TREE CORING AND INTERPRETATION

CONTENTS

SUPERCEDES: SOP #2036; Revision 0.0; 01/24/92; U.S. EPA Contract EP-W-09-031.

1.0 SCOPE AND APPLICATION

This standard operating procedure (SOP) describes the method for the extraction of a wood core using an increment borer and the interpretation of annual growth rings. This analysis will be used in conjunction with other plant ecological, physiological and toxicological techniques used to assess the impact of contaminants on plants. Included below are procedures for obtaining representative samples, quality assurance/quality control measures, and proper documentation of sampling activities.

Tree-ring analysis may be applied to the assessment of contaminant disturbance on woody vegetation. It is possible to date specific ecological events by their association with dated ring-structures. Tree-ring analysis may be used to determine a precise date for the onset of tree growth decline, perhaps pinpointing the identification of the triggering stress. Additionally, the extent and degree of growth reduction can be quantified.

These are standard (i.e., typically applicable) operating procedures which may be varied or changed as required, dependent upon site conditions, equipment limitations or limitations imposed by the procedure. In all instances, the ultimate procedures employed should be documented and associated with the final report.

Mention of trade names or commercial products does not constitute U.S. Environmental Protection Agency (U.S. EPA) endorsement or recommendation for use.

2.0 METHOD SUMMARY

After review of background information (i.e., site information, previous assessments, climatic factors, and environmental conditions) target trees will be chosen. Tree cores will be taken at breast height (1.4 meters above ground), placed in sample containers, labeled and documented. Cores will be stained, if necessary, to facilitate the enumeration and measurement of annual growth rings. Tree-ring analysis will be performed and an associated interpretation prepared. This procedure can be utilized throughout the year.

3.0 SAMPLE PRESERVATION, CONTAINERS, HANDLING, AND STORAGE

Core samples will be placed in individual plastic soda straws and resealable plastic bags. Cores will be interpreted as soon as possible after collection. If a delay must occur before sample processing, cores will be refrigerated (1^{o} to 5^{o}C) or frozen (-10^{o} to 0^{o}C).

4.0 INTERFERENCES AND POTENTIAL PROBLEMS

There are several potential problems and interferences that may occur when using an increment borer.

1. Site access must be obtained.

2. Target trees must be accessible without risk to the sampler.

3. The increment borer may become jammed in the target tree and may be extremely difficult to remove.

4. Microclimatic differences on a site such as variation in light, temperature, and moisture will affect tree growth and may mask effects of contaminants.

5. Improper selection of sample collection location, sample trees, and tree species may result in the collection of inadequate data.

5.0 EQUIPMENT/APPARATUS

Equipment needed for tree coring include:

- Increment borers. The increment borer consists of three parts; the handle, the borer bit, and the extractor. When not in use, the bit and extractor fit inside the handle. Borer bits of various sizes may be used. A borer bit of 5 mm diameter in a range of lengths (such as 6, 12, and 18") should be sufficient for purposes described here. Figure 1 (Appendix A) illustrates an increment borer.
- Beeswax block
- Plastic soda straws (1/4" diameter)
- Resealable plastic bags
- Field guide(s) of native trees
- Commercial spray lubricant, WD-40
- Tree wound paint
- Documentation supplies (i.e., field data sheets, chains of custody records, custody seals, logbook, and markers)
- Stereoscopic microscope
- Staining supplies and a fluorescent lamp (optional - required only when staining core samples, Section 7.2.3)

6.0 REAGENTS

A staining solution of 1% phloroglucinol in 95% ethyl alcohol (i.e., one gram of phloroglucinol in 95% ethanol) and a rinse solution of 50% aqueous hydrochloric acid makes growth rings more distinct, facilitating the task of counting and measuring the annual rings (Section 7.2.3). However, this procedure is not always required.

Additionally, if analysis of core samples is required, equipment must be decontaminated.

Decontamination solutions are specified in ERT/SERAS SOP #2006, Sampling Equipment Decontamination.

7.0 PROCEDURES

7.1 Sampling Considerations

7.1.1 General Site Survey

Prior to initiation of any sampling procedure, the appropriate sample collection area and species to be sampled must be determined. This may be accomplished with the assistance of remote sensing and/or topographic maps as well as with historical site information from available reports. Field guides to the regional tree species and experts knowledgeable about local conditions should be consulted. The extent of contamination should be established and a generalized vegetation map of the area of concern formed. When appropriate, core boring activities should be performed in conjunction with the

ERT/SERAS SOP #2037, Terrestrial Plant Community Sampling. Consideration must also be given to the location of specific sampling points so that they provide representative samples (Section 7.1.2).

