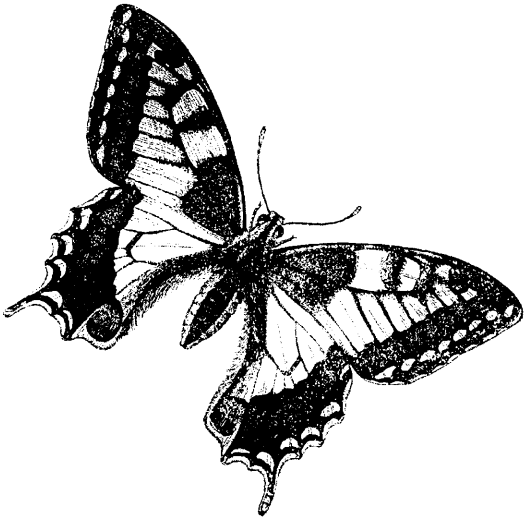
CREATING A SCHOOL HABITAT™

A Planning Guide For Habitat Enhancement on School Grounds in Texas



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Additional copies of this manual may be obtained from the offices listed on the next page. Training workshops are offered periodically through the year in association with this manual.

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To Obtain Additional Copies of Manual

CONTACT THE OFFICE NEAREST YOU:

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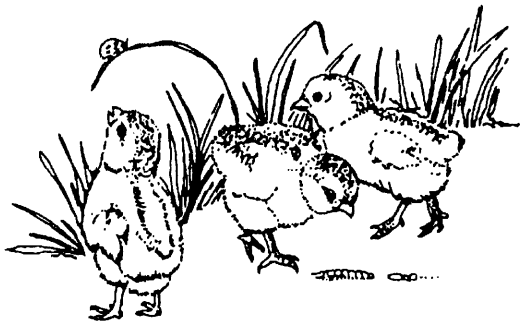
What is a School Habitat?

DEFINITION:

A school habitat can be called many names, including "outdoor classroom", "school sanctuary," and "nature study area." No matter what name the area goes by, every school habitat is defined as a piece of wildlife habitat growing on a school grounds. The habitat becomes an exploratory classroom where many aspects of modern education can be taught outdoors. Hands-on activities reinforce and complement classroom activities. The topics taught in a school habitat are limited only by your own imagination. However, the core of the teaching area is the habitat itself.



WHAT IS A HABITAT?

The habitat can be as simple or as complex as you desire. A school habitat should provide **FOOD**, **WATER**, **SHELTER**, and **SPACE** for wildlife. The idea goes beyond just providing a bird feeder, bird bath, and nest box. The key to the habitat is vegetation, with emphasis on diversity and layering. The limiting factors in a school habitat are the amount of space, growing conditions, and funding available. A school habitat should not be viewed as a manicured garden or traditional landscape project. A true habitat is a place where wildlife will feel comfortable visiting.

PLANTS ARE THE KEY!

Without the right plants, wildlife will not visit the school grounds. Without the plants and wildlife, there are no natural interactions and relationships for students to study. Plants are the crucial key. Select plants that:

- Are native to your area,
- Adapted to your site's growing conditions,
- Provide important benefits for wildlife,
- And require lower maintenance.

ACCOMPLISH YOUR CURRICULUM OBJECTIVES:

The school habitat is an obvious place for teaching environmental education, as well as other multidisciplinary subjects. The State Board of Education has established the Texas Essential Knowledge and Skills (TEKS) requirements for all grade levels which are regularly tested through Texas Assessment of Academic Skills (TAAS). Requirements for mathematics, language arts, history, social studies, art, music, physical science, geography, foreign languages, and other subjects can be achieved inside the school habitat. In addition, the habitat helps satisfy the requirement for lab and field work. As a teaching tool, the experiential, tactile nature of school habitat activities allows students to understand material when traditional teaching methods have failed.

LEARNING CENTER:

To turn the school habitat into a "learning center" or "outdoor classroom," you can add a variety of features to make learning easier, such as activity stations, weather stations, bird feeders, nest boxes, and themed sections in the habitat. The habitat forms the foundation for the learning center and the additional features create natural learning opportunities and teachable moments.

FIELD STUDIES:

Finally, the school habitat addresses a continuing concern, finding the time and funding to take students off campus for field trips. The school habitat can serve as an outdoor lab, a pre-field trip experience, a post- field trip follow-up, or an ongoing experimental station, requiring only one class period. School habitats compliment outdoor learning conveniently and efficiently.

PROMOTE STEWARDSHIP:

Students who help create and maintain the habitat gain an immeasurable sense of pride and ownership of this natural area. This experience prepares them to become future stewards of our environment.

Basic Steps

Creating a school habitat area is not difficult, if you have a plan in mind. Use the following step-by-step guide to design your school habitat.

1. Form a habitat development working team or committee.

2. Establish CLEAR project goals and objectives.

3. Select an appropriate location.

4. Inventory and evaluate the site.

5. Plan future uses and general habitat types.

6. Research the basic habitat components to include them in your master plan.

7. Explore interpretive features and decide which ones to include in your habitat master plan.

8. Design a detailed master plan.

9. Divide your master plan into phases with specific projects. Then rank the phases according to priority.

10. Determine sources of funding for each phase and seek funding as needed.

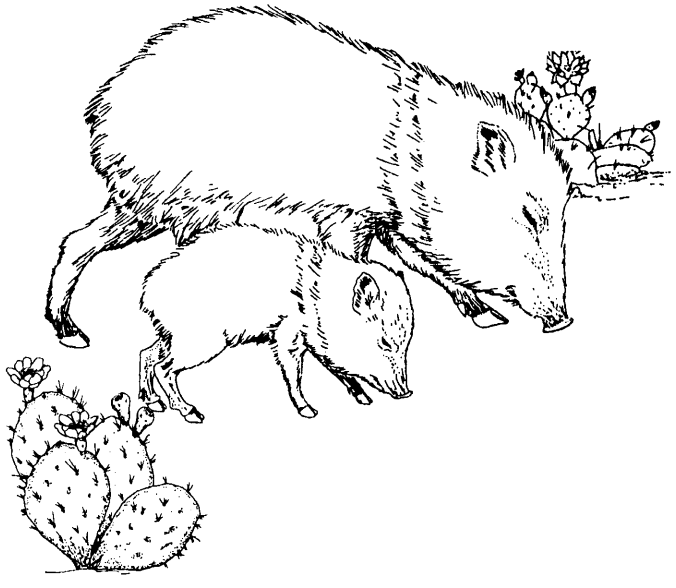
11. Prepare and organize prior to installation of the habitat.

12. Install the habitat. (Work Day!)

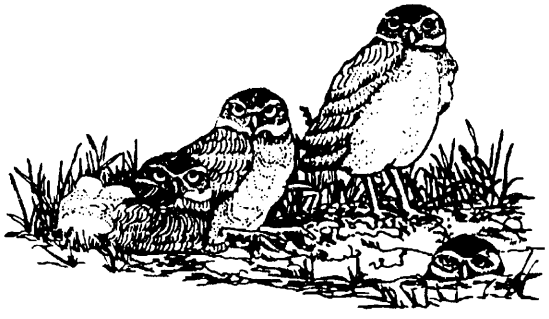
13. Maintain planted areas.

14. Apply for certification.

15. Celebrate!



Step 1. Form A Working Team



The key to a successful school habitat is an organized working team or committee. A common mistake made when planning a school habitat is for one enthusiastic person to tackle the project alone. This person can easily become overworked and overwhelmed.

To form a committee, invite enthusiastic, energetic, and innovative individuals who would be willing to shoulder some of the responsibilities necessary to develop and maintain such a project. Potential committee members include school administrators, board members, parents, grounds maintenance staff, local businesses, natural resource professionals, and others, but the essential members are teachers and students. The broader the committee, the better. Try to include a grounds maintenance person on the committee from the beginning. This person may be maintaining your site in the future and must understand the project's goals.

A school habitat committee will help you achieve the following:

- Assistance with tasks involved in planning and implementation.
- Incorporation of the project into the school curriculum.
- Perpetuation of the project, regardless of changes in individual committee members through the years.
- Completion of the project.

Committee members should visit local examples of school habitats to gather ideas or learn about potential problems from teachers who have experienced the same. Attend school habitat workshops where available.

One method to entice individuals to serve on the committee and reduce the work load on members is to divide the main committee into "working teams" or "subgroups". The working group focuses on and accomplishes a specific aspect of the habitat project.

Development and Maintenance Team:

The duties of this working group might include the following:

- Inventory the site and create a base map.
- Evaluate the site's suitability as habitat and its potential for education and curriculum development.
- Create a site master plan and determine which habitat and education features to include.
- Divide the master plan into workable phases, rank the phases according to priority, prepare for installation, and implement site construction.
- Schedule regular, publicized work days, and build partnerships with other teachers and students to encourage their participation in the site construction and maintenance.
- Develop a maintenance plan for the site and implement the plan after the site construction has been completed.

Curriculum Team:

Duties for the curriculum working group include:

- Develop integrated curriculum.
- Create a resource center with a central reference library available to all teachers.
- Compile a list of equipment/ tools needed for student use and work to obtain that equipment.
- Design any signs, trail guides, or activity stations to encourage habitat use.
- Coordinate in-service training for teachers.

Funding Team:
The funding working group should:
- Develop cost estimates for individual phases of the overall habitat project.
- Obtain funding for the projects through various sources, such as grants, donations, business partnerships, or fund-raisers.

Public Relations Team:
This working group may:
- Handle public relations, coordinate media contacts, and write news articles.
- Publicize work days.
- Serve as photographers and historians to keep the official project scrapbook.
- Work to make the project visible and seek coverage to bolster community support.

INTEREST SURVEY

Dear Parents:
Our school is creating a nature study area on our school grounds. Would you be willing to contribute your skills to this project?

❑ landscape design	❑ operation of heavy equipment	❑ carpentry
❑ drafting	❑ garden installation	❑ composting
❑ garden maintenance	❑ plant propagation	❑ grant writing
❑ getting materials donated	❑ fund-raising /promotion	❑ signage
❑ working with students	❑ plumbing	❑ photography
❑ graphics/ desktop publishing	❑ other _____	❑ curriculum development

When would you be available to help?
days evenings weekends
occasionally frequently as needed

Parent's Name _____ Child's Name _____
Day Phone _____ Evening Phone _____
Please return this form to:

Figure (1). Sample form to survey parents. Additional forms could be created to survey teachers and students about which features they would like to see in the future school habitat.

Step 2. Establish Clear Goals

Establish clear goals and objectives for the habitat. The goals should be so clearly written that future committee members will understand the purposes for the site, even when the original committee members have retired from the project.

To determine goals, survey others, brainstorm ideas, and examine your curriculum objectives. A survey of teachers, students, parents, and other interested parties will provide valuable feedback reflecting their expectations for the site. The curriculum TEKS and TAAS objectives are important sources for goals. All subjects, such as science, math, language arts, social studies, art, physics, music, and drama can utilize the school habitat.

To make the goal setting process easier, you may want to group your goals under headings, such as habitat goals, student involvement goals, curriculum goals, and others. Group them by the year to be completed, such as year one or year five, forming a timeline for project completion. Once the project goals have been established, the development process will proceed accordingly.

SAMPLE GOALS FOR SCHOOL HABITAT PROJECTS

"The overall project goal is to establish a natural habitat area that attracts a variety of local native wildlife. Three habitat types will be established: woodland, prairie and wildflower meadow, and pond with wetland."

"The school habitat will include native plant species only. The exception to the "all native" goal will be a non-native plant species that provides an outstanding wildlife benefit and grows well in our area. A list of native plants and acceptable exceptions is included."

"Students will participate in every stage of habitat development."

"The habitat site will be maintained by students and volunteers using organic and natural techniques. Individual classrooms will maintain specific areas. Each fifth grade classroom will maintain an area jointly with a kindergarten class to provide mentoring opportunities for both students and parent volunteers. "

"Each month, teachers will receive 3 hours of in-service training that relates to the school habitat. These hours may include organic gardening techniques, bird identification, plant identification, insect identification, historical plant uses, and more. Speakers may be other faculty or outside resource people."

"Outdoor plant identification signs will be created by the art classes. The art, language arts, and science classes will jointly produce a written trail booklet (guide)."

"Proceeds from monthly bake sales, aluminum can recycling, and paper recycling will be dedicated to the school habitat project. These funds may be used for student field equipment or habitat maintenance supplies."

GOALS FOR OUR SCHOOL HABITAT

1. Habitat Goal (Year 1):

_____

2. Habitat Goal (Year 2):

_____

3. Habitat Goal (Year 5):

_____

1. Student Involvement Goal (Year 1):

_____

2. Student Involvement Goal (Year 2):

_____

3. Student Involvement Goal (Year 5):

_____

1. Curriculum Goal (Year 1):

_____

2. Curriculum Goal (Year 2):

_____

3. Curriculum Goal (Year 5):

_____

Figure (2). Decide on main goals for your school habitat. Perhaps list them under group headings.

Step 3. Select a Good Location

After the goals have been clearly established, the selection of an appropriate location for the school habitat should be the next priority of the newly formed committee. The committee's goal is to create a permanent habitat, regularly utilized by both students and wildlife. After touring the school grounds and discussing the advantages of several potential locations, select a site that best enables the habitat objectives to be accomplished.

SITE CRITERIA: Once a school makes the commitment, expends the funds, and provides the labor to establish a habitat project, then the school habitat should become an integral part of the school grounds and remain in existence for many years. Ultimately, the best site is one that will 1) provide excellent opportunities for student education, 2) provide good quality benefits for wildlife, and 3) be incorporated as a permanent feature on the school grounds.

To select a good site, consider the following:

- Choose a site owned by the school district, preferably on the school grounds.
- Strive for permanency. Check the school's master plan to make sure that the proposed site is not slated for some other type of development in the future, such as conversion into a playground or portable classrooms. Find an aerial photograph or other map of the school grounds and locate the proposed site in relation to the existing school buildings, parking lots, and playgrounds.
- Choose a site away from main student walkways and heavy vehicular traffic areas to minimize interruptions to outdoor studies and reduce wildlife disturbance.
- Select a site that is easily accessible and close to the classrooms that are expected to utilize it most often.
- Avoid areas near school equipment that might require regular maintenance. For example, driving a truck into a habitat to repair large air conditioning units will probably disrupt student projects and may destroy vegetation.

CRITERIA FOR A SUCCESSFUL SITE:

_____ **Owned by school, on school grounds, close to classrooms**
_____ **Permanent habitat site, not slated for other development in future**
_____ **Away from high vehicle, foot traffic, noise, and heavily used student areas**
_____ **Good growing conditions for plants (correct light, good drainage, etc.)**
_____ **Good wildlife conditions, open space with few obstacles to access**

- Consider the potential for vandalism at the site.
- Study the potential growing conditions available for plants. Check the soil type, sun/shade patterns, water availability, and drainage patterns. Locate utility lines to avoid planting trees and other vegetation beneath the lines or over underground lines.

From a wildlife perspective,

- Invite wildlife to your school by choosing an open site, accessible to a variety of wildlife. A four-sided, fully enclosed, shady courtyard, filled with concrete paths and little soil would make a poor school habitat. In such a courtyard, plant selection may be limited to deep shade-loving plants. Wildlife access is restricted to flying or crawling, thus limiting the courtyard's success from the very beginning.
- If possible, choose a site located adjacent to or near a piece of existing habitat for added success.

RESOURCE PEOPLE

Consider contacting professional resource people for assistance with the project. See Appendix A for resource people in your area. Before the meeting, gather your maps, sketches, and goals together. Compile a list of questions you want to ask. Be prepared to tour the site and answer questions about the site conditions, such as the site's soil type, sun/shade patterns, and drainage patterns. Invite your committee members and volunteers to this meeting, as well. Take notes and follow up on suggestions.

Step 4. Site Inventory and Evaluation

BEGIN WITH A PLAN:

A successful school habitat involves more than haphazardly installing plants. Committee members should plan ahead to take into consideration the needs of both students and wildlife. The planning process is not difficult but does require some thought and discussion.

Why do you need a plan? A plan is simply a method of putting ideas down on paper and deciding which ones you like best. A plan allows you to evaluate your school grounds and consider your current and future patterns of use. A well-designed plan will create a harmonious, unified habitat, rather than a piecemeal project. The plan will help you sell your ideas to community leaders and volunteers. By planning ahead, you establish priorities and consider physical or financial limitations.

