

Quality Assurance, Training, and Certification in Ozone Air Pollution Studies

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Uniform, or standard, measurement methods of data are critical to projects monitoring change to forest systems. Standardized methods, with known or estimable errors, contribute greatly to the confidence associated with decisions on the basis of field data collections (Zedaker and Nicholas 1990). Quality assurance (QA) for the measurement process includes operations and procedures so that the data are of the specified quality within a stated level of uncertainty. Quality is acceptable when data are consistent, lack uncertainty, and meet users' needs. Some of the elements of a QA plan for ozone air pollution studies are proposed for use in the interagency project, Forest Ozone REsponse STudy (FOREST).

Site Data

Site data variables should be obtained by at least a crew of two independent observers. A third observation can be obtained by an individual who has acted as a trainer. Each measured variable should be determined to ± 10 percent (Zedaker and Nicholas 1990), and evaluations of categorical elements (forest type/community) should be determined after experienced observers agree on the following variables:

<i>Estimated or measured</i>	<i>Categorical definitions</i>
topo map location	landform type
azimuth	slope position
latitude	microrelief
longitude	aspect
elevation	forest type (3 main species)
percent slope	land use
site class	understory vegetation
	description, plot locator tree

To ensure that data collection meets the acceptable data quality objectives, the FOREST project cooperators should perform or delegate the remeasurement of plot variables on one of three plots established around each ozone monitor. The percent frequency of misclassification or greater than 10 percent difference in measured variables should be recorded. An independent remeasurement by the QA crew should also be done by expert crews.

Tree Data

To ensure that data collection meets the acceptable data quality objectives, the FOREST project cooperators should perform or delegate the remeasurement of tree variables on 10 percent of the trees in each plot. The percent frequency of misclassification or greater than 10 percent difference in measured variables should be recorded. An independent remeasurement by the QA crew should also be done. The tree data collection should include the following variables and their acceptable limits:

Data Quality Objectives and Quality Assurance

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Species	agreement by at least two observers
Crown position	agreement by at least two observers
Percent bare rock	± 10 percent
Tree height	± 1.0 m
Percent live crown	± 5 percent
DBH	± 0.2 cm
Mistletoe	$\pm$ one category (out of six total)
Conks	agreement by at least two observers of $\pm$ one category
Beetles	agreement by at least two observers of $\pm$ one category
Witches brooms	agreement by at least two observers of $\pm$ one category
Fire scars	agreement by at least two observers of $\pm$ one category
Mechanical injury	agreement by at least two observers of $\pm$ one category
Lightning scars	agreement by at least two observers of $\pm$ one category

Branch and Whorl Data

Each field season the following branch and whorl variables should be remeasured by a trained QA monitor, chosen by the cooperators. The QA monitor must be a Certified Data Collector, but should not be a member of the crew that did the original measurements.

Foliated length	± 1.5 cm
Number of whorls	± 1
Chlorotic Mottle	± 1 class
Retention	± 1 class
Needle length	± 1.5 cm
Biotic injury	± 1 category
Abiotic injury	± 1 category

Procedures require that the crew has numbered each branch and returned them to the shady side of the tree from which they were cut. The following steps should be followed on each of the three plots to assure consistent quality data collection:

- At the end of each field sampling day, two trees should be randomly selected from the total scored that day, until five QA trees have been identified for each plot.
- From the two trees selected that day, two branches should be randomly selected.
- Each branch should be tagged with plot and tree number. The branch number should already be written on the cut end of the branch, and it should still be legible.
- The branches should be bagged in plastic and kept refrigerated until all five QA trees have been scored for one plot.
- The 10 branches should be boxed and insulated with paper or equivalent material.
- Boxes of branches should be mailed to the QA monitor. Include data printouts or copies of data sheets for those branches.

The independent QA monitor reports the results of the remeasurements to the individual cooperators. Results for all cooperators/plots should be summarized in a report. This information should be used to either accept or

reject data sets collected in a given year. It should be reviewed at an annual debriefing meeting in which representatives from field crews should determine their needs for additional training.

Training and Certification

At least one member of each data collection crew will be a Certified Data Collector. A Certified Data Collector will have successfully completed at least one full session of training (2 days classroom, 1 field) and returned for the current year's field training day (second day of the full session). Only a Certified Data Collector may score branches.

The yearly training session should be scheduled no more than 1 month before the first crew is to begin collecting data, which has been specified as no earlier than the first week of August. The training session will consist of 1 full day in the classroom and 1 full day in the field. New trainees will attend both days; returning crews will be required to attend only the second (field) day. The classroom day will begin with presentations of the purpose of project FOREST and overviews of the data collection methods. In the afternoon, sub-groups will rotate between trainers to receive hands-on training in scoring branch and whorl variables.

The field day will begin with training on tree variables to be collected that year, demonstrations of cutting branches, and a review of QA procedures. Each sub-group will be assigned two trees from which they will cut two branches. Each member of the crew will score the branches. The groups will rotate to the next two trees (branches pre-cut by the previous group will be left at the base of the tree). After most of the day has been occupied with practice and questions, the students will evaluate different trees for DBH, height, percent live crown, etc. Branches already measured and evaluated for ozone injury will be presented to students as a test. The trainee's data sheets will be corrected against the instructor's results using the data quality standards. Any trainee who is not within acceptable QA limits will be retrained in the problem area and retested.