PROCEDURE

Warm-Up

Show an artificial flower to the group. What characteristics indicate that it is not alive? Show a living plant and a dried flower to the group. List characteristics of individual living plants and dead plants. List and discuss shared ideas on the board. Come to a consensus on what criteria will be used to determine which wetland plants are alive and which have died.

Activity

With students working in pairs or small groups, try the assessment techniques that seem most appropriate. Suggested grade levels are indicated, with the activities presented in order of increasing skill level. Field guides should be used as needed to identify plant species.

Usually monitoring all plants within a wetland is too difficult a task to accomplish unless the wetland is small. Transects and quadrants provide smaller areas (subsamples) that can be more thoroughly examined. The data gained from the smaller samples can be extrapolated to represent the entire wetland. Several transects throughout the wetland may be established as in the activity *What Grows There?* on page 127. Another option is to mark several scattered one-meter square (or larger) quadrants throughout the wetland using sticks and string, then analyze the plants within the quadrant. Or, if the vegetation is short, a hoop can be tossed randomly into the wetland, and plants within the hoop can be assessed.

In each case, be sure to measure and calculate the area sampled. For a transect or quadrant, use the formula:

$$\textbf{area} = \textbf{length} \times \textbf{width}.$$

For a hoop use the formula:

$$\textbf{area} = \pi r^2, \text{ if the radius is measured, or}$$

$$\textbf{area} = \pi (d/2)^2, \text{ if the diameter is measured.}$$

Grades K-12

A. PHOTOGRAPHIC MONITORING

Photographic monitoring of the entire wetland community is an effective tool for assessing survival. Choose several locations around the wetland to be used as permanent photographic sites. The number of locations depends on the wetland size. Mark these locations with a colored wooden stake, plastic pipe, a large stone, a brick, or some other type of marker that will last for a number of years and will not be moved. If photographs are taken at each site each season on approximately the same date (fall, winter, spring, summer), annual comparison will provide visual evidence of changes occurring in the wetland. Have the plants increased in size? Is there more or less ground covered by plants? Have some species of plants been replaced by invasive species, like common reed, purple loosestrife, or even cattails?

Maintain a photo album of the photographs for yearly comparisons and assessment of any changes. Be sure each photograph is clearly marked with its date and location.

B. PLANT SURVIVAL, PART I
Plants planted in the wetland can be monitored for survival by using the planting plans to locate them, then assessing whether they are alive or dead. Of course, this is only possible during the growing season. Why? (The above-ground parts of many plants appear dead during winter, but the below-ground parts are probably alive.) Record the number of **Live** plants and the number of **Dead** plants of each species on the *Plant Summary* Student Page.

Grades 5-12
C. PLANT SURVIVAL, PART II
Make the following calculations and record the percent survival for the planted wetland plants on the last line of the *Plant Summary* Student Page.

a. Total number of dead plants = ?

b. Total number of live plants = ?

c. Total number of plants planted = number of live plants + number of dead plants = ?

d. Percent loss = number of dead plants ÷ total number of plants = ?

e. Percent survival = number of live plants ÷ total number of plants = ?

f. If some plants died, were they all of the same species? If so, what might have caused the death of this species? Was this species planted at an appropriate location relative to the water level of the wetland?

g. Loss of up to 15% of new plants is acceptable. Were your losses greater? If yes, what might be the cause? Was supplemental water supplied during the first dry season?

h. Have insects, diseases, or herbivores attacked the plants? Plants should be monitored for the presence of disease and attack by such voracious herbivores as geese, deer, nutria, and muskrat. (See *The Dynamics of Wetlands* on pages 24-30.)

D. STEM DIAMETER OR BASAL AREA
Stem diameter is the maximum width of a plant stem. The **Stem Diameter** of most plants can be measured using a ruler and without cutting or injuring the plant. The measurement should be made one inch (2.5 cm) above ground level, because stem diameters usually become smaller higher up on the plant. For trees, the measurement should be made 4.5 feet (1.4 meters) above ground level; this is known as the diameter at breast height, or d.b.h. Be sure to record all measurements on the *Individual Plants* Student Page.