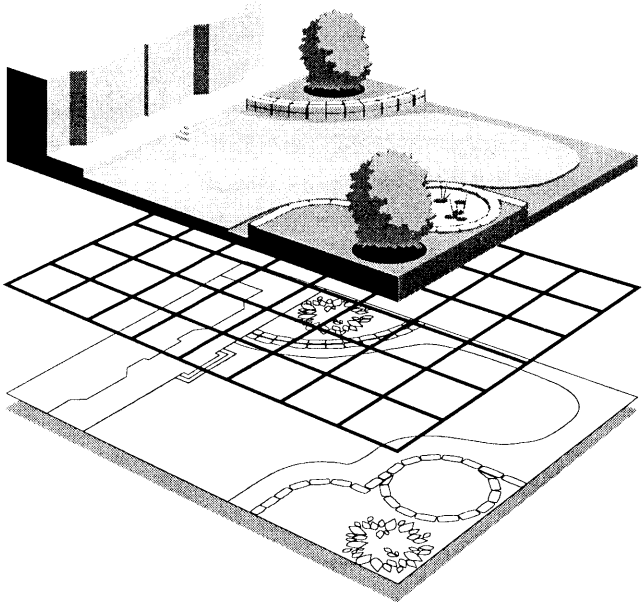
Design your entire habitat now, although you may complete the project in phases over several months or years. Even if your preferences change over time, you can always update your plan to meet your changing needs.

INVENTORY CHECKLIST

- ____ **Utility lines, above & below ground**
- ____ **Nearest water faucet & electric outlet**
- ____ **Soil type, growing conditions**
- ____ **Drainage patterns, standing water**
- ____ **General direction of ground slope**
- ____ **Light (sun/shade) patterns**
- ____ **Existing vegetation**
- ____ **Door and window locations**
- ____ **Access points for large equipment**
- ____ **Spots needing clear access for maintenance**
- ____ **High traffic areas that may affect site**
- ____ **Existing wildlife or education features**
- ____ **Existing habitat area located nearby, if possible**
- ____ **Features on surrounding property that may affect site**

CREATE A BASE MAP:

Once you have selected a good location, evaluate the site and draw a detailed map. This will be your "base map." See Figure 3.



- Measure the dimensions of the site and decide on the scale for your map. (Example: one inch equals four feet.) Be sure the scale you select is large or small enough to indicate your entire habitat site. Note the scale and a "north" directional arrow on your map.
- Sketch your site to scale, indicating the correct dimensions and shapes. If you want to show more detail, draw another map of that section in a larger scale.
- Show the location of buildings, sidewalks, playgrounds, driveways, adjoining roads, and other hard surfaces on the map. Note the locations of doors and windows.
- Make extra copies of your base map to use during additional design stages.

INVENTORY AND EVALUATE THE SITE:

On one copy of your base map, continue the inventory of your site to determine existing conditions, vegetation, and features.
See Figure 4 for examples.

- Show features, such as overhead utility lines, buried cables, water lines, water faucets, fences, and air conditioning units, on your map. Note any areas that may be hazardous for digging or may need access for maintenance through the year. You may need to check the school master plan or maintenance staff for the correct locations of underground lines.

- Indicate the soil type (clay, sand, gravel, etc.) for the site. You can take a sample of your
- soil to a local nursery or extension service to determine the soil type. Refer to the Soil Texture Pyramid (Figure 19) in the "Constructing a Pond or Wetland" section, or Appendix H "Key to Soil Texture by Feel" chart.

- Show the drainage patterns and ground slope on your map, especially noting the direction the water flows. Note any areas that hold water frequently or places where other parts of the school (buildings, roofs, lawn) drain into the site.

- Note the light patterns for the site, including the amount of sun each section receives per day. Students can assist by mapping the sun/shade patterns each hour. Plant growers define "full sun" as six hours or more of direct sunlight daily, including four hours of hot afternoon sun. "Full shade" is defined as four hours or less of direct sunlight per day. "Partial sun" and "partial shade" fall somewhere in between.

- Indicate existing vegetation, flower beds, and other areas that you wish to keep in the master plan.

- Measure trees and large shrubs from the middle of the trunk out to the tip of a branch to estimate the canopy width. Mark these measurements on your map.

- If possible, identify each large plant, shrub, or tree by its common name.

- Note existing plants that affect the energy conservation and comfort in nearby buildings by providing shade or windbreaks.

- If classrooms overlook the habitat site, mark the location of the classroom windows and doors. Measure and note the distance from the ground to the bottom of the window. You may wish to encourage wildlife observation from the windows or choose plants of a certain height for planting near windows.

- Identify any wildlife or educational features that may already exist, such as weather station, dead tree, feeding areas, tree cavities, nesting areas, or water sources.

- Do any wildlife species currently use your habitat site? Does this site join to an existing habitat nearby? Would wildlife feel comfortable traveling from the existing habitat to your future site, or would the animals feel exposed?

- Indicate any features on surrounding property that may affect your habitat site, such as parking lots, noisy neighborhood pets, overhanging trees, or an existing habitat area.

BASIC INFORMATION ABOUT THE SELECTED SITE TO FORM A "BASE MAP":

1.) Map scale: 1 inch equals 20 feet.
2.) The site is owned by the school district and is not currently in use. It will never be used for a purpose other than a school habitat.
3.) Selected site is rectangular in shape, located inside a U-shaped courtyard between building wings.
4.) East and west site boundaries are 130 feet in length, each.
5.) North and south site boundaries are 120 feet in length, each.
6.) A small area of wildlife habitat exists north of the site, outside of school owned property.

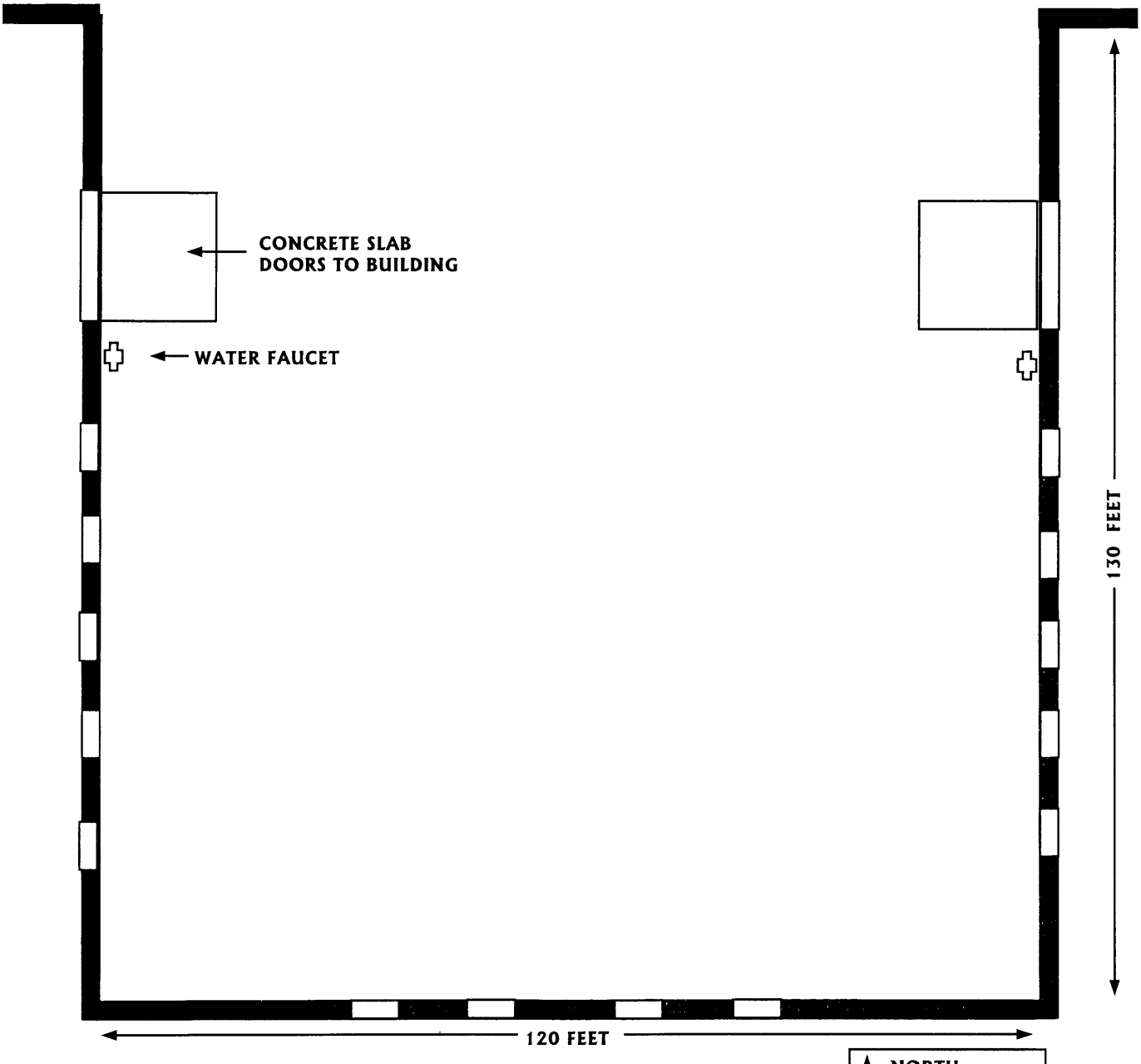


Figure (3). Base map of school habitat site, showing dimensions and buildings to scale.

INVENTORY MAP:

1.) Site consists of an open lot, surrounded on three sides by classrooms. Windows begin two feet off the ground.
2.) The soil is clay with a thin top layer of sandy loam.
3.) Water stands in the southwest corner of the site where the water runs off the roof after rains. The ground slopes toward the northeast. A shallow, 1 1/2 foot deep drainage ditch exists 5 feet from northern boundary.
4.) Existing vegetation consists of two large oak trees.
5.) Students access the site from two doors, one on the west wall and one on the east wall. Doors open onto a 8'x8' concrete slab.
6.) A water faucet is located near each door.
7.) An overhead power line exists 5 feet beyond the north boundary line, 12 feet above ground.
8.) Sun/shade patterns are as indicated on the map.

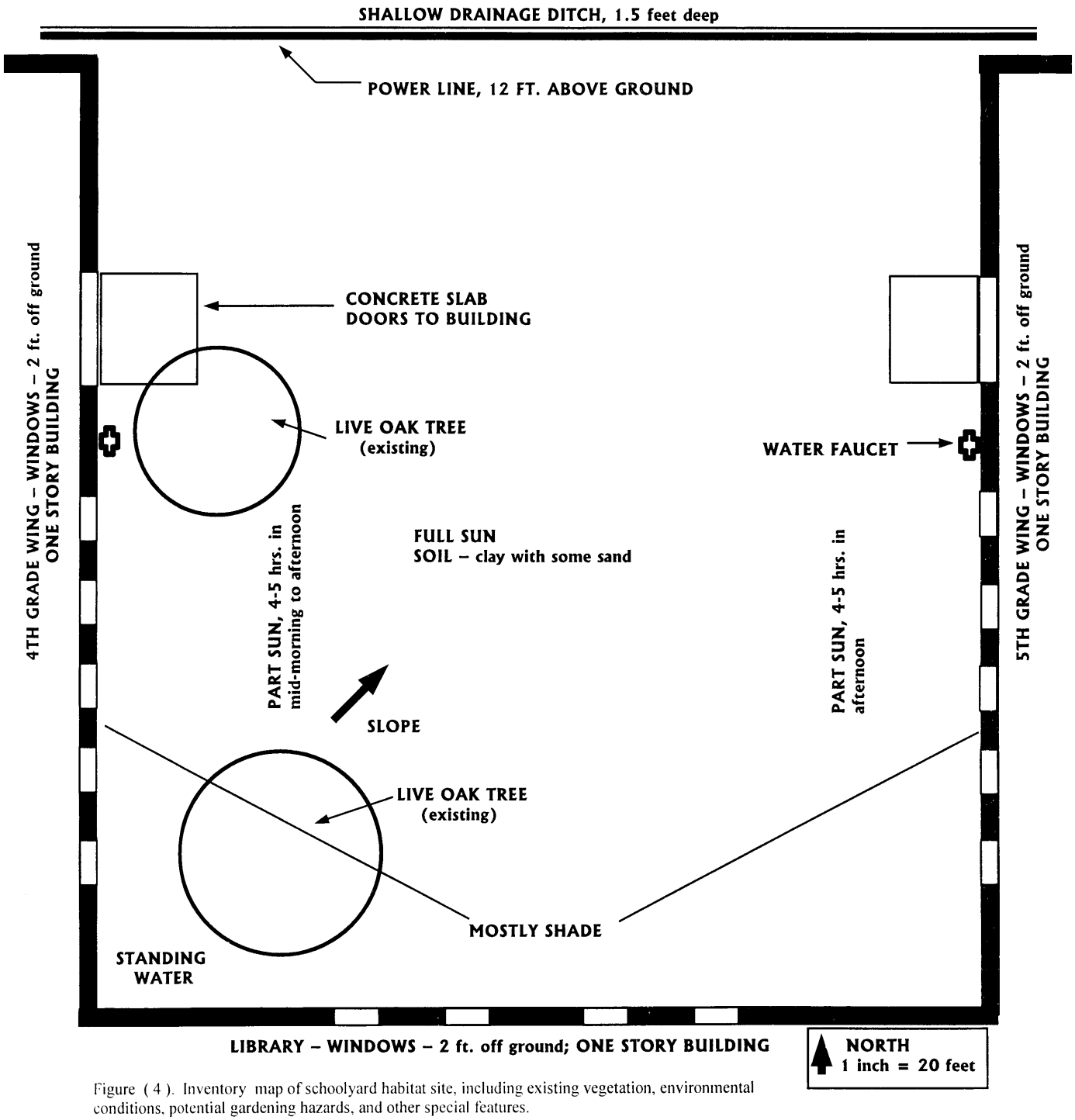


Figure (4). Inventory map of schoolyard habitat site, including existing vegetation, environmental conditions, potential gardening hazards, and other special features.

Step 5. Plan Future Uses and General Habitat Types

PLAN FUTURE USES:

Now that you have completed your site inventory and evaluation, decide future uses for the site. Refer to your inventory map (Figure 4) and begin sketching tentative ideas and notes on another copy of your base map. Now is the time to create your "dream school habitat," on paper at least. See Figure 5 for example.

- Experiment with a variety of layouts on paper. Moving plants, pathways, and ponds on paper is much easier than physically rearranging them on the ground.
- Get feedback!!! Ask committee members, faculty, and students to brainstorm ideas for this new habitat site.
- Refer to your goals list that you created in Step 2 "Establish Clear Goals". What features could you add to make accomplishment of the TEKS and TAAS objectives easier for each teacher? What can you add that will make the student's visit comfortable and interesting?

SELECT GENERAL HABITAT TYPES:

Remember your responsibility to provide the habitat components for wildlife: food, water, and shelter. Please read Step 6 for additional information about the basics of habitat.

- Determine what you can add to the site to make it comfortable and beneficial to wildlife. Try to mimic the kinds of habitats found locally in your area. Examples might include forest, wetland, prairie, wildflower meadow, scrub, and desert prairie.
- Once you have decided on your major areas, sketch in the future locations of these general habitat types on your plan. See Figure 5 for ideas.
- Do not think about specific plants yet. Read through the following pages to gather ideas about the types of plants you will need in your habitat.

FUTURE GOALS MAP:

1.) Fence off the north end of the area to satisfy liability concerns and limit vandalism opportunities. Include a double gate for large equipment access.
2.) Add greenhouse and storage building in northeast corner to store garden tools and field equipment.
3.) Create a habitat with three sections: woodland, wildflower meadow/prairie, and wetland. Place hummingbird and butterfly nectar plants near student windows. Include a section of larval plants.
4.) Add a shallow pond with gently sloping edges. Extend the water line from building to pond area to refill pond as needed. Construct wooden deck along one side of pond to provide student access to pond and limit damage to wetland plants.
5.) Place 4' x 8' raised vegetable garden beds at north end of courtyard near the fence.
6.) Place composting bins near the vegetable gardens.
7.) Create a shady, outdoor seating area that will hold 25 students.
8.) Fix the drainage problem in the southwest corner by filling the wet spot with soil or gravel and slope toward wetland.

