TERRESTRIAL PLANT COMMUNITY SAMPLING

CONTENTS

SUPERCEDES: SOP #2037; Revision 0.0; 01/24/92; U.S. EPA Contract EP-W-09-031.

TERRESTRIAL PLANT COMMUNITY SAMPLING

1.0 SCOPE AND APPLICATION

This standard operating procedure (SOP) describes the method for sampling terrestrial plant communities on hazardous waste sites. Analysis of vegetation will be used, in conjunction with other bioassessment techniques, to assess the impact of site contamination on plant life. Vegetation will be evaluated for shifts in community structure as a function of site contamination. Included below are procedures for obtaining representative measurements and guidance on quality assurance/quality control measures.

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

The use of this SOP is dependent on weather and season. Non-woody plants will not endure throughout a winter with freezing temperatures, and thus cannot be evaluated by these methods during this part of the year in such climates.

A survey of site history will be made with all readily available information. Information on site contaminants, site and regional vegetation, and local climatic conditions will be considered. Remote sensing and topographic maps, when available, will be obtained and reviewed. Information on rare and endangered flora that may exist within the study areas should be obtained and reviewed.

Plots and transects are used to collect information representative of vegetative communities of the study site. Choice of appropriate sampling technique (i.e., plots vs. transects) depends upon site characteristics, plant characteristics, and study objectives. Information concerning species identification, enumeration, spatial arrangement, and size/shape attributes of the vegetation will be recorded in logbooks and on field data sheets. Signs of stressed vegetation will be noted. Samples representative of study location flora will be gathered for taxonomic verification. Values for species density, coverage, and frequency will be computed, as necessary.

3.0 SAMPLE PRESERVATION, CONTAINERS, HANDLING, AND STORAGE

Samples of vegetation may be required for taxonomic verification. Whole plants or selected parts (i.e., leaves, twigs, or flowers) will be placed in a resealable plastic bag and kept cool (4°C) to slow decay. All materials, with the exception of woody specimens, should be kept from temperature extremes and should be identified as soon as possible. If more than a week will pass before the samples can be identified, the samples will be placed in a plant press. Samples may also be archived by placing them in a plant press after identification.

4.0 INTERFERENCES AND POTENTIAL PROBLEMS

There are several potential problems and interferences that may occur when sampling plant communities.

1. Access to study locations must be obtained prior to study commencement.

2. Environmental disturbances, such as drought or fire, may confound data collection and interpretation. In addition, physical disturbances by man, such as the mowing or trampling of site vegetation, will further complicate assessment.

3. Microclimatic differences, such as sun/shade and moisture/drought, will affect plant growth and response.

5.0 EQUIPMENT/APPARATUS

Equipment needed for plant community sampling may include, depending upon the study objectives, the following items:

- Stakes - with sufficient height to be observed and sufficient width to stay in place during the period of study
- Line or rope
- Tape measure and/or plot frames
- Shovels and hand trowels - both of which must have unpainted stainless steel blades
- Pruning shears and/or knives
- Resealable plastic bags
- Cooler with ice
- Regional field guides to native plants
- Compass
- Vernier calipers
- Clinometer (optional) - necessary when measuring tree heights
- Documentation supplies (includes logbook, chain of custody records and custody seals, field data sheets and sample labels)
- Plant press (optional)

6.0 REAGENTS

Reagents are not required for preservation of vegetation samples. Samples should, however, be cooled to 4°C in order to minimize the degree of deterioration. Decontamination of sampling equipment may be required. 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 vegetation sampling, the appropriate sample collection area(s) should be determined. This may be accomplished with the assistance of remote sensing and/or topographic maps. Field guides to the regional vegetation species and experts

knowledgeable about local conditions should be consulted. The extent of contamination should be established.

Consideration must also be given to the location of specific sampling points so that they provide representative samples (Section 7.1.2). The presence of rare or endangered species should also be determined and care taken not to adversely impact these communities during site activities.

A site sampling plan which details the number and general areas to be assessed will be prepared prior to plant community sampling activities.

7.1.2 Representative Samples

For representative sample collection, seasonal community fluctuations should be determined and climatic patterns analyzed. Topography and soil types should also be considered.

Sampling of vegetation should occur during seasons of the year where the species of interest are present. For example, if a complete vegetation survey were to be performed, plant assessment may be required over several seasons. If the species of concern were annuals, vegetation study should occur during the growing season while these species display characteristics that can be observed. Additionally, depending upon the study objectives, it may be necessary to survey plant communities several times during the growing season or throughout the year.

7.2 Sample Collection

The ecological parameters of density, coverage, and frequency reflect vegetational community structure and are those that are discussed in this SOP. Additional information may be collected for use in studies of plant community structure. Additional parameters useful in determining and comparing plant community structure include diversity and similarity indices. These parameters will not be addressed in the present SOP; however, measurements used to calculate these parameters may be collected at the same time as sampling activities described in this SOP. For a description of these additional parameters, refer to Brower and Zar.[(1)]

The size, shape, and number of vegetation sample locations ultimately depends upon the vegetation type present (i.e., herb, shrub, tree, vine, etc.) and their distribution pattern. Basically, there are two general approaches to plant community sampling: plots/quadrats and transects.

