, I. Jonckheere, and P. Coppin. 2004. Review of methods for in situ leaf area index (LAI) determination Part II. Estimation of LAI, errors and sampling. Agricultural and Forest Meteorology **121**:37-53.

APPENDIX A Field data sheets

The following field data sheets serve as a backup procedure for times when electronic data collection devices (PDA) are not available.

Field datasheets to be prepared for the D10 2011 Field Ops prototype include:

- None – no data (other than QC data) are collected in the field for this procedure.

APPENDIX B Lab data sheets

There is no laboratory procedure associated with this protocol.

APPENDIX C Considerations for implementation

Indicate activities that could result in equipment damage, degradation of sample, or possible invalidation of results; listed here and at the critical steps in the procedure.

Describe any component of the process that may interfere with the accuracy of the final product.

Discuss how to avoid common errors in sampling or common ways samples can be contaminated.

Clearly flag things that might impact their work or the scientific data that aren't covered in the procedural pieces (stupid examples: "We're measuring nitrates, if you are exposed to or using nitrates at home on your lawn, trace amounts might contaminate our data"; "If it's raining, sky water getting into the samples before you seal them could alter results")... i.e. call out weird issues and folklore explicitly. See: http://en.wikipedia.org/wiki/Phantom_of_Heilbronn

APPENDIX D Procedure checklist

Field and laboratory QC checklists to be prepared for the D10 2011 Field Ops prototype include:

- LAI QC

APPENDIX E Figures

Figure 1. General layout of Ecosystem Productivity (EP) plot, and associated leaf area index measurement locations at CPER.

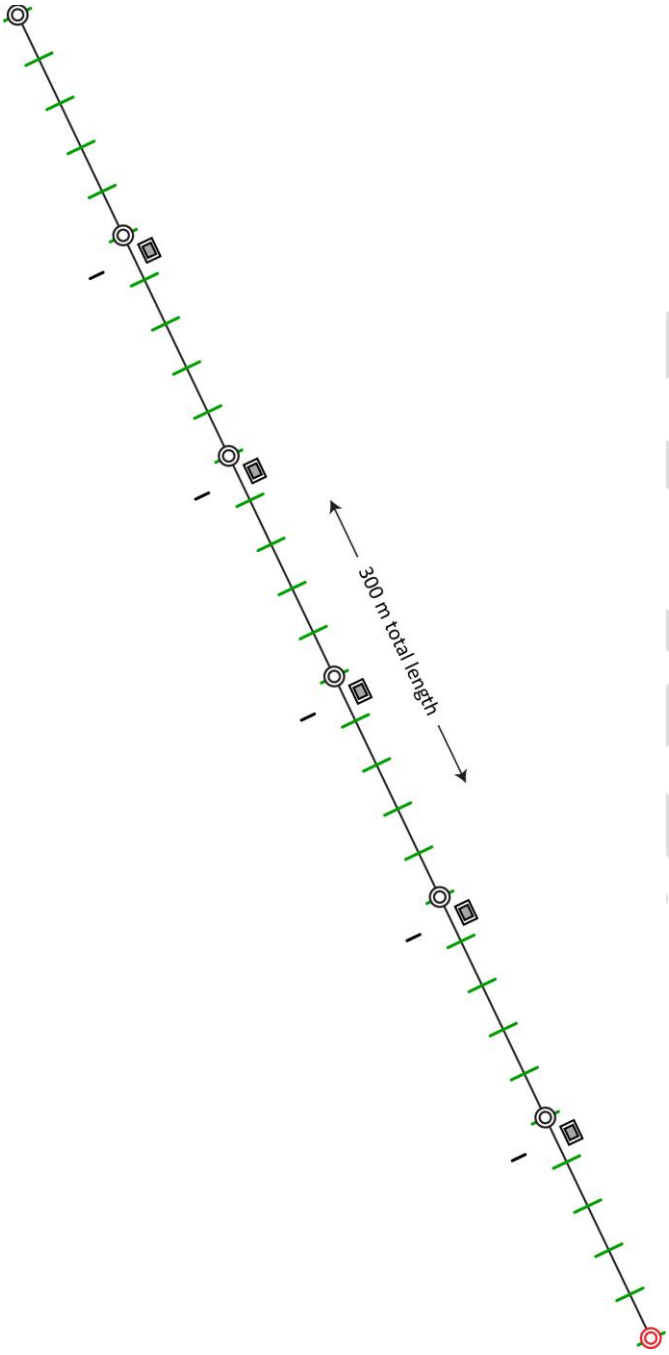

Figure 2. Front view of the LAI-2200 console.