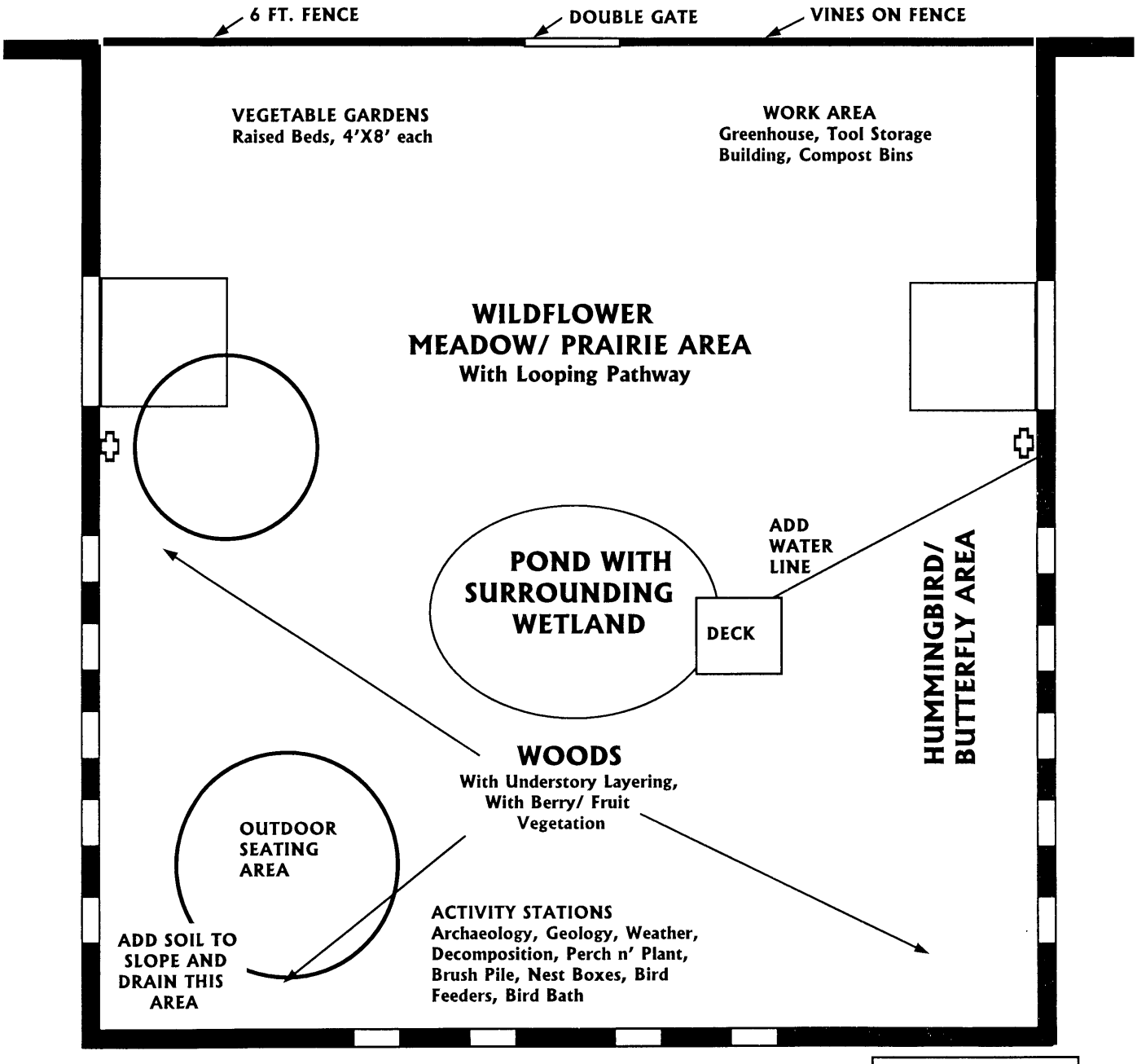


Figure (5). Future plans sketched on a copy of the base map. Note the general ideas and functions each plant will serve.

Components of a School Habitat

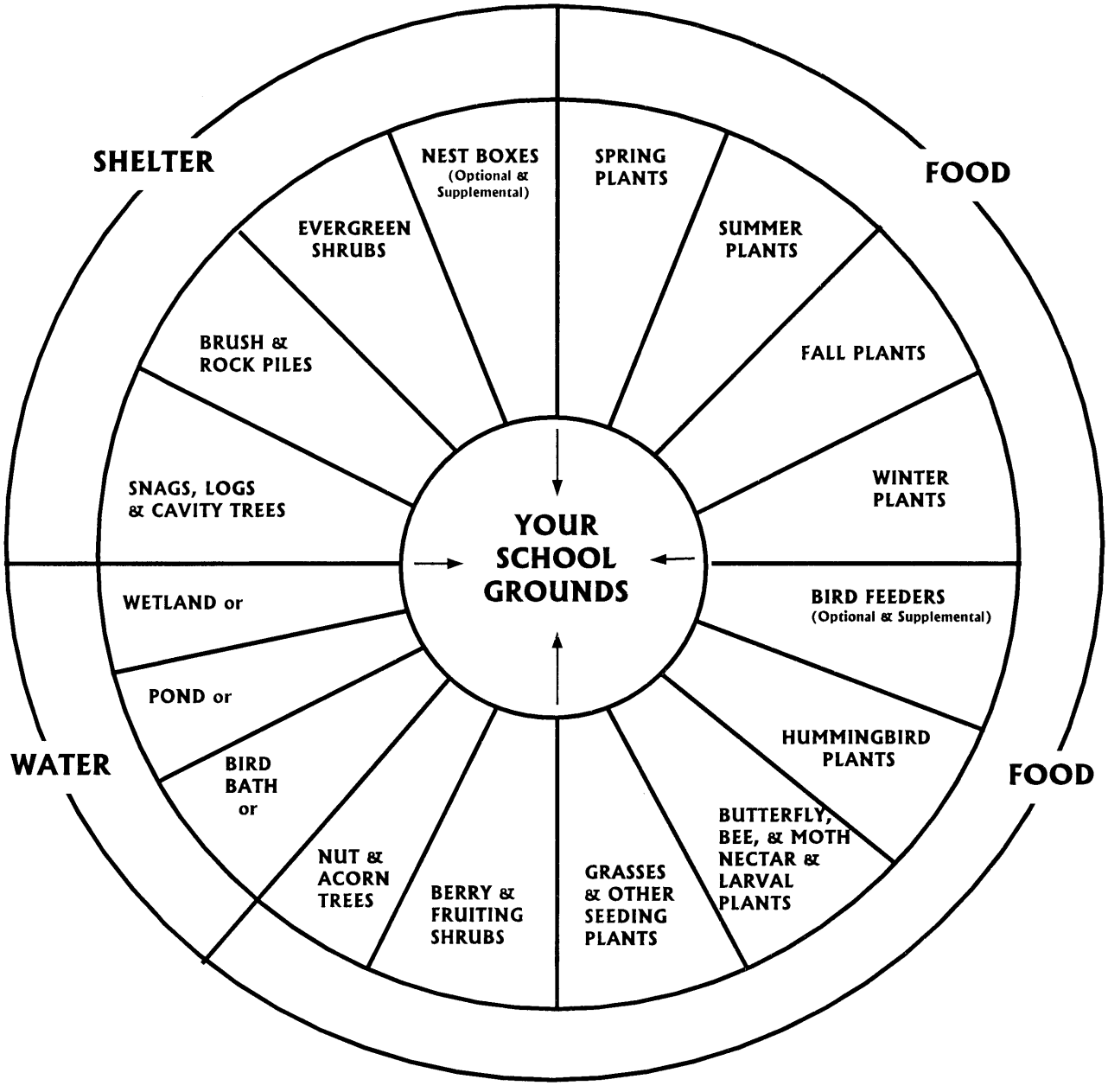


Figure (6). The major components of a habitat (food, water, and shelter) are comprised of a variety of smaller components. School habitats should try to include as many of these smaller components as possible.

Step 6: Include the Habitat Basics

A successful school habitat strives to reproduce the components of a natural habitat, primarily by selecting appropriate beneficial plants, providing accessible water sources, and allowing adequate space for wildlife. Secondary components include supplemental feeders and nest boxes. Once the habitat has been established and the wildlife arrive, students have numerous opportunities to study the intricate relationships between plants and animals.

To attract the wildlife, it is necessary to design a quality habitat that includes all the components. The following suggestions may look difficult and complex, but understand that your habitat will support an ever-changing living community. You can start with the basic components and add to your habitat to build in complexity over time.

BASIC HABITAT COMPONENTS:

Every animal requires a combination of:

- **food**
- **water**
- **shelter**
- **space**

These habitat components must be easily accessible and connected, when possible. For example, if food and shelter exist on one side of a busy road, but the water is on the other side, then the habitat is not easily accessible and may be dangerous for wildlife species that must crawl or run across the road.

DESIGN APPROPRIATELY:

To design a quality habitat, first decide what types of wildlife you are likely to attract to your site. You will create your habitat to meet the needs of those wildlife species. Be realistic in your expectations. For example, a courtyard will not attract a white-tailed deer, but may attract a hummingbird. Secondly, design according to the growing conditions on your site. Although planting exotic, tropical plants to represent a tropical rain forest sounds like a great idea, the area will probably freeze during winter, will require more maintenance than native plant species, and will not attract many native wildlife species.

STRIVE FOR DIVERSITY:

By installing a variety of plant species, you will attract more types of wildlife. For example, if a school habitat has two oak trees, grass, and three non-native ligustrum shrubs, only a few squirrels may visit the site. However, if you add a variety of nectar and berry-producing plants, you would attract birds and butterflies.

CONNECT TO NATURAL HABITAT NEARBY:

If natural habitat exists near your school habitat site, connect the new site to the existing area with a corridor of shrubs, trees, or grasses. This vegetation corridor allows wildlife to travel safely from that existing habitat to yours. Fragmentation of habitat is a statewide problem, especially in urban areas. By connecting these small pieces of habitat, we are creating larger continuous pieces of habitat that are beneficial to wildlife.

CREATE LAYERS OF VEGETATION:

In every natural habitat, there are vertical layers or levels of vegetation. Picture a forest in your mind. See Figure (7). Tall trees form the tallest canopy. Smaller trees form the mid-story. Below that, small and large shrubs make up the understory. Then the grasses, flowers, and herbs serve as the groundcover. Even a prairie has levels of vegetation, with some species rising taller than others.

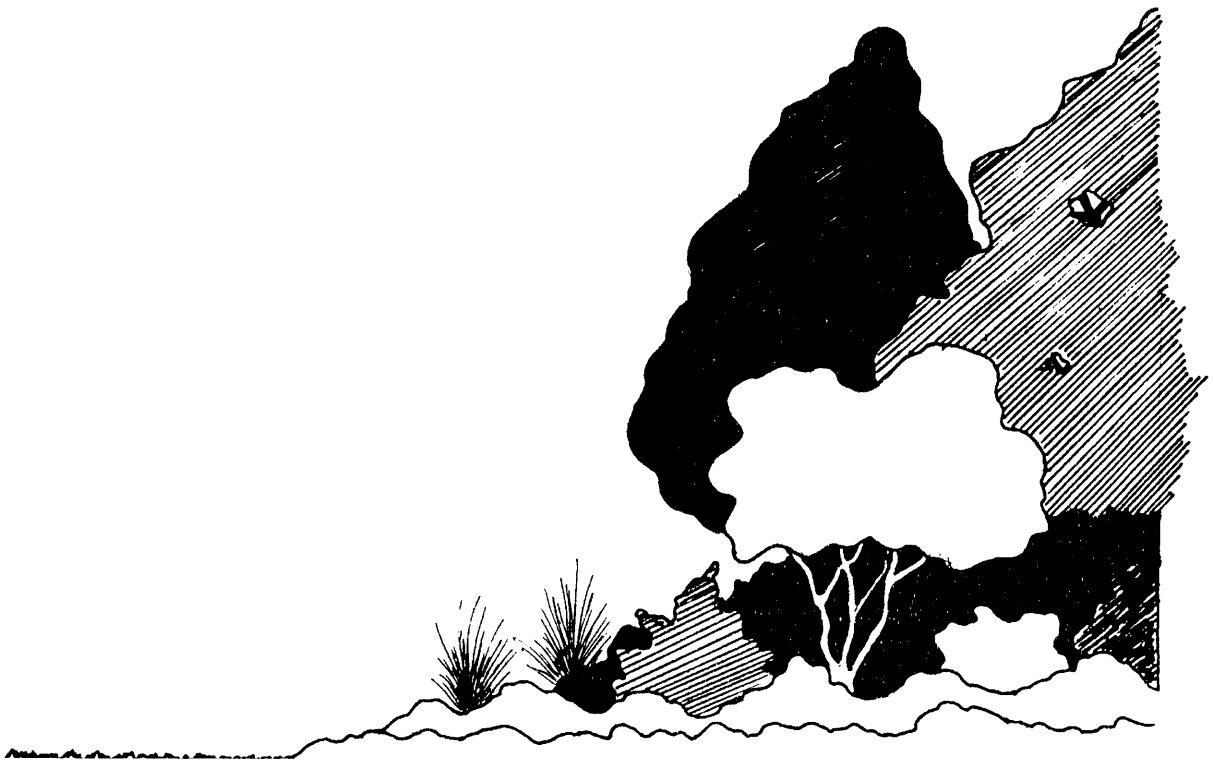


Figure (7). Vertical layers of vegetation provide habitat for a variety of wildlife species. Illustration by Michele G. Foss.

Research shows that two-thirds of the bird species studied utilize plants in the lowest two-thirds of a habitat. Yet, most people remove those parts of a habitat because we tend to like a "manicured" look. A habitat does not always look "messy," but does need to include all of the necessary components. To make a successful habitat, you need to replicate the layers of vegetation. Your goal is to re-install the lower two-thirds of the habitat on your school site. To accomplish this task, add native plants which produce seeds, nuts, berries, or nectar to create important food sources. Plant midstory trees and shorter shrubs below tall trees. Place low groundcovers in front of the taller perennials.

UNDERSTAND CARRYING CAPACITY:

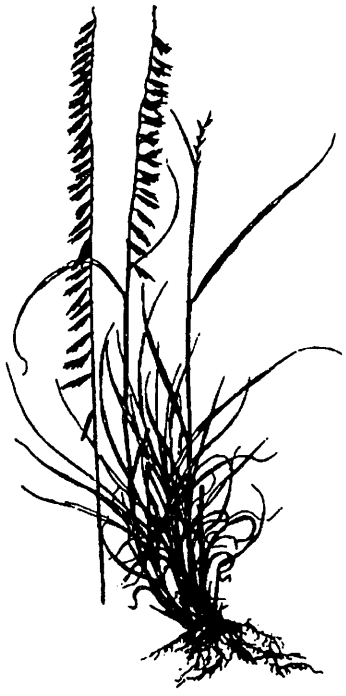
A habitat can support a limited number of animals in a healthy manner. This "carrying capacity" is determined by the quantity and quality of the habitat components. Survey your school habitat periodically. Make sure that one wildlife species is not overpopulating your habitat, to the detriment of the habitat. This situation is often discovered in a pond with too many turtles. The pond vegetation is quickly consumed and the water turns a pea green (algae) due to the waste matter produced by the turtles. Soon the pond is devoid of anything but turtles. By removing some of the turtles, you are restoring the habitat's carrying capacity. Avoid introducing animals (domestic or rehabilitated wild species) to your habitat and allowing them to run freely. There is no "limiting factor" to control their population or their effects on the habitat. For example, several domestic rabbits roaming your habitat will eat large amounts of your plant material, resulting in a loss of food sources for other wildlife species and a loss of habitat diversity.

IDENTIFY LIMITING FACTORS:

Every population is governed by limiting factors. Limiting factors may be a habitat component that is in short supply, such as food or water. Predators, automobiles, disease, territorial boundaries, and weather may also influence a population's density. If you have low population numbers for a certain wildlife species in your habitat, try to identify a limiting factor that could be changed to help increase the population of the desired species.

Why Native Plant Species?

Native plant species are attractive, interesting, and beneficial, but many people rarely take the time to discover them. A "native" plant is one that grows in an area without the intervention of people.