7.1.2 Representative Samples

Trees to be cored should be of the same species growing under identical environmental conditions, in order to obtain representative samples. Attempts should be made to minimize as many noncontaminant-related factors as possible by using within-site replicates from trees of the same species, age, and stand history.

Improper selection of location, individual trees, and tree species to be sampled will result in collection of inadequate data. Young trees generally have too few annual rings to provide adequate information, thus they should not be sampled. Trees of subtropical and tropical locations may not produce annual rings as there may be a continual growing season, thus collection from these species should be avoided. Trees in extremely arid conditions or those at the limits of their ecological range produce false or missing annual rings and must not be used. Fritts and Swetnam(1) discuss additional considerations that are involved in choosing locations, species, and individuals to be sampled. Success depends upon proper sample selection which is reflected in how skillfully the sampling sites and trees have been chosen. The responsibility for development of a sampling strategy and selection of sampling sites must be delegated to trained dendroecologists.

Samples must be collected from a reference location as well as contaminant areas. The reference location must be chosen with consideration given to ecological similarity to the contaminated site. If a representative reference location is not located or is not sampled, data interpretation will be severely limited.

7.2 Sample Collection

Prior to boring a tree, several items should be considered to facilitate the procedure as well as to maintain the efficiency and extend the life of the increment borers. These include lubrication and cleaning of the bit (refer to the last step in the boring procedure below).

When boring, the tool should be aligned in a plane that is at a right angle to the longitudinal axis of the tree trunk and placed so that the bit will extend into the center of the tree. In any other alignment, the annual growth rings observed in the core will be distorted and could result in erroneous growth rate analysis. Additionally, select straight trees to prevent boring into compression or tension wood. Tension and compression wood are types of reaction wood that form within the tree from assaults such as gravitational pressure or insect damage. For example, a tree leaning to the north will have compression wood on the north and tension wood on the south. The borer may be locked into the tree by the force of compression wood while tension wood does not usually have representative ring widths. Therefore, boring would be completed on the east or west side of the tree in the example, if an alternate tree was not available.

7.2.1 Increment Boring Procedure

1. Remove the borer bit and extractor from inside the handle and assemble the handle and bit by pushing the locking latch away from the handle and inserting

the square end of the borer bit into the handle. Return the locking latch completely around the bit and tighten the locking latch screw.

2. Apply beeswax to the threads and shank, completely covering the outer surface.

3. Align the borer bit and handle so that the bit will penetrate through or towards the center of the tree and at right angles to the longitudinal axis of the tree. Place the bit threads against the tree, at breast height, preferably in a bark fissure where the bark is thinnest. Hold the threaded end steady with one hand while pushing forward on the handle and turning to the right. Turn until the threads penetrate the wood enough to hold the bit firmly in place.

4. Place both hands, palms open, on the ends of the handle and turn clockwise until the bit reaches the desired depth, attempting to drive through the absolute center of the tree.

5. Insert the full length of the extractor, concave side up. Then turn the handle one-half turn counterclockwise to break the core from the tree and also to turn the extractor.

6. Pull the extractor from the borer bit. The core will be resting in the concave side of the extractor, held in place by the toothed edges at the tip. Remove the borer bit from the tree before examining the core sample. If unsatisfactory results are obtained (broken core, unclear core, or incorrect placement), repeat the preceding procedures on another nearby section of the tree.

7. Paint the wound with tree wound paint, covering the open hole.

8. Slide the core sample into a plastic soda straw and label accordingly. Several straws may be taped together end-to-end if the core sample is long. Place each sample in a labeled resealable plastic bag. Store the cores in a refrigerator to discourage mold growth or freeze them until examination takes place.

9. At the end of each working day, the borer and extractor should be sprayed with WD-40. This will remove resinous deposits and prevent acid-etching of the borer by residual sap. Sprayed surfaces should then be wiped with a clean cloth. The inside of the bit should also be lubricated. A piece of cotton ball fastened onto a rod and coated with lubricant works well in coating the inner surface. WD-40 is acceptable for use <u>only</u> if the tree cores are not to be chemically analyzed or if the components of this lubricant will not interfere will the interpretation of the chemical analysis results.