Calculate the **Average Stem Diameter** per plant species by adding all the widths and dividing by the number of plants of that species. Calculate the **Area Sampled** by multiplying the length of the area sampled times the width of the area sampled. Record the calculations on the *Plant Summary* Student Page.

Basal area is the area (A) of the surface of the tree's stump if a tree were to be cut at breast height. (Measuring the basal area of a tree is preliminary to determining how much of the tree can be used as lumber.) To calculate basal area of small trees, when the diameter can be measured, use the formula:

$$A = \pi (d/2)^2$$, where d = diameter and $\pi = 3.14$.

For large trees, measure the circumference 4.5 feet above ground level using a tape measure or string and meter stick. Calculate the **Basal Area** for each tree using the formula:

$$A = c^2 \div 4\pi$$, where c = circumference and $\pi = 3.14$.

Record the **Basal Area** on the *Individual Plants* Student Page.

Calculate the **Average Basal Area** per tree species by adding all the basal area numbers for one species and dividing by the number of trees of that species. For a quadrant, calculate the **Area Sampled** by multiplying the length of the area sampled times the width of the area sampled. Be sure to record these calculations on the *Plant Summary* Student Page.

E. PLANT HEIGHT
Plant height is the distance from the ground at the base of the plant to the very top of the plant. **Plant Height** (H_t) can usually be measured directly using a meter stick. Record measurements on the *Individual Plants* Student Page.

The size of shadows on a sunny day can be utilized in a ratio to determine the height of tall shrubs and trees. Students must measure their own height, the length of their shadow, and the length of the tree's shadow. The height of each tree (H_t) will equal the student's height (H_s) times the length of the tree's shadow (L_t) divided by the length of the student's shadow (L_s).

$$H_t = H_s \times L_t \div L_s$$

If several trees are to be measured, have students measure all of the tree shadows and one student shadow at the same time. Why would this be important? (Shadow length changes over time; so measuring all shadows at the same time allows greater accuracy.)

Now calculate the **Average Height** per species by adding all of the heights together and dividing by the number of plants. Also calculate the **Area Sampled** by multiplying the length of the area sampled times the width of the area sampled. Record this data on the *Plant Summary* Student Page for comparison in following years.

F. PLANT COVER
Cover is the area of ground covered by a plant's shadow at noon. This is called canopy cover if tall shrubs and trees are being measured. Measure the widest diameter (d) of the plant's shadow at noon, then calculate the area (A) using the formula:

$$A = \pi (d/2)^2$$

Measurements need not be made at noon, but may be estimated at any time by looking down at smaller plants (see **Figure 10.1a**) or up at the canopy of taller plants, then placing small sticks in the ground to mark the area that would be covered by the plant's shadow at noon (see **Figure 10.1b**). Ignore small gaps between branches. Record the diameter measurements (**d**) and calculations of the area covered (**A**) on the *Individual Plants* Student Page. Calculate the **Average Area of Cover** for each species by adding the areas and dividing by the number of plants. Calculate the **Area Sampled** by multiplying the length of the area sampled by the width of the area sampled, then record the data on the *Plant Summary* Student Page for comparison in future years.

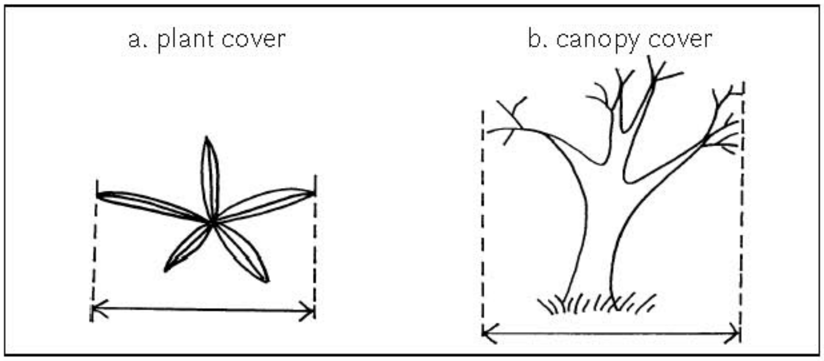

Figure 10.1 **(a)** Looking down on shorter plants, measure the diameter of the area that would be shaded at noon. **(b)** Looking up at the taller plants, mark on the ground where the outermost edges of the shadow would be if the sun were directly overhead at noon. Measure the diameter of the area marked on the ground.