BENEFITS OF NATIVE SPECIES:

By using native species, you will:

- educate students about native plants.
- reduce garden maintenance.
- benefit wildlife.

STUDENT EDUCATION:

Students should understand the role native plants play in the ecosystem, especially the fascinating relationships between plants and animals. Encourage students to discover the interesting historical and modern uses of native plants. For example, Native Americans prized the wood of the arrowwood viburnum shrub because the straight branches formed excellent arrow shafts.

REDUCED MAINTENANCE:

Reduce the time, labor, materials, and costs involved in habitat maintenance by selecting native plant species. Plants that are native to a specific region are comfortable with the growing conditions there. Each plant type has created specialized defenses against drought, floods, freezes, diseases, and insect damage. When you work with the plants' individual growing preferences and natural defenses, the result is lower maintenance in your garden. The plants protect themselves.

WILDLIFE BENEFITS:

Native wildlife species readily recognize native plant species as sources of food and shelter. If you plant a non-native plant species, the local wildlife may never utilize that plant as a food or shelter source.

RIGHT PLANT, RIGHT LOCATION:

Just because a plant is native does not mean it can survive in undesirable growing conditions. For optimal health and survival, place each plant in its preferred location. For example, if a plant prefers to grow in full sunlight in well-drained soil, place it in those conditions. You will waste your money and time if you place that sun-loving plant in a shady, wet spot.

PLANTS TO AVOID IN A SCHOOL HABITAT

Certain plants should not be planted in your habitat due to their invasive growth habits or poisonous properties. Consult your local resource professionals for a plant list and advice about which plants to avoid.

6A: Provide a Variety of Food

NATURAL VARIETY AND SEASONAL SOURCES:

Birds eat a wide variety of foods. To attract many kinds of birds and other wildlife, your habitat should provide food in the form of nuts, berries, fruit, seeds, nectar, and insects. The more variety you plant, the greater the wildlife diversity in your habitat. The plants represent sources of food, shelter, travel corridors, nesting and roosting sites. By relying on plants rather than artificial feeders to provide food, you are reducing the costs involved and the amount of work (filling feeders) you do each day.

"MULTI-BENEFIT" SOURCES:

Many plants supply a food benefit to more than one species. For example, sunflowers furnish nectar for butterflies while blooming and provide seeds for birds through the summer and fall. Dead trees, or snags, provide food for small insects as the wood decays. Woodpeckers and other insect-eating animals feed upon the insects in the decaying wood. Evergreen shrubs, such as yaupon and cedar, supply winter berries and shelter. Native grasses become excellent sources of seed and shelter during the fall and winter.

AIM FOR YEAR-ROUND SOURCES:

In order to truly benefit wildlife, your school habitat should exist year round, through every season. Select plants to provide food sources in each season: spring, summer, fall, and winter. Use the Seasonal Food Chart located in the Appendix to chart food availability through the seasons.

HUMMINGBIRD FOOD:

Attracting hummingbirds to your schoolyard is easy, as long as you plant the appropriate nectar sources. A ruby-throated hummingbird weighs approximately 3 grams. On average, a hummingbird eats half its weight in nectar each day. A hummingbird may feed 5 to 8 times each hour. Hummingbirds feed on tiny insects, as well as nectar. Hummingbirds are initially attracted to red, tubular flower types, such as salvias, coral honeysuckle, and hummingbird bush (Hamelia patens). Masses of red tubular flowers should be placed in obvious sight on the outside edge of your schoolyard to direct newly arriving hummingbirds to your site. The birds will test other colors and flowers as well, once invited to the area. Islands of blooming plants appeal to hummingbirds because the birds can fly freely and approach flowers from several directions. Choose varieties of flowers that will bloom when hummingbirds are migrating or nesting in your area.

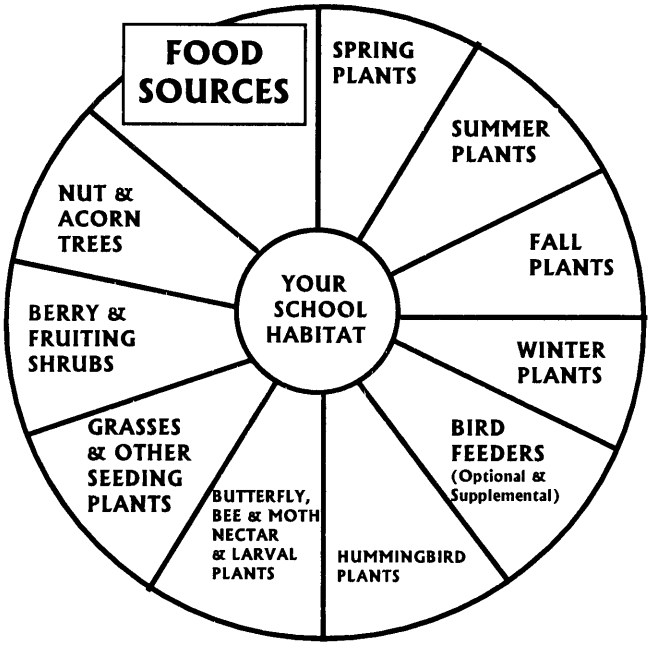


Figure (8). Try to include a variety of food components in the habitat to attract many kinds of wildlife.

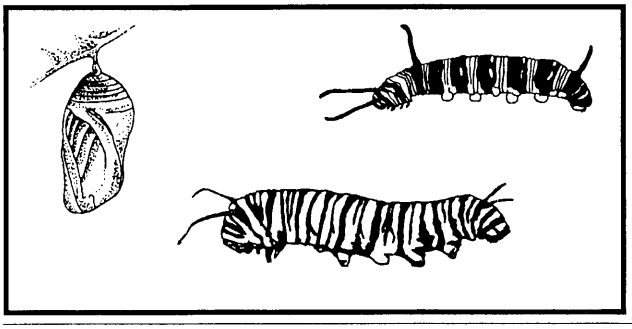
BUTTERFLY FOOD:

The feeding strategies of butterflies differ from hummingbirds. Butterflies prefer to visit flowers located in full sun. Plant tall nectar-producing trees, shrubs, and vines around the habitat perimeter as a windbreak so the butterflies can avoid strong winds while feeding. Masses of flowers and colors, in shades of pink, purple, yellow, and orange attract butterflies. Fragrant, small tubular flowers clustered in "bouquets", such as lantana, verbena, or viburnum; or composite flowers, such as sunflowers, entice butterflies to sample the rich nectar. Select plants carefully to offer blooming nectar sources every month of the year.

LARVAL FOOD:

Don't panic if you see a caterpillar munching on leaves in your habitat. This caterpillar may become the very butterfly you are trying to attract. Butterflies choose specific plant species, called larval host plants, to deposit eggs. For example, the monarch butterfly selects milkweed plants (Asclepias sp.) for egg laying. The gulf fritillary chooses tender leaves of the passionflower vine to lay her tiny yellow eggs. Several swallowtail species lay eggs on dill, fennel, or citrus plants.

- Allow your students to experience the butterfly life cycle by selecting plants to share with caterpillars.
- Learn to recognize the various caterpillars in your garden. Field guides and other reference books can assist with insect identification.
- When watering your plants, don't spray your flowers with hard jets of water since this washes away nectar and tiny caterpillars. Water on or near the ground using soaker hoses or drip irrigation techniques instead.



INSECTS:

A good habitat becomes the home to a variety of insects. Leaves, nectar, fruit, and other food sources entice insects to inhabit the area. In return, these insects will become food for the other animals in the habitat. Realizing that insects are a vital ingredient in your habitat, avoid using pesticides. Use organic gardening techniques and integrated pest management methods instead. Refer to your local resource professionals for assistance.

SUPPLEMENTAL FEEDING STATIONS:

Feeding stations may supply a food source for squirrels, hummingbirds, butterflies, or seed-eating birds. However, feeders should only be used to bring certain wildlife species into viewing range, not as a single source of food to maintain a population. Feeders can create excellent opportunities for student activities, such as bird identification methods, bird population surveys, and food preference studies. Feeder maintenance is a labor intensive, year-round chore.

Seed Feeders:

Feeders come in all shapes and sizes. A feeder with a thin tray around the bottom or with small perches is designed to attract smaller bird species. A wooden tray or mesh box will allow larger birds to land. Clean feeders regularly to avoid transmitting fungal or bacterial illnesses, or diseases between birds. Feeders with peaked roofs and sealed seams prevent rain from molding the seeds. Moldy seed can be fatal to birds that eat the seed.

Seed Selection:

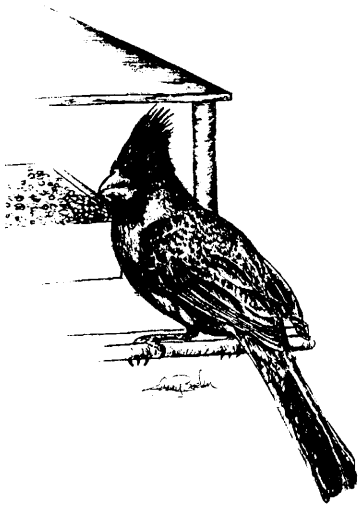
The type of seed you choose for your feeder may influence the bird species that visit your feeding stations. For example, cheap seed mixes usually have a large percentage of milo and millet seeds which attract doves, blackbirds, grackles, and pigeons. However, a seed mixture with a higher percentage of black oil sunflower seed attracts other birds, such as cardinals, blue jays, woodpeckers, chickadees, and more.

Suet:

Suet is often offered as a winter treat, especially in more northern states. Due to our hot temperatures, suet should only be offered during the coldest winter weather when the temperatures stay below 70 degrees Fahrenheit. Suet usually melts in hotter temperatures and will attract ants to your feeding station. Some birding supply stores sell a suet "dough" and other alternatives more appropriate for our state. Another treat is peanut butter spread on a pine cone and rolled in raisins, seeds, or nuts. As in suet, high temperatures can cause peanut butter to become rancid, so this treat should be limited to cold winter weather.

Hummingbird Feeders:

An artificial feeder with red colored plastic will attract hummingbirds. Do not add red dye to the sugar-water mixture. Fill the feeder with a mixture of 1 part sugar to 4 parts water. Boil the mixture and let it cool before filling the feeder. Store extra solution in the refrigerator. The sugar water should be changed every four days, depending upon the outside temperature. If the temperature climbs above 75 degrees Fahrenheit, change the mixture more often. Otherwise the mixture ferments and may make the hummingbirds ill. Clean hummingbird feeders with hot water. Add less than a teaspoon of bleach or vinegar to the water to remove any mold. Rinse the feeder thoroughly to remove bleach or vinegar residue. Hang feeders in sheltered, shady areas whenever possible. Wind causes the sugar water mixture to slosh out, requiring frequent replacement of the liquid. To prevent ants from visiting the feeder, smear a coating of petroleum jelly on the hanging cord. To discourage bees and wasps from visiting the feeder, select a feeder with "bee guards." These guards look like little round yellow or red cages that fit over the plastic flower opening. The guards prevent the bee or wasp's tongue from reaching the sugar water mixture.



Take hummingbird feeders down when the feeders are not in use to avoid the extra maintenance involved. You will not prevent a bird from migrating by leaving the feeder up past a certain date. In southern parts of the state, if you do not mind the extra maintenance involved, you may want to leave a feeder up during the winter. It may attract some of the more unusual hummingbird species that wander along the migration routes. Take note: If you keep a feeder up during the winter, your feeder may become the only food source for that hummingbird during freezing weather. In sub-freezing conditions, thaw the sugar water mixture often during the day. At night, the hummingbird goes into torpor, a state of reduced metabolic activity similar to hibernation. Torpor helps the bird conserve energy.

6B: Provide Shelter and Space

SHELTER:

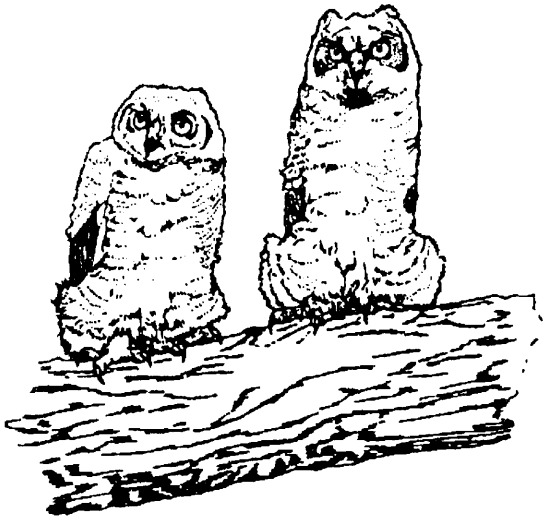
Animals need shelter from harsh weather conditions, hiding spots from predators, night roosting or sleeping areas, and nesting sites. By carefully selecting plants for your school habitat, you can give wildlife a variety of sheltered places to choose from. Thick evergreen shrubs are preferred as winter shelter. Clump the shrubs to form sheltered thickets. Leaf litter, rock walls, wood piles, brush piles, rotting logs, and hollows under rocks can provide shelter for smaller animals, such as lizards, skinks, and toads. Native grasses often make good shelter, especially in the winter.

SPACE:

Space is defined as the area occupied by an individual or family group. The size of an animal's living space depends on the animal's body size and habits. Certain wildlife species need more space than others. An animal's home range is the space it requires to find all of the food, water, and shelter it needs to survive. In your school habitat, space is limited to the area you plan to enhance. Your activities should focus on increasing the quality and availability of food, water, and shelter. The amount of space an animal requires may decrease as the quality of the habitat improves.

PROPER ARRANGEMENT:

Consider the comfort and security preferences of wildlife when deciding how to arrange the components of your habitat. Easy access by many types of wildlife is one goal of your habitat arrangement. For example, if a shallow water source is located at one end of the school campus and the good berry bushes are on the other end near a parking lot, then wildlife must cross the campus and parking lot to use each one. That arrangement is inconvenient and uncomfortable. By making wildlife feel comfortable on your school campus, you will increase the viewing opportunities for your students.



SAFETY "BUFFER" ZONES:

Safe travel is another goal. For most wildlife species, large expanses of mowed grass represent vulnerability to predators, so allow shrubs near the edge to branch all the way to the ground. Help wildlife feel more secure by planting shrubs and trees around the perimeter of your school grounds, away from high traffic areas, such as parking lots and playgrounds. Animals are more likely to visit isolated patches of vegetation in the center of your campus if there are safe places, called buffer zones, to retreat along the perimeter.

CORRIDORS:

Animals must travel daily and seasonally in search of food, water, breeding areas, or shelter. Their survival depends on sheltered travel lanes or corridors between various habitat components. Terrestrial wildlife, such as rabbits, fox, turtles, or deer, use sheltered areas along fences, creek beds, and other thick vegetation as travel corridors. If quality wildlife habitat exists near your school habitat site, try to create corridors to connect the two areas.

OTHER TYPES OF SHELTER:

Artificial Nest Boxes:

Each bird species creates their own preferred nesting structure. Some construct a stick nest in a tree or shrub. Other birds and squirrels use cavities in hollow trees as homes or nesting sites. A nest box (bird house) replicates that preferred tree cavity. Before constructing or purchasing a nest box:

- Decide what type of animal may be attracted to your nest box. Research that species and make sure it is likely to nest in your part of Texas and under the conditions you have available.
- Determine the animal's preferred box size and shape. See Appendix Q for specifications.
- Don't put perches outside of the nest box opening. This perch encourages English sparrows to land and take over the nest box.
- Nesting birds must guard against predators sneaking up to the nest. A predator guard placed on the pole beneath your nest box or on the box itself prevents surprise visits. Nest boxes are safer if erected on a metal pole, rather than a wooden post or tree. Avoid nest boxes if your habitat is frequently visited by neighborhood cats.
- Nest boxes must be cleaned, sometimes several times a season. By cleaning the box, you are removing tiny insects, like mites, and preparing it for use again. Nest boxes, such as purple martin houses, may be taken down during the winter when not in use. To keep wasps out of a nest box, rub the inside walls with a mild unscented bar soap.

Bat Houses:

A bat house may provide an artificial roost site for bat species that live in colonies or roost in caves or cavities. Not every bat species will reside in a bat house. Several species roost in trees during the day and will not live in an artificial bat house. Those species that may utilize a bat house include the big brown bat, evening bat, Mexican free-tailed bat, and a few others.