7.2.1 Sample Plots/Quadrats

A sample plot or quadrat is the specific area within which vegetation analysis will occur. The number, size, shape, and location of sample plots will depend upon the types of vegetation to be sampled and the objectives of the study. For example, smaller plots may be required for a site with dense or rich flora.

Typically, rectangular or circular plots are used. Circular plots are easy to set up. They require only a stake and premeasured line (or measuring tape). Circular plots are often

used in the assessment of woody species. However, rectangular plots have been found, in general, to yield better results for plant surveys.(1) Rectangular plots require at least four stakes and a plot frame of desired size (or measuring tape and a means to make right angles) to be constructed.

The following procedure will be followed when surveying plant communities:

1. Divide vegetational areas of the site to be assessed into a grid. If soil/sediment sampling is also performed, it is most efficient and advantageous to use the same sample location grid for both soil/sediment sampling and plant community assessment. When vegetation is collected for analysis, use of the same grid locations will provide the potential for comparison of contaminant concentrations in the soil/sediment and the vegetation.

2. Select locations for a predetermined number of plots (as described in the site sampling plan) using randomly-selected grid coordinates. (X and Y coordinates can simply be paced out from the appropriate axis.)

3. Establish plots according to study objectives and the following vegetation classifications:

    a. Closely Spaced Herbs - [plants of less than 1 meter (m) in height]use a rectangular plot of 1 m^2 (for example, 1.0 m x 1.0 m)

    b. Bushes/Saplings/Shrubs - [woody plants with height greater than 1 m and main stem diameter of less than 10 centimeters (cm), excluding vines] use a plot area of 10 m^2 (for example, 2.5 m x 4.0 m)

    c. Trees - [any non-climbing woody plants with main stem diameter at breast height (DBH) of greater or equal to 10 cm. (DBH = 1.5 m above ground level)]identify each tree within a 10 meter radius of the selected center point of the sample plot

    d. Woody Vines (Lianas) - (woody climber with DBH of less than 10 cm) identify each vine within a 10 meter radius of the selected center point of the sample plot (usually associated with tree plots)

4. Identify and count species in each plot.

5. Estimate species coverage within plot area. Measure DBH for tree species, when applicable, to calculate basal area form which cover estimates are made.

6. Note visual cues of stress and overall health of plot vegetation (including wilting, browning, stunted growth, chlorosis, etc.).

7. Note habitat characteristics (for example, moisture availability, degree and direction of exposure of slope, tidal location, etc.).

8. Collect vegetative samples from each plot, as necessary, for taxonomic verification. Store samples as described in Section 3.0.

9. Repeat the above procedures for an uncontaminated reference area during the same period of study.

10. Perform appropriate calculations (Section 8.0) and appropriate statistical analyses upon the data.

11. Prepare generalized vegetation map showing plant communities and sampling locations.

7.2.2 Transect Sampling

When the use of plots is impractical, transects may be used. Transects are especially useful in the evaluation of transitional communities. Ecological parameters that are studied utilizing plots can be studied utilizing transects. Additionally, changes in the vegetation in relation to environmental gradients may be observed. The type, size, number, and locations of transects chosen will depend upon study objectives, vegetation type, and site characteristics. Longer transects should be made when plants are widely dispersed.

Types of transects include belt transects and line intercept transects. A belt transect is a line transect with width. It is essentially a long, thin quadrat or can be divided into zones (each of which act as plots). In the line intercept method a known length of rope or tape measure is laid out in a line and information is collected as vegetation intercepts the line. The line intercept method is particularly useful for surveys of shrubs. This method is used for vegetative cover estimates and species composition estimates. With this method, only estimates of linear density can be made, as area is not involved.

The following procedure applies to plant community sampling using transects:

1 Determine which transect method best suits the objective(s) of the study and habitat available.

2 Establish transects according to the study objectives and the appropriate transect method:

a. Belt transect

- ·establish transect length and width
- locate belt transect(s) randomly in the selected study area(s) or with bias along a specific gradient or feature of interest
- identify and count species
- estimate coverage and measure DBH (on woody species, when required) within plot(s)

b. Line intercept

- · establish transect length
- Short lines (under 50 m) are used for assessment of herb species
- Long lines (greater than 50 m) are used for assessment of some shrub and tree communities
- locate transect line(s) randomly in the selected study area(s) or with bias along a specific gradient or feature of interest
- divide transect line into equal intervals
- record the length of the line intercepted for each plant intercepting the line
- count, measure, and identify plants that either intercept the transect line or are within a small distance from the line, depending upon the density of the vegetation

3. Note visual cues of stress and overall health of plot vegetation (including wilting, browning, stunted growth, chlorosis, etc.).