7.2.2 Special Considerations for Chemical Analysis

Chemical analyses can be carried out on whole or specific segments of core samples for contaminants of concern. Special considerations for core samples collected for chemical analysis include:

- Decontamination of increment borer bit and extractor will be required to prevent cross-contamination of samples. The decontamination procedure will follow that of ERT/SERAS SOP #2006, Sampling Equipment Decontamination.

- Core holders (i.e., straws or foil) and gloves that will come in contact with the sample tissue to be analyzed must be clean and free of all contamination that would interfere with the chemical analysis.

- Preservation and storage procedures may be altered, depending upon the analyte determined. These procedures will be documented in the site-specific sampling plan.

Additional considerations on species selection must be made. Radial movement of compounds within the wood in many tree species can greatly complicate the evaluation of elements/compounds in tree rings. Also, larger bore diameters may be required to collect sufficient material for analysis.

7.2.3 Use of Phloroglucinol

Annual rings may be difficult to distinguish in a sample core due to species-specific characteristics such as in diffusely porous species (for example, Nyssa sylvatica and Liriodendron tulipifera). Irregularities within the tree due to climatic or site influences may also create difficulty in ring evaluation. In these instances, sample cores may be stained with phloroglucinol solution which stains the lignin of the wood red and leaves the cellulose unstained, therefore making the growth rings more distinct. Two solutions are required: a solution of 1% phloroglucinol in 95% ethyl alcohol and a solution of 50% aqueous hydrochloric acid.

Procedure:

1. Soak sample cores in phloroglucinol solution for one minute.
2. Place cores in hydrochloric acid solution.
3. Remove the cores from the acid solution when they begin to turn red (approximately one minute), then rinse carefully in water.
4. Allow the cores to dry.
5. Examine under fluorescent light. Growth rings will become more distinct as the core sample dries.

7.3 Core Sample Interpretation

Dendrochronology is the science of dating past events by the study of the aging of trees. Past events which may be dated through tree-ring analysis include drought, fire, and chemical waste discharge. The fundamental principle of dendrochronology is cross-dating: the correlation of growth patterns among trees for a given sequence of years. Cross-dating is performed by dendrochronologists who have had many years of experience and training. After consultation with a dendrochronologist has been made concerning the scope of work, core samples may be sent to the associated research laboratory/institution for analysis.

After a brief introduction and training period, some interpretation of tree cores, such as determining tree ages, may be made. Tree age is measured in a core sample by the enumeration of annual rings from the center of the tree to the bark. To accurately interpret growth rings, it is necessary to obtain information on the variation in growth ring formation for the species studied. Some trees may form more than one ring per year. Difficulties in interpretation occur when growth stressors such as drought, fire, and temperature extremes interrupt the annual ring formation cycle.

Difficulties in interpretation also occur when multiple rings form from temporary interruptions in the annual growth cycle, such as with a late spring frost. Therefore, environmental changes as well as the passage of time are reflected in growth rings. Local historical climatic data may be available for the study area and should be utilized in growth ring interpretation when available.

8.0 CALCULATIONS

No calculations are required for successful completion of the increment boring. Some calculations may be necessary when interpreting core samples; refer to Innes and Cook (1989), Fritts and Swetnam (1989), and Sheppard et al. (1988).[(1),(2),(3)]

9.0 QUALITY ASSURANCE/QUALITY CONTROL

The following quality assurance/quality control procedures apply:

1. All data must be documented on field data sheets or within field/site logbooks.
2. All instrumentation must be operated in accordance with the operating instructions supplied by the manufacturer, unless otherwise specified in the work plan. Equipment checkouts and calibration activities must occur prior to sampling/operation and they must be documented.
3. Samples will be collected from uncontaminated reference sites for comparison to those collected from contaminated areas.
4. A sampling plan, including sample size, will be created prior to sampling.
5. Results will be checked by an experienced dendrochronologist.
6. Adequate numbers of samples must be collected to assure correct chronology. Some preliminary sampling may be required to assess the variation found at a specific site and/or in a specific species so that sufficient sample size can be determined.

10.0 DATA VALIDATION

The data generated will be reviewed according to the quality assurance/quality control considerations listed in Section 9.0.

In addition, taxonomic information will be confirmed on-site by a biologist familiar with the vegetation of the selected site(s).

11.0 HEALTH AND SAFETY

When working with potential hazardous materials, follow U.S. EPA, OSHA, and corporate health and safety procedures.

Care must be taken to avoid the sharp threads of the borer bit. Proper handling and conscientious labor are required.