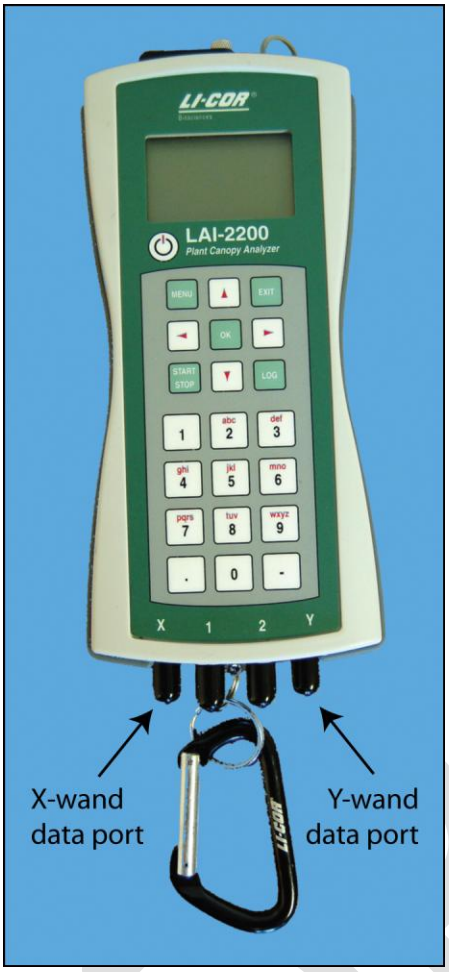

Figure 3. View of LAI-2200 console ports (left) and wand port (right).

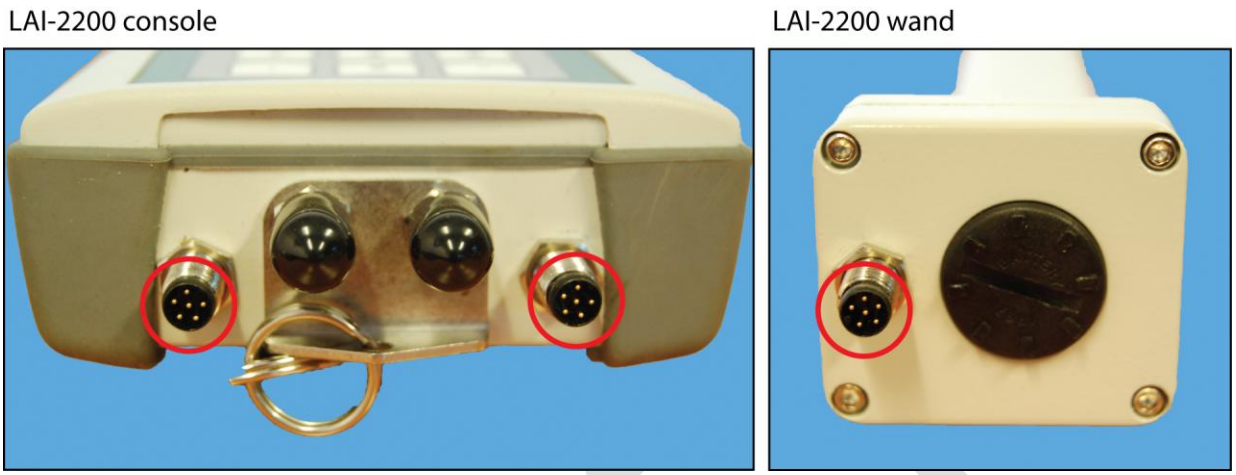

Figure 4. The LAI-2200 wand configured for overhead, above-canopy **A** data recording.