4. Note habitat characteristics (for example, moisture availability, degree and direction of exposure of slope, tidal location, etc.).

5. Collect vegetative samples from each transect, as necessary, for taxonomic verification. Store samples as described in Section 3.0.

6. Repeat the above procedures for an uncontaminated reference area during the same period of study.

7. Perform appropriate calculations (Section 8.0) and appropriate statistical analyses upon data

8. Prepare a generalized vegetation map showing plant communities and sampling locations.

7.3 Sample Collection Variation

Taxonomic identification to the species level is often required for the vegetation assessment methods described. When no such knowledge is desired and/or available, a generalized physiognomic approach may be utilized. Physiognomy is the study of form, structure, and spatial arrangement of an organism. The resulting data may be sufficiently detailed and organized and can be collected comparatively rapidly.

Physiognomic characteristics that may be observed and documented include:

- Life form - presence, dominance, or absence of specific structural life forms (herbs, trees, vines, etc.)
- Stratification and zonation - layers of vegetation from the ground-layer to the canopy
- Foliage density - amount of shading vs. light penetration
- Coverage - sparse (less than five percent coverage) to dense (greater than 75% coverage)
- Dispersal pattern - arrangement of species (rows, clumps, solitary, etc.)
- uniformity (evenly-spaced vs. irregularly distributed) –

- spacial separation (distant vs. dense)

8.0 CALCULATIONS

8.1 Calculations for Plots and Belt Transects

Density for Species i (D_i)

$$D_i = n_i / A$$

where:

n_i = total individuals for species i
A = total area sampled

Relative Density for Species i (RD_i)

$$RD_i = n_i / \sum n$$

where:

n_i = number of individuals of species i
Σn = total number of individuals of all species in sampled plots

Coverage for Species i (C_i)

$$C_i = a_i / A$$

where:

a_i = total area covered for species i
A = total area sampled

Relative Coverage of Species i (RC_i)

$$RC_i = C_i / \sum C$$

where:

C_i = coverage for species i
ΣC = sum of coverage for all species

Frequency of Species i (f_i)

$$f_i = j_i / k$$

where:

j_i = number of plots containing species i
k = total number of plots

Relative Frequency of Species i (RF_i)

$$RF_i = f / \sum f$$

where:

f_i = frequency of species i
Σf = sum of frequencies of all species

8.2 Calculations for Line Transects

Linear Density Index of Species i (ID_i)

$$ID_i = n/L$$

where:

n_i = number of individual of species i
L = total length of all sampled transects

Relative Density for Species i (RD_i)

$$RD_i = n_i / \sum n$$

where:

n_i = number of individual of species i
Σn = total number individuals of all species in sampled transects

Linear Coverage Index of Species i (IC_i)

$$IC_i = I/L$$

where:

l_i = sum of intercept lengths intercepted by species i
L = total length of all sampled transects

Relative Coverage of Species i (RC_i)

$$RC_i = I_i / \sum I$$

where:

l_i = sum of intercept lengths intercepted by species i
Σl = sum of intercept lengths for all species intercepting transects

Frequency of Species i (f_i)

$$f_i = j_i / k$$

where:

j_i = number of intervals containing species i
k = total number of intervals on transects

Relative Frequency of Species i (RF_i)

$$RF_i = f_i / \sum f$$

where:

f_i = frequency of species i
Σf = sum of frequencies of all species

8.3 Additional Calculation for Tree Species

Basal Area at Breast Height (A), calculated for each tree

$$A = \pi r^2$$

where:

pi = 3.1416
r = radius (in cm)

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 as supplied by the manufacturer, unless otherwise specified in the work plan. Equipment checkout and calibration activities must occur prior to sampling/operation and they must be documented.
3. Calculations will be checked by an additional person at a rate of ten percent.
4. A sampling plan, including sample size, will be created prior to sampling.

10.0 DATA VALIDATION

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 by a regional biologist familiar with the site's vegetation.

11.0 HEALTH AND SAFETY

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

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 samplers 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]Brower, J.E., and J.H. Zar, "Field and laboratory methods for general ecology," William C. Brown Publishers, Dubuque, Iowa, 1984.

BIBLIOGRAPHY

Bonham, C.D., "Measurement for terrestrial vegetation," John Wiley and Sons, New York, NY, 1989.

Greig-Smith, P., "Quantitative plant ecology," University of California Press, California, 1983.

Kapustka, L.A. and M. Reporter, preparers, "Evaluating exposure and ecological effects with terrestrial plants: Proceedings of a workshop for the US EPA Exposure Assessment Group," United States Environmental Protection Agency, Region 10, Seattle, Washington, August 28, 1991.

Smith, R.L., "Ecology and field biology," 3rd Edition, Harper and Row, New York, NY, 1980.

United States Army Corp of Engineers, "Wetlands delineation manual," Vicksburg, Mississippi, 1987.