When sampling at a known or suspected contaminated site, precautions must be taken to safeguard the samplers from chemical and physical hazards. In addition, it would benefit the sampler to be familiar with and avoid any contact with plants that present a contact hazard such as poison ivy, poison sumac, and poison oak.

12.0 REFERENCES

(1)Fritts, H.C. and T.W. Swetnam, "Dendroecology: A tool for evaluating variations in past and present forest environments," Advances in Ecological Research, Vol. 19, 1989, pp. 111-188.

(2)Innes, J.L., and E.R. Cook, "Tree-ring analysis as an aid to evaluating the effects of pollution on tree growth," Canadian Journal of Forest Research, Vol. 19, 1989, pp. 1174-1189.

(3)Sheppard, P.R., J.E. Means, and J.P. Lassoie, "Cross-dating cores as a nondestructive method for dating living, scarred trees," Forest Science, Vol. 34, No. 3, September 1988, pp. 781-789.

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APPENDIX A
Figures
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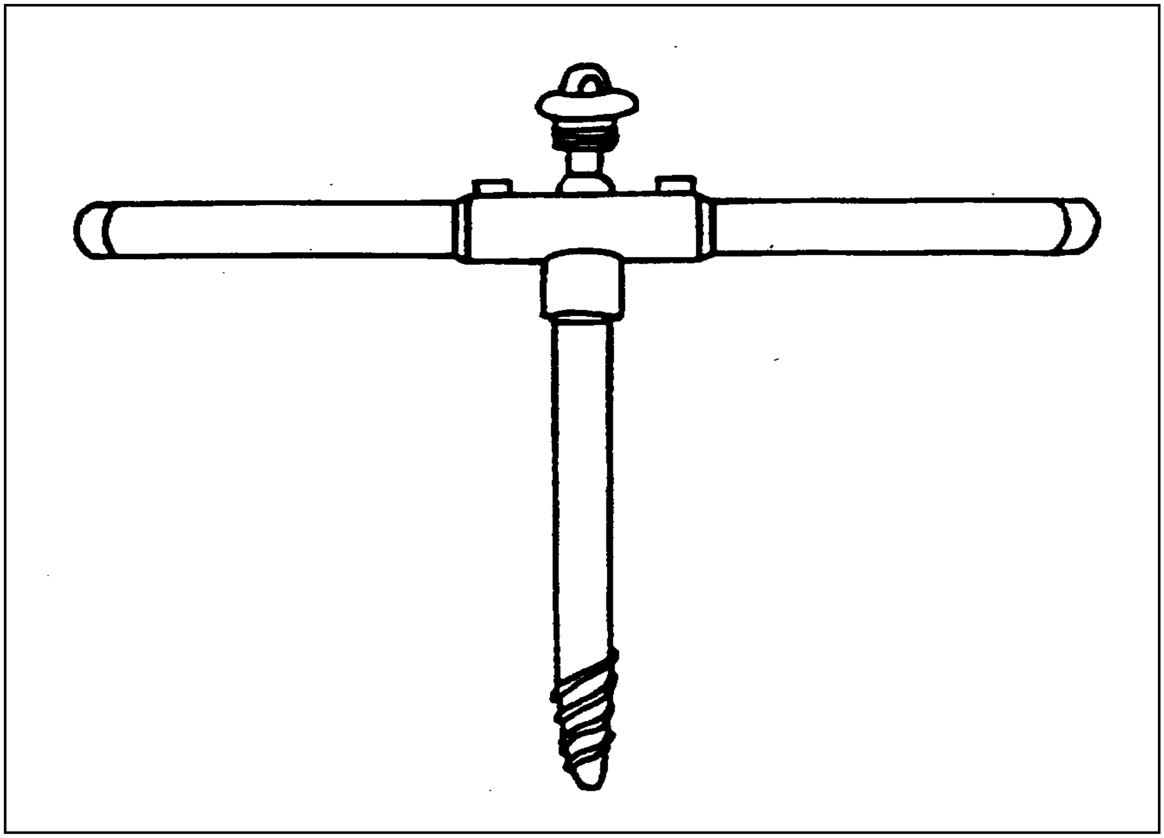
FIGURE 1. TYPICAL INCREMENT BORER



Note that, although not clearly illustrated above, the borer bit is a hollow tube threaded at the boring end. (Source: Bonham, C.D., "Measurements for terrestrial vegetation," John Wiley & Sons, New York, NY, 1989, p. 45.)