<u>Grades 7-12</u>

G. PLANT BIOMASS

Biomass is the dry weight of part or all of a plant. The process used to determine biomass is a destructive process that should only be used for specific plant parts or representative plants (for example, three cattails out of a stand of thirty). Depending on the species of plant and the comparisons to be made, biomass can be measured for the above-ground parts, the below-ground parts, flowers, seeds, leaves, or stems.

First collect all of the plant parts or plants to be evaluated. Measure the **Wet Plant Biomass** for each individual plant (or the parts from a plant). Use a measuring balance that is appropriate for the mass and size of the plant. Tall plants may be cut into pieces, each piece weighed, then the weight of the pieces totaled. Place each plant (or its parts) in a brown paper bag and label it. Dry them very slowly in a warm (not hot) oven, until their mass is the same for two consecutive dry measurements. Record the **Dry Plant Biomass** on the *Individual Plants* Student Page. Calculate the **Average Biomass Per Plant** for each species by adding the biomass and dividing by the number of plants. Record the information on the *Plant Summary* Student Page.

Wrap-Up

Store all the data collected in this activity to compare with previous and future years. Our understanding of wetlands is evolving based on knowledge gained from such accumulated data.

What changes are occurring to the wetland plants from season to season, and year to year? Describe these changes and hypothesize reasons for them.

ASSESSMENT

Have students do the following:

- Draw or name three to ten plant species found in the wetland and list their characteristics.
- Orally or in writing, name and describe the tallest and shortest plants, the widest and thinnest plants, the plants with the greatest and least cover, and those with the greatest and least biomass.
- Is the wetland successful and healthy? What data supports this evaluation?
- Compare the most recent data collected with previous data and give reasons for the changes that have occurred in the wetland over time.
- Hypothesize how the wetland plants will change in the future, giving reasons for the changes.

EXTENSIONS

If this is the first year for the activity, have students create separate line graphs of average stem diameter, average basal area, average height, average area covered, and average biomass/plant. Set up the graphs for a ten year period, but only enter the data points for the first year. Five to ten species can be plotted on each graph if different colors or symbols are used for the data points.

If this is not the first year for the activity, have students add their data points to the graphs that have already been created.

Create a field guide, illustrating the most abundant plant species and listing their characteristics.

RESOURCES

Caduto, M.J. 1990. *Pond and Brook.* University Press of New England, Hanover, NH.

Firehock, K., L. Graff, J.V. Middleton, K.D. Starinchak, and C. Williams. 1998. *Save Our Streams: Handbook for Wetlands Conservation and Sustainability.* Izaak Walton League of America, Gaithersburg, MD.

Kent, D.M. 1994. *Applied Wetlands Science and Technology.* CRC Press, Boca Raton, FL.

Project Learning Tree, Environmental Education Activity Guide. 1995. American Forest Foundation, Washington, DC. Especially: Trees in Trouble and How Big Is Your Tree?

Tiner, R.W. 1998. *In Search of Swampland: A Wetland Sourcebook and Field Guide.* Rutgers University Press, New Brunswick, NJ.

INDIVIDUAL PLANTS

DATE: ____________________

Plant Species	Stem Diameter	Basal Area *	Plant Height *				Plant Cover		Plant Biomass	
	d	A	H_s	L_t	L_s	H_t	d	A	Wet	Dry

* Shaded columns are for large tree measurements only.

PLANT SUMMARY

DATE: ____________________

Plant Species	Survival		Average Stem Diameter	Average Basal Area *	Average Height	Average Area of Cover	Average Biomass Per Plant	Area Sampled
	Live	Dead						

* Shaded column is for tree measurements only.