Debate continues about what type of bat house to use and how to orient it in an urban setting. For now, houses should be constructed of unpainted or untreated rough wood with dividers placed inside to create spaces of one inch wide or less. Erect the bat house in an open area, fifteen or more feet off the ground. Locate the house close to a good insect and water source. Refer to Appendix R for a bat house construction plan.

Rock Pile:

A rock pile provides shelter and basking sites for amphibians, reptiles, and insects. Cracks in a brick or rock wall provide sheltered windbreaks for caterpillars, lizards, frogs, and such. A cracked clay plant pot placed on its side in the garden can form shelter for a toad.

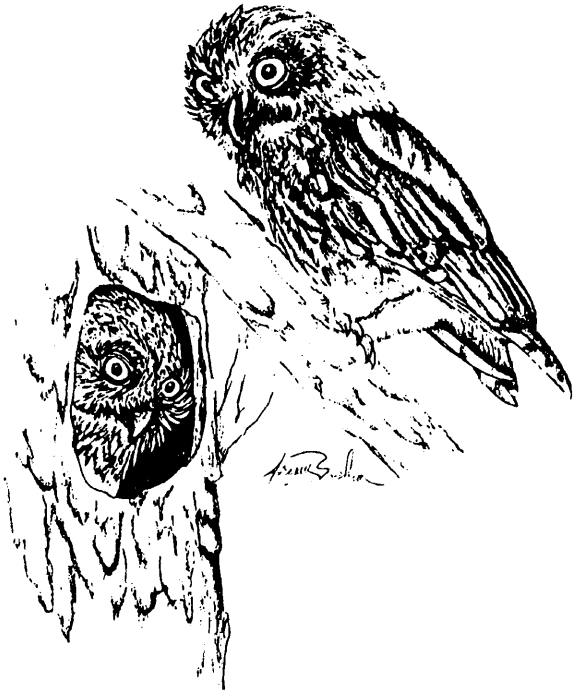
Brush Pile:

A brush pile supplies shelter for small mammals, reptiles, amphibians, and insects. Use sticks, twigs, and logs to form the pile. Insects often gather among the dead twigs and leaves, in turn attracting lizards, wrens, and mockingbirds. Rabbits may use such piles for shelter. Snakes may visit a brush pile too. For that reason, brush piles should be placed in areas away from regular student activity. Flowering or evergreen vines can be grown over the pile to make it more pleasing to view.

Snag:

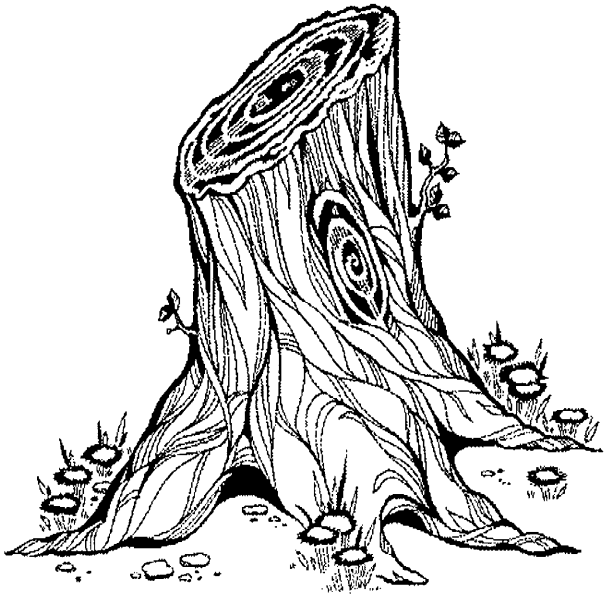
A snag is a dead or dying tree that is left standing to provide an insect source and nesting cavities for birds and small mammals. Woodpeckers, chimney swifts, screech owls, flying squirrels, and many other species utilize snags.

Dead trees may be a safety issue on a school campus. One school solved the problem by cutting down the snag and saving several large branches. They then roped the branches onto the upright supports of an arbor. Birds chisel homes and seek insects on the hollow branches while students observe the activity. The branches are replaced as needed. Another school cut off the branches but left most of the trunk standing for wildlife use.



Logs:

Logs placed horizontally on the ground can provide an interesting decomposition study area for students. Insects, fungi, and others decompose the log to provide soil nutrients. Woodpeckers and other insect-eating animals may visit the log periodically.



REFERENCE MATERIALS

Woodworking for Wildlife: Homes for Birds and Mammals by Carrol Henderson, Minnesota Department of Natural Resources, 500 Lafayette Rd., St. Paul, MN, 55155, (612) 296-0700. Also available from Texas Parks and Wildlife Department, Nongame section, 4200 Smith School Rd., Austin TX 78744, (800) 792-1112.

The Complete Birdhouse Book by Donald and Lillian Stokes, Little, Brown and Company publishers.

Bat House Builder's Handbook, Bat Conservation International, P. O. Box 162603, Austin, TX 78716-2603, (800) 538-BATS.

Audubon Society Guide to Attracting Birds by Stephen Kress, Charles Scribner's Sons publishers.

6C: Provide Water

Water is a vital ingredient in every habitat. Moving, bubbling, or spraying water attracts wildlife. Water can be provided in a variety of ways. Some methods require more maintenance or are initially more expensive than others. Ponds, shallow pools, bird baths, ceramic trays, or plastic saucers work well to provide a constant, clean water supply.

Every type of water source must be
- **permanent.**
- **shallow around the edges.**
- **with gently sloping sides.**

BIRD BATHS:

The water source can be as simple as a plastic plant saucer or as elaborate as a concrete bird bath, located at ground level or elevated. While a bird bath or container is not considered a permanent water source, it may be the only source of water allowed by some school administrators.

- If a container or bird bath is used as your only water source, keep the container full at all times to offset water lost through evaporation. This regular maintenance is especially important during the summer months.

- Make the water accessible to a wide variety of wildlife. If the water container is elevated, access to the water is limited to birds and squirrels. A solution is to place a water container at ground level as well.

- To reduce hiding spots for predators, remove tall vegetation around the edges or base of a bird bath.

- If your bird bath has a deep bowl, add a flat rock in the bowl to give birds better access to the water and enable them to easily judge the water depth.

- A bird bath requires regular maintenance. To clean a bird bath, use a weak bleach and water solution, scrub with a rough brush, and rinse several times until no bleach remains. Refill with water.

- By placing a bird bath under the partial shade of a large shrub or tree, the water stays cooler. Birds and squirrels appreciate a branch overhanging or near the bird bath. This high perch allows animals to survey the area for lurking predators before traveling to the water source. One downside is that leaves tend to collect in the bird bath.

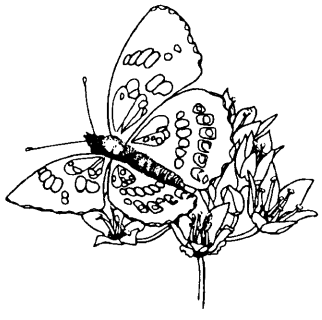
- Place the bird bath near classroom windows for student viewing.

PONDS:

Ponds are easy to construct, if you have people or equipment to dig the hole. Depending upon the soil conditions in your habitat, you may need to line the hole with a liner material to make sure the pond holds water. Pond construction will be discussed in more detail on the next page. Every pond should have gently sloping sides, shallow ledges, or depressions where puddles form around the edge. Wildlife will drink or bathe in these puddles. The best water depth for wildlife is **one to three inches.** In some school districts, a pond may be deemed a safety hazard and must be fenced. Check with your school district to determine their policy. See the next page for pond construction techniques.

BUTTERFLY PUDDLES:

Butterflies receive water from the nectar they sip. However, they also obtain salts and minerals from moist soil. If moist spots are not available in your habitat, you can create them by spraying water on a dirt or gravel path.



Constructing A Pond or Wetland

One of the goals of a school habitat project is to bring wildlife into view for students to appreciate and study. No other habitat component does this quite as predictably as a variety of water sources. A pond or wetland has the potential of attracting the most wildlife diversity as well as allowing for the observation of the life cycles of plants, invertebrates, and amphibians. The following pages will guide you through the steps to create a natural pond with wetland edge. **This plan does not need a filter or water pump to circulate water.**

The process of establishing a pond or wetland can be separated into -

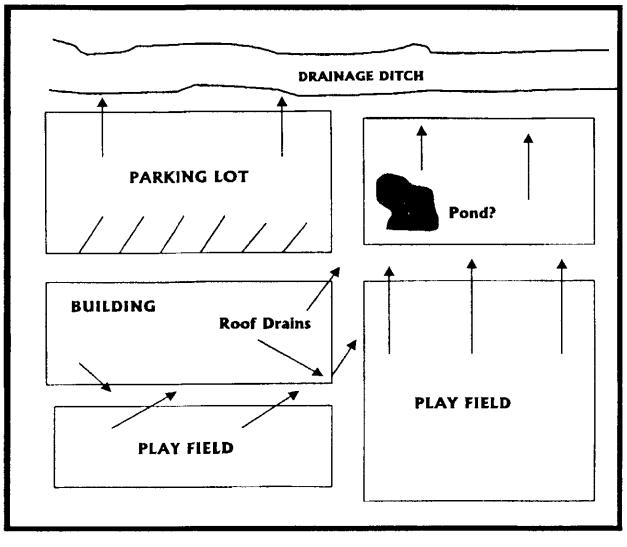
FOUR PHASES:

1. **Site selection**
2. **Design**
3. **Installation**
4. **Maintenance**

1. SITE SELECTION:

Selecting a site to construct a pond or wetland should be part of your overall site evaluation. Consider the following when surveying your area:

- **Topography**
- **Hydrology**
- **Sunlight**
- **Soils**
- **Access**



Topography - Note those areas that appear to be low lying, where water tends to stand, or where the soils stay wet for an extended period of time. If no natural collection areas exist, then note all flat areas that may be suitable for an excavation. Some schools may have opportunities to block a shallow drainage swale or other area where suitable topography directs rainwater flow.

Hydrology - Where will the water come from for your project and how will it get there? Most schoolyard ponds will not be large enough to maintain water between rainfall events during a typical summer. If you want to construct a large capacity pond, determine what the potential watershed might be. Schoolyards, athletic fields, parking lots, and the school roof may offer opportunities to collect and direct rainfall to your pond. However, most sites may have to supplement rainfall with an additional water source, such as municipal water. Determine where the nearest tap is located and how far will it have to be piped to reach the pond. However, in parts of the state where municipal water is limited, you may have to rely entirely on rainfall. This fact may also limit the size of your pond.

Figure (9). Determine the drainage pattern for various areas around your potential pond site. The arrows show the water flow direction in this illustration. Is your pond located where it can be refilled from runoff? Try not to block all of the drainage or flooding might result in undesirable places. Also try to avoid drainage from heavily fertilized fields or asphalt parking lots. Fertilizers and oily runoff from those sources may pollute your pond and cause plant/animal deaths or algae blooms.

Sunlight - Most wetland plants require at least five hours of sunlight to survive and thrive. Be aware that trees and buildings may cast shadows on your pond for long periods each day. Note where the shadows of new trees might fall as they mature.

Soils - Probably the best and by far the least expensive pond is a natural one, a result of digging a hole in suitable soils and filling it with water. The key to a soil's ability to hold water is its clay content. Relatively simple tests can be conducted to evaluate your soil. Often this test can be conducted by your students (refer to the "Ponding Potential Test" in this section for soil testing procedures). Your test results will help you decide the type of pond you can build. Resource professionals can also help with this evaluation.

Access - The site you choose must be accessible in several respects. It should be accessible for student instruction, for wildlife recruitment, for construction, and for maintenance.

If your pond will be dug by a piece of construction equipment, the operator must be able to get to the site and have room to maneuver during the excavation process. Dirt excavated may have to be removed with a dump truck. Access for that equipment must be considered. Without access for such equipment, hand digging is your only option.

2. DESIGN:

Once a suitable location has been chosen, you can proceed with project design. Considerations to be made during this phase of your project include the following:

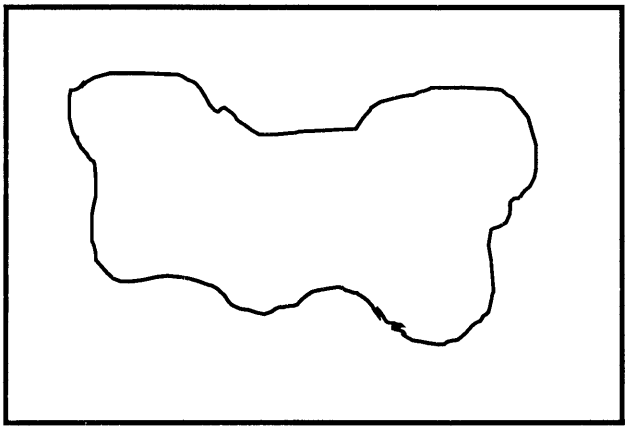
- **Shape**
- **Size**
- **Depth and Profile**
- **Lining Options**
- **Pre-form Designs**
- **Access**

Shape - If your soils prove to be suitable for a natural pond, your shape can be as freeform (irregular) as you would like. Regular is not better. Curves, dips, points, and coves provide more shoreline and better hiding places for animals. Keep in mind the necessary excavation method and whether this chosen method will result in the shape you conceive.

If your soils are not suitable for a natural pond and a lining material is necessary, then complex shapes may not be practical. The need to use a clay or synthetic liner will likely require shapes that are more circular or rectangular. Liners have limits on their ability to conform to every contour.

Size - Pond size is only limited by your site, needs, hydrology, and budget. Most schools will need an additional water source to maintain their pond year round. Runoff from rainfall will probably not be a viable option. A pond approximately 20 feet wide and 20 feet long, with an average depth of one foot will hold 3,000 gallons of water (7.5 gallons per cubic foot). Water costs can then become a factor in deciding pond size. Disposal of excavated soil (spoil) also has to be considered. Excavated soil occupies more volume than when it was a part of the earth. The excavated soil may become many dump truck loads of dirt. Where will you put it? Do you create a pile somewhere or haul it away?

IRREGULAR POND SHAPE



Depth and Profile - Pond sides with gradual slopes allow for the establishment of a diverse plant community and easy access for wildlife. If children are allowed at the edge of a pond, gentle slopes will limit missteps to wet feet only, rather than complete submergence. A ratio of 3 feet horizontal run for every 1 foot of vertical depth is sufficient. Some sides of your pond may be steeper and some flatter if needed. A maximum depth of 2 feet is sufficient for most ponds on schoolyards. If your site can accommodate a pond with greater depth, great. In northern parts of the state, check with your resource professionals to determine the depth needed to

GRADUAL SLOPE

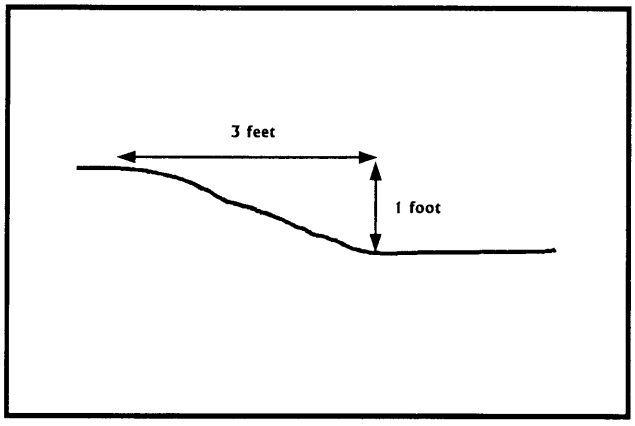


Figure (10). Ponds with gradually sloping sides enable plant growth and easy access for wildlife. A ratio of 3 feet horizontal run for every 1 foot of vertical depth is suggested.

- Synthetic Liners: Materials made of vinyl, polyethylene, and butyl rubber are available from various local sources. These materials vary in cost, thickness, and width. Check on the availability of standard widths and size your pond accordingly. Standard sizes are usually cheaper than custom orders. If you require a custom fabricated liner for your pond, the cost per square foot will increase. Also check on the liner's temperature tolerances to make sure it can withstand freezing temperatures. When designing a pond with a liner, remember to over-excavate to allow for returning at least 6 inches of top soil back into the hole as growing medium for plants. If you have rough soils or jagged tree roots in the hole, you may need to cushion the liner with materials, such as thick layers of newspapers, old carpet, or thick layers of sand.

prevent your pond from freezing solid in the winter. Keep in mind that some school districts may have concerns about drowning if you make your pond too deep. Some municipalities may regulate ponds, based on their size and depth.