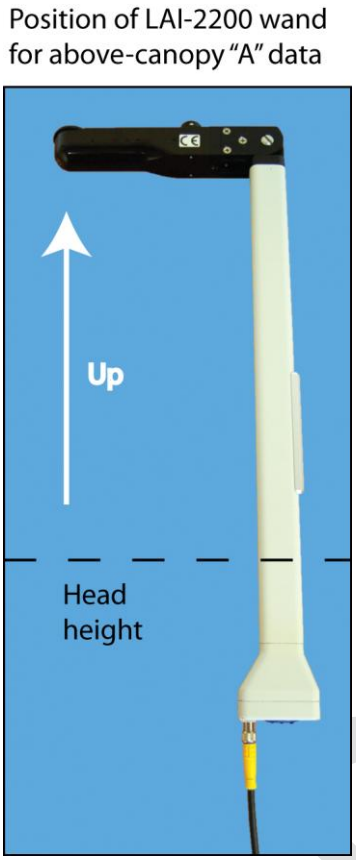

Figure 5. Proper placement and orientation of the 90˚ view-cap over the LAI-2200 wand lens.

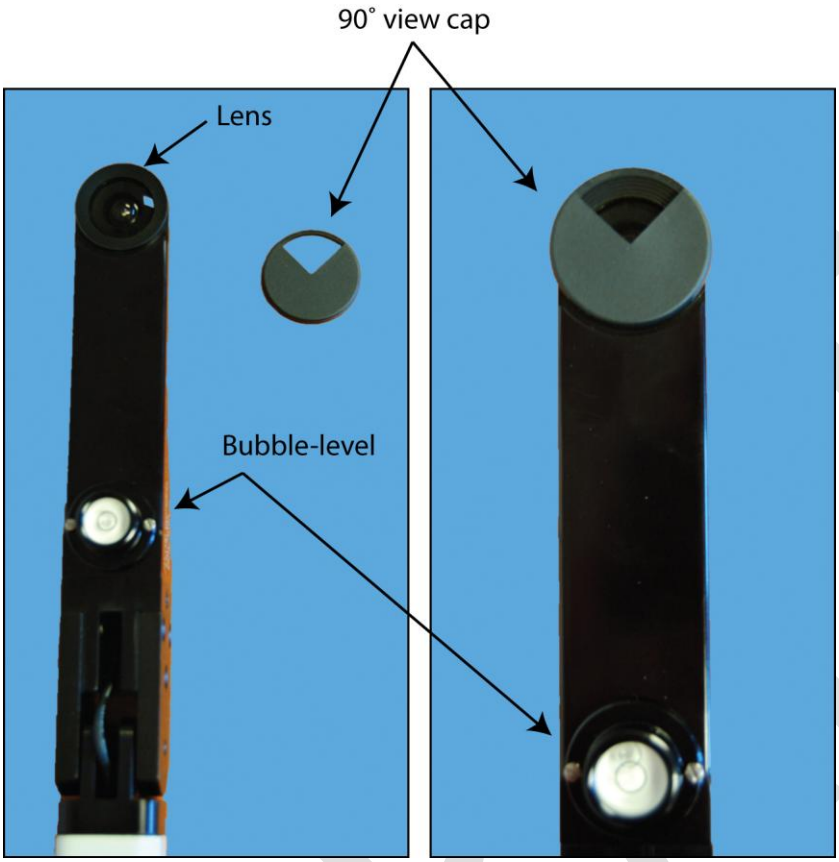

Figure 6. LAI-2200 wand handle, showing the blue "Above" LED lit for above-canopy **A** data collection (left) and off for below-canopy **B** data collection (right).

Figure 7. Leaf area index data collection scheme at a given point along the center-line of an Ecosystem Productivity plot.

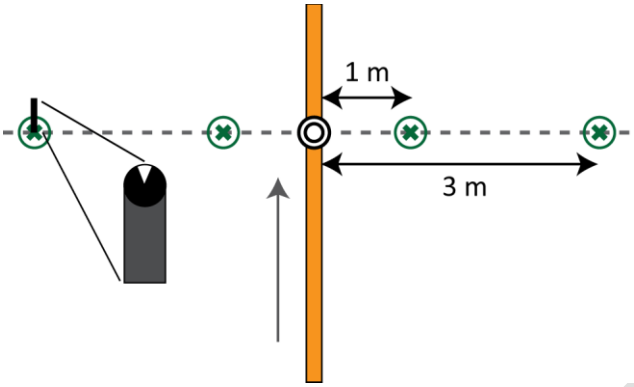

Figure 8. The LAI-2200 wand configured for below-canopy **B** data recording.