Liner Options - If you discover your soil will not hold water, you must then modify the excavation with a lining material.

- Clay Lining: Bentonite, a processed clay product, can be mixed with existing soil to form a waterproof lining. However, the product can be expensive and application may be difficult. Natural clay is another alternative and may be purchased in some areas. It is applied in a uniform layer up to 12 inches thick throughout the excavation. Compaction is then recommended. Deeper excavation is required to allow space for the layers of clay and top soil needed to bring your pond back to its designed depth and contour.

OVER-EXCAVATE POND DEPTH

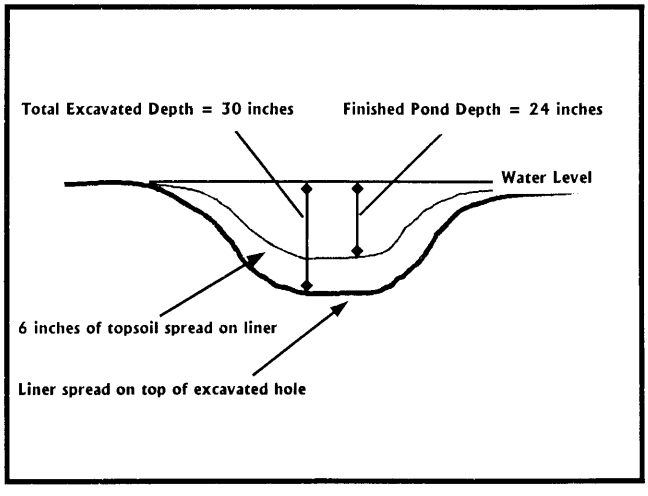


Figure (11). Over-excavate the pond depth to allow for topsoil on top of liner. For a 2 foot pond, excavate at least 30 inches deep. Remember to maintain the gradual slope along the pond edge.

DETERMINING LINER SIZE

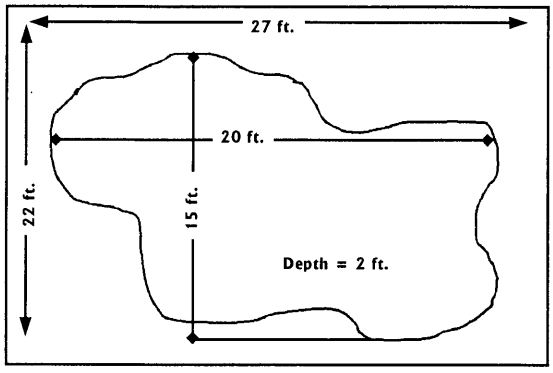


Figure (12). Determine the necessary liner size by measuring the longest and widest points on your pond.

CONSIDER ALL THE MEASUREMENTS

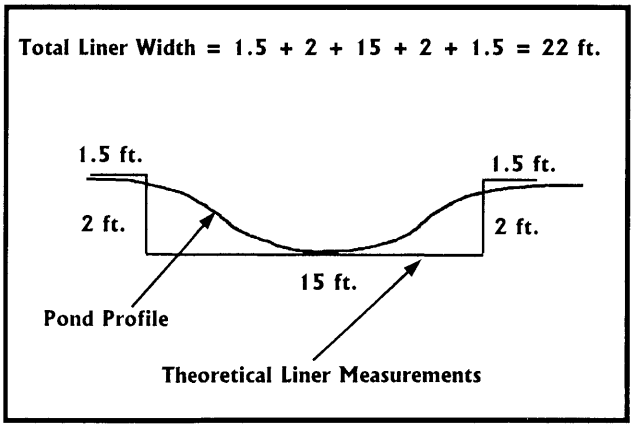


Figure (13). Determine the liner size by adding the overlap on each side, the depth on each side, and the bottom width or length.

When calculating the size of your liner, a rule of thumb is the width or length, plus two times the maximum depth, plus three feet.

Example:
L = Length W = Width D = Maximum Depth
L = 20 ft. W = 15 ft. D = 2 ft.

Liner size = (L + 2D + 3) by (W + 2D + 3)
Liner size = (20 + 4 + 3) by (15 + 4 + 3)
Liner size = 27 feet by 22 feet

Pre-form Ponds - Pre-formed, molded plastic, or fiberglass units are available. Your choice is limited by size and configuration. Most pre-form designs are not suitable for wildlife use since shallow areas are not usually included in the design.

Access - Most school ponds or wetlands will not be of sufficient size to withstand the impact of students gathering around the vegetated edges. A study platform or deck extending over the pond edge will allow for student access, protect vegetation, limit wildlife disturbance, and reduce the possibility of students returning to class wet and muddy. Remember the Americans with Disability Act (ADA) requirements when designing this structure. See Appendix V for an example design.

3. POND INSTALLATION:

Building a pond is like any other construction project. You will need to follow a stepped process to achieve your desired results. Because of access for construction equipment and soil disposal requirements, pond construction may have to be the first phase of your school habitat project.

Step 1: Layout - With your location known and your design in hand, lay out the perimeter of your pond on the ground. This can be accomplished with something flexible, like a garden hose or rope, or you may use spray paint, lime, gypsum, or flour.

Step 2: Excavation of Soil - This can be accomplished by hand, with shovels and wheelbarrows, or with construction equipment, such as a backhoe or bulldozer. Before excavation begins, have your plan in place for soil disposal. If you are lining your pond, set aside enough of the excavated top soil to go back into the hole to cover the liner at least 6 inches deep. Tools, such as a string and line level, surveying level and ruler, carpenter's level with straight edge, or a builder's level or transit will be needed to check for proper depth and uniform level grade around the perimeter of the excavation.

After excavation, in soils with marginal clay content, compact the bottom and sides of a pond using a tamper or plate compactor. These are available from local rental companies.

IMPROPER LEVELING

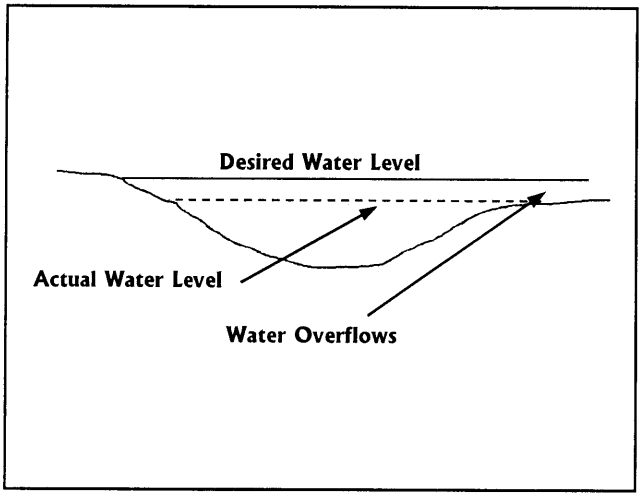


Figure (14). During the excavation phase, make sure all of the edges of the pond are at the same level. If one edge of the pond is lower, the water will overflow on that side. You may correct this problem by placing excavated soil in the low areas to build up the low side.

BOARD LEVELING METHOD (for smaller ponds)

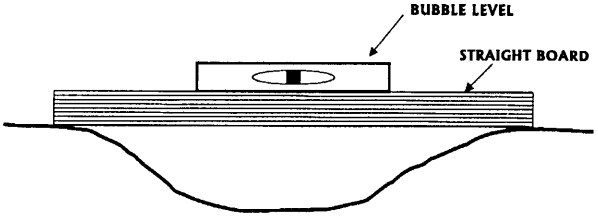


Figure (15). Board Leveling Method. Lay a straight 2"x 4"x10' or 2"x 4"x12' board or other straight material across the pond. A carpenter's bubble level placed on the board should show that the pond edges are level with each other.

TUBE LEVELING METHOD

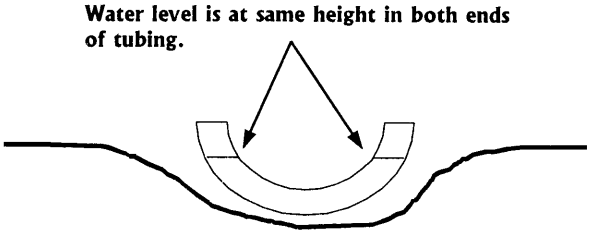
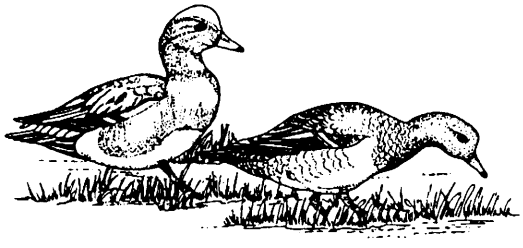
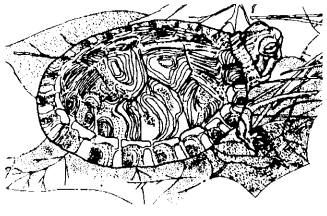


Figure (16). Tubing Leveling Method. Place a piece of clear tubing (at least 1/2" diameter) across the bottom of the pond, extending up both pond sides. Fill the tubing with water until the water level inside the tubing is even with one side of the pond. The water level inside the tube on the other side should also be at the same height as that pond edge. If not, adjust the soil level of the pond edges until the tubing water level matches on both sides.



Step 3: Installing the Liner - If your soils allow for a natural pond, this step is not necessary.

- Whether you use clay or a synthetic liner, it is best to install your liner soon after excavation is complete. A delay could result in a rainwater filled hole, requiring additional delays for pumping and drying.
- If using a clay lining, the clay should be applied as uniformly as possible and compacted.
- Remember to over-excavate to allow for the clay lining. If your completed design calls for a 24 inch pond depth, the excavation must be as much as 18 inches deeper (42 inches total) to allow for up to 12 inches of clay and 6 inches of top soil to go back into the hole.
- Fill a clay-lined pond with water as soon as possible after completion. If allowed to dry out, the clay may shrink, crack, and fail to hold water.
- A synthetic liner may not require as much over-excavation as a clay lining. However, you must consider sand or topsoil placed over the liner for plant growth and any material placed under the liner to protect it from punctures.
- Check your excavation prior to putting the liner in place. Sharp objects, such as rocks or tree roots, may damage the liner. Remove such objects or cover them with a layer of sand, old carpet, or multiple layers of newspaper or cardboard.
- While plants can be grown in pots, it is best for wildlife to have a natural pond bottom. Place sand or top soil over your liner to create the pond contour of your design. You may leave some of the liner uncovered to exclude plant growth in those areas.



Step 4: Adding the Study Platform or Deck - It is easier to construct a study platform or deck prior to adding water to your pond. If your deck design requires support posts inside the pond, install them as soon as possible after excavation is complete. Natural bottom ponds can have these posts installed like fence posts. Ponds with liners will require a concrete stepping stone or deck foundation block, cushioned by the soil, and placed above the liner to support such posts. Care should be taken to ensure that posts located inside the pond are extremely stable and sturdy prior to student use. See Appendix V for a sample study platform/deck design.

Exterior grade pressure-treated pine is typically used for these projects. Consider using some of the new, high tech materials for your deck. Lumber made from recycled plastic or a combination of recycled plastic and wood fibers is available. While these products may cost more initially, they have a longer life span, do not have splinters, and do not leach any chemicals.

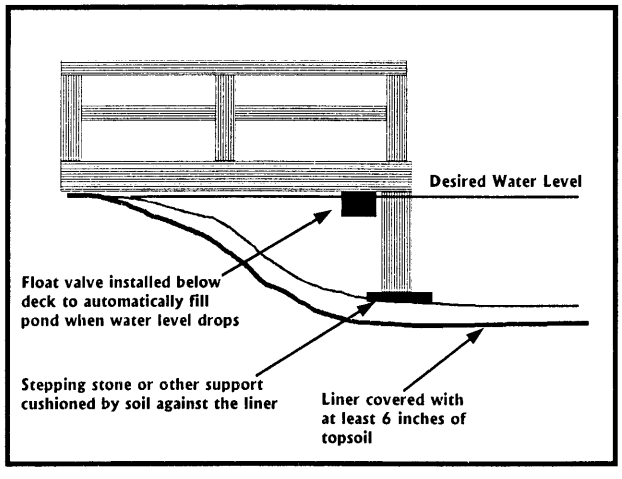


Figure (17). Ponds with synthetic liners require a cushioned concrete pad to support the posts of the deck.

Step 5: Filling - Once work in the excavation is complete, start filling your pond with water - either rainfall or municipal water. Allow the pond to remain full for several days before introducing your plants. This will allow pH levels to stabilize, any chlorine to dissipate, and the soil to soften enough to install your plants. Water streams from runoff or a garden hose may cause erosion in fresh soils. Lay a piece of burlap, old carpet, or a tarp at the discharge point to reduce this problem.

Step 6: Planting - Choose aquatic plant species native to your area. Aquatic plants establish and spread quickly, so you may not need many. Look for diversity in size, structure, and growth habit when selecting your plants. Include emergent, submergent, and floating-leafed species in your selection. See Figure 18. There are commercial sources for many aquatic plants, but check with other schools or individuals with ponds to ask about getting transplants. Be aware that many non-native species have become established locally. Some are harmful or potentially harmful due to their aggressive, invasive growth habitats and are prohibited from possession.

PROHIBITED (ILLEGAL) AQUATIC PLANTS IN TEXAS

Alligatorweed
Eurasian watermilfoil
Giant duckweed
Salvinia, all species
Hydrilla
Water hyacinth
Water lettuce
Water spinach
Rooted water hyacinth
Torpedograss
Lagarosiphon
Paperbark (Melaleuca)

These plants are highly invasive and detrimental to a pond. These species are against the law for you to possess. Many pond and aquatic plant books have photographs of these plants so you can recognize and avoid them. Check with your local resource professionals for more information.

4. MAINTENANCE:

Pond maintenance will mostly consist of maintaining water levels and controlling excess vegetation. In shallow ponds (up to 3 feet deep), vegetation will eventually cover the entire water surface. Less desirable plants, such as cattails, can cover a pond in one or two growing seasons. Ideally a ratio of half open water and half vegetation should be maintained. For small ponds, the easiest method of control is simply to pull plants out and dispose of them. You can do this as often as necessary, but it may be required at least annually. If you have a large pond, excavating portions of it to depths over three feet will help keep those areas free of emergent vegetation. Remember, you will not need a filter or electric water pump for this type of pond. The plants will filter the water.

Float Valves -

If your water levels will be maintained with municipal water, allow no more than 10% of the water volume to be replaced at a time. This will eliminate the problem of chlorine shock. Problems associated with monitoring and maintaining water levels can be eliminated by installing an automatic float valve on a live water line connected to your pond. Two models, the Dare-O-Matic Farm Tank Float Valve and the Hudson's Revolutionary Water Control Valve, are inexpensive units that may be available locally. Installing your valve beneath the study platform keeps it out of sight, away from tampering, and accessible for maintenance.

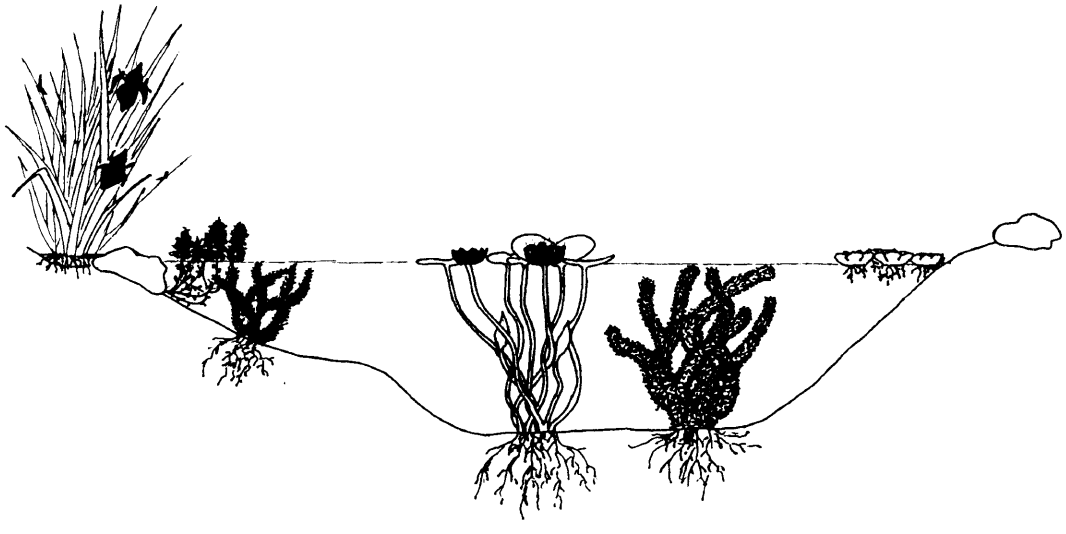


Figure (18). Ponds with gradually sloping sides support a variety of plant types. Install a mixture of emergent, submergent, and floating plants in your pond. Illustration by Michele G. Foss.

EVALUATING YOUR SOILS FOR PONDING POTENTIAL

The ability of a soil to hold water depends on the size and proportion of its mineral particles, referred to as texture. Particularly important are the clay particles. Soils containing at least 20% clay particles will generally hold water.

You can assess your soil's potential to hold water by judging its texture and testing its percolation rate. Both tests can be done by students. For most sites, the test needs to be conducted at only one location. If your pond or wetland is large, you may have to establish multiple sampling points.

PONDING POTENTIAL TEST:

Step 1: Dig a hole at least 6 inches deeper than your planned excavation depth. A post hole digger will work fine for this operation.

Step 2: Take a soil sample every 6 inches and perform the "Soil Texture by Feel" test (Appendix H) for each sample. Compare your results with the soil texture pyramid. Note any obvious change in soil color as you take each sample.

Step 3: Fill the hole with water and place a marker, such as a meter stick, in the hole to monitor any drop in water level. Cover the hole with something, such as plywood, to reduce evaporation. If the water level drops no more than 2 inches in 48 hours, a natural pond can probably be constructed in your soil type. Depending upon the season, you may have to add water to the hole two or three times, until the soil surrounding the hole is saturated and your water level stabilizes.

Soil surveys, available from the local office of the Natural Resources Conservation Service, can also be consulted. Representatives of state and federal resource agencies may also be of help in this process.

SOIL TEXTURE PYRAMID

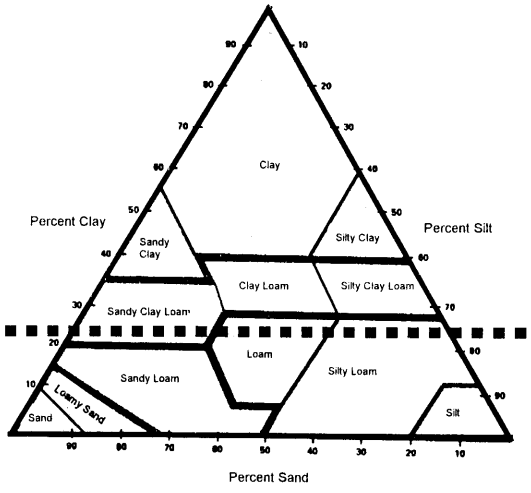
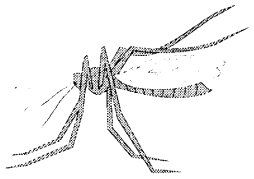


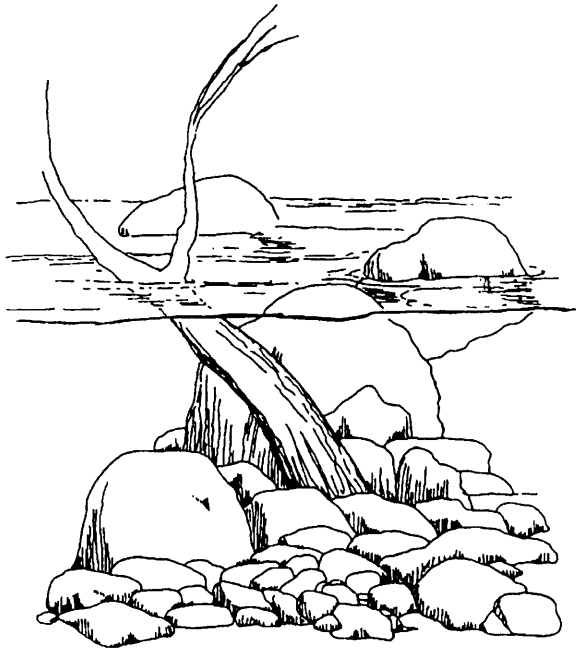
Fig. (19). Usually the more clay a soil contains, the more it is capable of holding water. Soils located above the dotted line are capable of holding water. Refer to the Appendix for the "Key to Soil Texture by

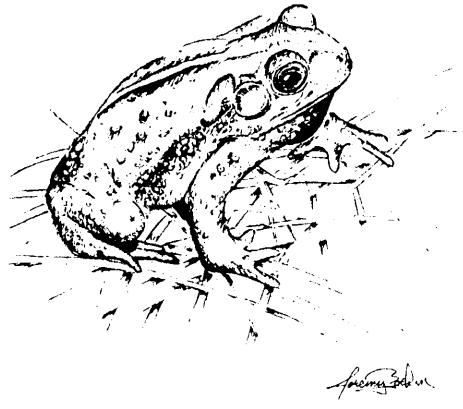
MOSQUITO CONCERNS



Mosquitoes are part of the natural environment and, as such, can be expected to be associated with your habitat. Properly constructed and maintained, your pond will not be a source of mosquitoes, but will actually help control them. Making sure your pond has mosquito fish (*Gambusia* sp.) or other such predatory fish species will eliminate your concerns. Ponds with such predators actually become "mosquito sinks," encouraging the female mosquitoes to lay their eggs. The eggs and larvae are then consumed by the fish and insect predators, so no adult mosquitoes emerge. You may even notice fewer mosquitoes rather than more. This will be especially true if you eliminate other sources of still, standing water in the area - those without mosquito predators.

Another method to control mosquitoes is the use of a "BT dunk." Dunks are specifically designed to use in ponds. They use the bacterium, *Bacilllus thuringiensis*, to kill targeted insect pests. There is a BT variety, called BTI or *Bacillus thuringiensis* var. *israelensis* that specifically attacks mosquito larvae when applied to standing water. The bacterium will not harm fish or other animals.





REFERENCE MATERIALS

The Complete Pond Builder, Helen Nash, Tetra Press.

Complete Guide to Water Gardening, Peter Robinson, American Horticultural Society, DK Publishing.

WOW! The Wonders of Wetlands, (curriculum) An Educator's Guide, Environmental Concern, Acorn Naturalists, (800) 422-8886.

Pond Life, Golden Guide series, Golden Press.

Wetlands, Investigating Swamps, Bogs, Fens, and Marshes by Pamela Hickman, Acorn Naturalists, (800) 422-8886.

Guide to Freshwater Ecology by Christine Kolbe and Mark Luedke, Texas Natural Resource Conservation Commission, P. O. Box 13087 Austin, TX 78711-2087.

Step 7. Explore Interpretive Components

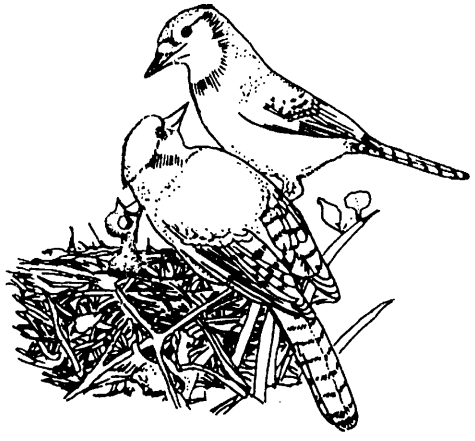
Involvement is the key!

This project should involve students from the very beginning, from planning to development and maintenance. Student input is critical and valuable. By encouraging their participation in each step, you are fostering pride and ownership in the site, instilling confidence in the students' abilities, and perhaps reducing future vandalism problems. Students can accomplish amazing things when they put their minds to the tasks.

The school habitat is valuable only if students are given opportunities to explore and learn from it. Encourage awareness and appreciation for nature. Build the learning foundation. Students should be involved in every stage of habitat planning, inventory, development, implementation, and fund-raising. When students are involved, they feel ownership in the project and care about the end results. Students are more likely to guard against vandalism of the site.

ENCOURAGE INVOLVEMENT: The list of activities available to involve students is endless. Survey teachers and students to generate more ideas. Teachers know their students' capabilities and can recommend activities. Don't be afraid to use your imagination. The following ideas have been used successfully at other schools.

- Allow a student committee to oversee certain aspects of site maintenance, such as trail maps, signage, weeding, or watering.
- Give extra credit or other special incentives to students who participate in work days or after school habitat clubs.
- To assist with ongoing maintenance, assign a specific bed or habitat area to a specific classroom to maintain for the year.
- Younger students could fill feeders and bird baths each day.
- Train specific students to give guided tours of the habitat, or to serve as mentors for younger students beginning their gardening activities in the habitat.
- Ask art students to design signs to identify plants or activity stations.
- Encourage math students to map or graph the site, especially during the inventory stage.
- Invite language arts students to write the text for signs, trail guide, or trail maps.
- Assign social studies students a native plant to research, including the medicinal or other uses of native plants by early pioneers and Native Americans. This information can be included in the trail guide.
- Listen to bird call tapes and encourage music classes to write songs from bird calls.
- Drama students could write plays or design puppet shows about food chains or unusual events occurring in the habitat.
- Ask construction classes to design and build benches, picnic tables, nest boxes, and feeders.
- Parent volunteers or families might water and weed the area during the summer months when school is in recess.



COORDINATE WITH YOUR CURRICULUM:

A school habitat is not a stand alone classroom. If the habitat is only seen as a place to visit once a year, then the activities accomplished there will have little meaning to anyone. Coordinate activities in the habitat with the school curriculum, including all subjects, not just science. Include activities from the TEKS or TAAS objectives in the school habitat. Thousands of other outdoor-type activities exist in outside reference books, so many that only a few can be listed in this workbook. Share good reference materials and include them in the school's resource center.

TEACHER TRAINING:

Teachers must feel confident in the school habitat before they feel comfortable leading student activities in the habitat. For that reason, your school habitat committee should offer periodic in-service workshops to continue teacher training. For example, invite guest speakers to present programs or workshops on topics like wildlife observation skills, plant identification, insect identification, or pond maintenance. Project WILD and Aquatic WILD, Project WET, Project Learning Tree, Texas Amphibian Watch, Adopt-A-Wetland, and the Master Composting program have curriculum and local teacher workshops associated with each program.

DEVELOP A RESOURCE CENTER:

To encourage year-round utilization of the habitat by many classrooms and teachers, establish a resource center in an easily accessible area. The resource center should include activity books and other curriculum ideas, reference books for teachers, field guides, trail maps, and field equipment. The resource center could be as simple as a large trunk located in the teacher's lounge, library, or other central location. Store gardening tools where they will be accessible to all teachers.

ADDITIONAL STUDENT ACTIVITIES:

- Demonstrate composting in the classroom through vermiculture (worm composting). The worms turn lunch leftovers and newspaper into a rich compost.
- Establish activity stations along the trail where students complete a specific activity. Themes or topics could include plant anatomy, plant identification, wildlife observation and identification, geology, soil, erosion, archaeology, and more.
- Create a larval food section in the butterfly garden to observe the butterfly or moth life cycle.
- Plant a moth garden with night blooming plants. Set up a "moth trap" at night, using a white sheet and bright light. Identify each moth and count the numbers of each to determine population and diversity.
- Inventory the wildlife visiting or living in the habitat through various methods: observation, census counts, insect traps, soil litter traps, track boxes, and others.
- Learn to use an identification key.
- Participate in the Monarch Watch, Texas Amphibian Watch "Adopt-a-Pond" Program, Hummingbird Roundup, or Cornell's Project Feeder Watch.

ANIMAL TRACK PLOT:

Clear a 3' x 3' area of all grass or vegetation and fill with sand. This cleared area could be a portion of secluded pathway. Place food scraps, grain, or other bait near the plot to attract wildlife. The night before the student activity, moisten the sand so that it is soft enough to leave clear impressions by animal feet. Permanent track casts can be made by filling the tracks with plaster.

PERCH N' PLANT:

This study area allows students to observe a fence row and watch plants develop without human help. Clear all vegetation on a narrow strip of land. Till the soil, if possible. If the land is located along an

existing fence, clear vegetation on both sides of the fence. Otherwise, erect a fence post on each end and stretch a thick wire or rope between the posts. As birds begin perching on the rope, their droppings will be "planting" a variety of seeds. Keep a list of the bird species observed perching on the rope and what types of plants begin growing underneath the rope to determine bird food preferences. A variation of this activity might include placing the perch on only one end of the area, while allowing the other half to establish and grow naturally. Then have students compare and contrast the plant species between two areas.

PLANT SUCCESSION AREA:

By leaving an undisturbed piece of the land in your habitat, students can observe the natural process of succession. Either start with a bed of bare soil, or leave an unmowed area along an edge of the habitat. Survey the area each month to identify each plant that appears. Keep a chart to record changes through the months or years.

Succession is the gradual replacement of one community of plants and animals by another group. Every acre of soil and water has a definite sequence in plant cover that occurs over time, called successional stages. In general, the stages of plant succession that occur over time on land are: 1) bare ground, 2) annual forbs and/or grasses, 3) perennial forbs and/or grasses, 4) shrubs, 5) young woodland or trees, and 6) mature woodland or trees. A single step in this succession may take weeks, years, or centuries, depending on a variety of natural and human-caused factors. Wildlife species using the area will change as the plant community changes. (See Stages of Succession, Appendix O.)

TIME CAPSULE:

It's fun to look at momentos from the past, particularly when those items have some personal significance. Clues to what was news, what was popular and more can be rediscovered when placed in a time capsule to be opened years later. For example, kindergarten students might place news clippings, photographs, tapes, and other items in a time capsule to be opened when they reach the fifth grade. Place a time capsule in an undisturbed, permanent location. Mark the spot. Identify a date when the capsule will be reopened.

WILDLIFE FOOD PLOTS:

Planting strips of grains or other food plants, such as soybeans, sorghum, sunflowers, and partridge pea, provides a good food source for wildlife over the winter. A typical food plot would be 8-10 feet wide by a certain length. However, an old vegetable bed might serve the purpose. Plant the food plots in alternating strips or parallel to a fence row, wooded edge, or creek bank. Allow the seed heads to remain on the plants through the winter. Remove the large plants and till the site in the spring.

COMPOSTING AREA:

Compost is an important component in the health of your school habitat, as well as providing an interesting educational activity for students. Compost is nature's fertilizer. Compost improves soil structure, texture, aeration, and increases the soil's water holding capacity. Compost loosens clay soils and helps sandy soils retain water. Adding compost promotes soil fertility and stimulates healthy root development in plants.

To create compost, you will need equal amounts of "browns" and "greens". "Browns" are dry materials, such as dried leaves, wood chips, and twigs. "Greens" are fresh, moist materials, such as grass clippings, weeds, and food scraps. Avoid using woody stalks, large branches, fats, and meats. These items will take much longer to decompose and may attract nuisance animals. Keep your compost moist. A good rule of thumb is to keep the material as moist as a wrung-out sponge. Turning your compost is necessary to ensure proper aeration, which promotes aerobic decomposition. Turning should be done once a week, or whenever you add new material. For additional composting information, contact the Texas Natural Resources Conservation Commission (TNRCC).

WILDLIFE VIEWING BLIND:

One of the best ways to observe birds and other wildlife is from behind a viewing blind. A simple wood frame structure is covered with wire mesh or wooden lattice, and then camouflaged with leaves, vines, and other natural vegetation. Be sure to leave small openings at the right height for student viewing. The blind should overlook an area frequently visited by wildlife, such as the wetland or pond. The blind can be a permanent structure, or constructed in a way so it can be folded and moved.

ARCHAEOLOGICAL DIG:

Create an area where students can learn the traditional techniques used in archaeological digs while unearthing artifacts that were previously "planted." This type of activity can be used to incorporate social studies and soil investigations into the school habitat.

GEOLOGY AREA:

Begin with a group of large rocks that are too heavy to be thrown. Place the rocks in a pile or along a fence row, wall, or other area away from mowers. Encourage students to bring rock samples from home or from their vacations. Each rock should have an interesting feature or special classification to study. Besides geology/earth science, rocks can be used during math and physical science to study weights, mass, volume, geometric shapes, and properties of physics.

SOIL STUDIES:

Soil is a precious natural resource. Students should be provided opportunities to learn about the soils in your area. Use the information from your county soil survey and determine if you have a variety of soil types. Establish a soil testing area for each soil type. Students should examine the soil, layer by layer. Compare and contrast the vegetation growing on the various soil types. Your county Natural Resources Conservation Service agent can provide a free copy of your county soil survey, as well as classroom activities dealing with soils.

EROSION CONTROL DEMONSTRATION:

An area with moderate slope can be used to demonstrate the effects of erosion and methods used to control it. The area should range from 10 to 30 feet wide. If a suitable slope cannot be found, one can be created by mounding and compacting soil in a hill about 3 to 4 feet high. (The soil removed from pond excavation could be used to create this.) Remove all grass and other vegetation from the area, leaving only the bare soil exposed. Divide the area into 3 equal sections. In Area A, leave the soil exposed. In Area B, cover the soil with rip rap (large stones). In Area C, plant a ground cover noted for controlling erosion. (See Plant Tables in Appendix W.) Control the ground cover so that it does not invade Area A or B. Students can study the effects of wind and water erosion on bare ground, as well as observe which methods are effective to control erosion in your area. To quantify the amount of erosion occurring in each section, a collection container can be placed at the base of each section to collect sediment and water from runoff. The amount of sediment and water can then be measured and charted.

GROUNDWATER MONITORING AREA:

This activity provides students with the opportunity to observe fluctuations in the water table throughout the year. Data charted on a regular basis may show monthly and seasonal fluctuations. If your school has more than one soil type, your students will be able to compare their results for each soil type. Refer to the county soil survey (available free from your county Natural Resources Conservation Service agent) to check your soil types and expected water tables. To make a groundwater monitoring hole, use a post hole digger or auger and dig a hole 5 to 6 feet deep. Take a piece of PVC pipe and drill many one-eighth inch holes in it. Place the pipe in the hole to prevent the surrounding soil from caving in. Cap the top of the PVC pipe with some type of removable cover. Use a meter stick or other calibrated stick to take measurements of the groundwater level.

INSECT TRAPS:

To provide opportunities for students to learn more about insects, insect traps can be used for collection purposes. Traps vary depending upon the type of insect to be collected. Traps can include a 1) mashed banana placed in a jar, 2) jar or can placed in hole in ground (with thin layer of rubbing alcohol in the bottom of jar), or 3) a commercially purchased insect trap containing a pheromone to attract a specific kind of insect. Another method of attracting insects at night is to hang a sheet against a wall or between two trees. Shine a black light onto the sheet. To view the insects, turn off the black light and use a flashlight to spotlight each insect.

NATURE'S TREASURE CHEST:

Establish an area where students can donate interesting nature-related items to share with other students. Students may use the area like a bank, depositing a new item and withdrawing another item on loan to study for awhile. Items may include rocks, galls, leaves, bones, or other interesting items.

TREE RING STUDIES:

Major events in a tree's life are recorded in the growth layers or rings of a tree. Students can study a cross section of a tree and learn about drought, floods, fires, lightning strikes, struggles against insects, battles against diseases, competition with other trees, and more. Students can use the cross section as a calendar, marking significant events in our history on the rings. Students can visualize the tree's growth rate by comparing the tree's diameter in various years.

WEATHER STATION:

Students are usually fascinated by weather. By installing a few weather instruments on the school grounds, students can observe and record the weather on site and compare it to the local television news or newspaper. They can chart fluctuations both daily , seasonally, and annually. The equipment is relatively inexpensive. Students can keep daily records of temperature, precipitation, barometric pressure, relative humidity, wind speed, and wind direction. The equipment should be placed in a location where it will not be influenced by the school buildings or overhanging vegetation.

USING KEYS:

It is helpful to know how to use a key when you're doing a plant or animal inventory. Many plant identification books include keys to separate one similar plant from another. The best way to understand a key is to construct one.

Learning the Use of Keys:

The objective of the following technique is to help your students become independent and persistent in their search for the correct name. This is a case where directing their experience can be helpful. The first attempt might be a class effort with your assistance.

Method:

Assemble a small collection of common objects, such as, fruit (apple, orange, pear, lemon, banana, tomato). Discuss ways in which these fruits differ. These differences (shape, texture, color, taste, size, etc.) will provide clues leading to their names.

Start by making a pair of statements (clue 1) about one of the differences. Group the fruits in accordance with these clues.

Clue 1:
Round - apple or orange or tomato. Move to clue 2.
Not round - pear or lemon or banana. Move to clue 4.

(Deal with the round things first. Make another pair of statements for the second clue.)

Clue 2:
Skin rather tasteless - apple or tomato. Move to clue 3.
Skin bitter tasting - orange.

(Since an orange is the only fruit fitting this clue, it is not necessary to go any farther.)

Clue 3:
Soft, easily squashed - tomato.
Hard, not easily squashed - apple.

(Now return to the group of fruits that were not round.)

Clue 4:
Less than 6 inches in length - pear or lemon. Move to clue 5.
More than 6 inches in length - banana.

(Make the final clue to separate the pear and lemon.)

Clue 5:
Skin thick (more than 1/8 inch) - lemon.
Skin not thick (less than 1/8 inch) - pear.

Figure (20). This activity was reprinted from Homes for Wildlife, by New Hampshire Fish and Game.)

WILDLIFE OBSERVATION SKILLS:

- Be quiet. Loud noises startle animals. Most wildlife species have excellent hearing, making it difficult to sneak up on them. Move quietly. Speak in whispers or not at all.
- Move slowly with no quick, surprising movements. The closer you are to an animal, the more slowly and quietly you should move. Or freeze in place while you observe the animal.
- Keep your eyes glued to the animal first for one minute, then look down to record the information you observed. Take note of how the animal moves, the sounds it makes, its body shape, its coloring, and which part of the habitat it prefers.
- Be patient! If you continue observing quietly, the animal may eventually move into a good spot where you can see it better.
- Get the sun at your back. If possible, move around so that the sun is shining on your back. That way, the sun will be shining on the animal you are observing, illuminating the animal's coloring better.
- When using binoculars, keep your eyes on the animal. Bring the binoculars up to your eyes while holding your head still.

REFERENCE MATERIALS

Project Feeder Watch, Cornell Laboratory of Ornithology, 159 Sapsucker Woods Road, Ithaca, NY 14850-1999, (800) 843-BIRD.

Monarch Watch, Dr. Taylor, Dept. of Entomology, University of Kansas, Lawrence, KS 66045, (913) 864-4051, http://monarch.bio.ukans.educ/.

Green Teacher magazine, Issue #47, "Schoolyard / Outdoor Classrooms", and Issue #50 "The Outdoor Classroom", P. O. Box 1432, Lewiston, NY 14092.

Nature at Your Doorstep, Real World Investigations for Primary Students by Carole Basile, Teacher Ideas Press.

City Kids and City Critters, Activities for Urban Explorers, by Janet Roberts and Carole Huelbig, Learning Triangle Press.

Mapmaking with Children, by David Sobel, Heinemann Publishers, 361 Hanover St., Portsmouth, NH 03801.

STUDENT SAFETY GUIDELINES

There are potential hazards in any outdoor setting. The school habitat is no exception. Explore the habitat, but do so safely. Enforce student safety rules to establish expected behavior and explain the rules to students before venturing into the habitat. A few good safety rules include the following:

- The school habitat is a place for study, just like inside your classroom. Classroom rules of good behavior still apply outside.
- Listen carefully and follow all directions your teacher gives you.
- Handle field equipment with care.
- Do not leave the study area without permission from your teacher.
- Never put anything in your mouth, especially berries or other plant parts, unless your teacher gives permission.
- Walk, don't run. Watch where you are walking. Stay on the path unless your study requires leaving the path.
- Don't put your hands where you cannot see. Use a stick or tool handle to turn over logs, instead of using your bare hands.
- Don't place objects in the path where other people may trip on them.
- Leave the habitat the way you found it or better. Pick up litter and equipment before you return to the classroom.

Step 8: Design the Site Master Plan

The site goals, site evaluation, your research, your committee's ideas, and your imagination combine to help you develop your site master plan. Creating a design that includes the specific features of your school habitat is not as difficult as it may seem. You have already selected the general types of habitats (Step 5). Now you are ready to add in specific shapes to represent those habitat types. Take into account everything you have learned about the habitat components and educational ideas.

Eventually you will select specific plants to fulfill the desired functions and accomplish your objectives. However, think in general terms now.

DRAW IN GENERAL SHAPES:

PATHWAYS – Sketch in the basic shape and direction for your pathway. Use a double-set of curved lines to represent the pathway. Typical pathways may range from 4 feet to 8 feet wide. Choose the width you want and space the lines the appropriate distance apart for the scale you are using. Make sure the pathways will take your students where you want them to go.

POND – If one of your goals is to construct a pond or wetland, sketch in the pond's location and shape now. Add a study platform or observation deck. The deck gives students one access point to the pond and prevents trampling damage to the remaining pond edges.

TREES, SHRUBS, AND OTHER PLANTS – Draw in the general shapes of the plants, to the correct scale, to fulfill the habitat types you have selected. For example, a wooded area would be represented by large circles (large trees), medium circles (small trees), small circles (shrubs), and other symbols to represent groundcovers and perennials. Remember to represent the layers in a forest, including the overlapping trees and shrubs. When you draw them on your plan, the tree and shrub circles will overlap as well, showing that the trees are growing above the shrubs. See Figure (21) as an example. To get a general idea of tree and plant sizes, consult the Plant Tables (Appendix W).

ACTIVITY STATIONS AND LEARNING AREAS – Determine the major educational components you plan to include in the habitat. If those activities will require a "station" or space to conduct the activity, then decide where you would like to place them. Examples of activity stations might include a weather station, outdoor seating area, or decomposition area. Use squares to show the space for those activities.

DESIGN TIPS

- **Curves replicate nature better than straight lines. Curved lines fool your eyes to make spaces seem larger or more distant. This would be important when dealing with a small site.**
- **Disguise boundaries. A small space looks more confined when its edges are obvious. Use shrubs or vines to soften the straight lines of a fence or wall. Or use open fencing materials, such as chain link, split rail, or lattice to gently define a boundary.**
- **Plant masses of color to create a visual impact and attract certain species, such as hummingbirds or butterflies.**
- **Remember to design your habitat vertically with layers of vegetation, including trees, shrubs, and groundcovers. Place shorter plants in the foreground with taller plants in the background.**
- **To make maintenance easy, research your plant choices and make sure you are planting each species in its preferred location. If you are dealing with potentially invasive vines or plants, isolate these species in a separate area.**

SELECT SPECIFIC PLANTS:

Study the general habitat types you have created, along with the more detailed shapes. Now you will fill in specific plants species to create your habitat.

START A SPECIFIC PLANT LIST:

Study the Plant Tables (Appendix W) and other reference materials. Make a brief list of essential plants that provide excellent wildlife benefits that you want to include in your habitat. Consider the many types of wildlife that will potentially visit the habitat. Select a variety of plants that will appeal to those wildlife species. Concentrate your efforts on plants native to your area. Every plant you select to include in your habitat should benefit wildlife in some way.

CONSIDER THE SEASONS:

Use the "Seasonal Food Chart" (Appendix F) to determine additional planting needs. Determine whether you have selected plants that offer food through every season. If not, then focus your efforts on choosing plants to accomplish that goal.

SELECT FOR MULTIPLE BENEFITS:

For best success, select plants that provide multiple benefits for wildlife. For example, a rusty blackhaw viburnum blooms in the early spring, providing nectar for butterflies. Those same flowers mature into ripe berries and become an excellent food source for birds in the fall. Native grasses offer fall and winter food, larval food, winter shelter, and spring nesting material. By choosing plants that supply more than one wildlife benefit, you are saving money and accomplishing your goal of year round habitat.

CONSIDER LANDSCAPING NEEDS:

Identify plants (See Appendix W) to fulfill other specific people-related landscaping functions, as well. For example, if your site lacks shade, then select trees to provide the amount of shade you desire. Possible landscaping goals may be screening, hedges, shade, color, erosion control, ground cover, or evergreen cover, among others.

RESEARCH THE PLANT'S NEEDS: Study each plant and consider its growing requirements (mature height and width, soil type, sun/shade, blooming or fruiting period, and more). Consult the Plant Tables (Appendix W) and native plant books, visit nurseries, and talk to resource professionals for help. Take note of special features for each plant, like berries produced on female plant only, or potential problems, such as invasive roots.

MATCH THE PLANT TO LOCATION:

Choose a plant that fits both the desired purpose and the available growing conditions. The process is like plugging pieces into a puzzle. You need to fit the plant comfortably into the correct location on the site.

CHOOSE OTHER MATERIALS:

PATHWAYS:

Consider the suitability of various materials for pathways. Options include decomposed granite gravel, shredded bark mulch, pecan hull mulch, pea gravel, sand, mowed grass, concrete, asphalt, and others.

- Concrete and asphalt are extremely expensive, but low maintenance and last a long time. These non-porous surfaces may cause water to drain off-site, rather than percolating into the soil.

- Granite and pea gravel are less expensive and low maintenance. Decomposed granite packs down to make a firm surface, which is important if you anticipate wheelchair use. Decomposed granite also drains well after rains, but allows water to flow through to replenish the soil. You may need to add more granite to low spots after a few years. Pea gravel does not pack down well and tends to migrate into other areas of the site. Both types of gravel are not good options to use on steep slopes.

- Mulch is cheap, often free, but may require frequent maintenance. Bark mulch decomposes rapidly, so new mulch must be added periodically to the path. The larger the bark chunk, the slower it will decompose. Pecan hulls may make an attractive mulch material. Some pecan growers offer the hulls free if you haul them yourself. Weeds like mulched paths, so frequent weed removal by hand or with herbicide may be necessary. Installation of a weed block material beneath the mulch may

prevent some weeds from emerging from the soil below, but other weed seeds will sprout on top of the mulch.

- The placement of pathways can affect the drainage pattern of the site. Consider the drainage when selecting pathway locations and material. Or insert PVC pipe or other material beneath the pathway to allow water to flow through.

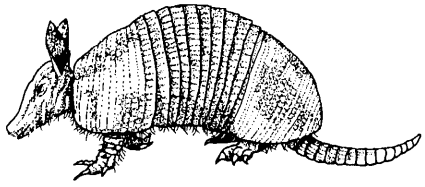
- Accessibility for students with special needs should be considered when designing pathways. Check with your school district to determine their Americans with Disabilities Act (ADA) requirements. Some material may not be suitable for special needs students.

EDGING ALONG PATHWAYS:

An edge along your pathway or trail is not required. However, some schools like to install an edge to prevent path material (granite, gravel, mulch) from spreading and plants from growing into the path. Edge materials can include chunks of wood, landscape timbers, stones, rocks, brick, pavestone, steel, plastic, concrete, and others. Choose an edging material that fits into the aesthetics of your design, stays within your budget, and is easily maintained. Edging may create a trip hazard, so choose your materials carefully.

DECKS, BENCHES, AND MORE:

Select a design for decks, benches, boardwalks, trellises, and fences that blends aesthetically with your other master plan selections. Check with your school district for their ADA access requirements prior to deck design. Emphasize low maintenance by choosing exterior grade lumber or recycled plastic construction materials. Refer to Appendix U for a sample bench design and Appendix V for a simple study platform/deck design.



MAP THE DESIGN:

Once you have identified specific plant species for each area, determined pathway materials, and selected benches, add the details to your master plan.

FEEDBACK:

Get feedback. Modify your plan, as desired, to accommodate that feedback.

MASTER PLAN CHECKLIST

Does your school habitat master plan include the following:

_____ **Variety of native plants**
_____ **Layers of vegetation**
_____ **Variety of food sources for each season**
_____ **Water source (shallow, permanent)**
_____ **Variety of shelter sources**
_____ **Winter shelter (evergreen shrubs, etc.)**
_____ **Dead snags or nest boxes**
_____ **Wildlife observation spots for students**
_____ **Comfortable path for student/teacher use**
_____ **Accessibility for special needs students**
_____ **Your goal:**
_____ **Your goal:**
_____ **Your goal:**
_____ **Your goal:**
_____ **Your goal:**

Refer to your goals from Step 2 to fill in the blanks.

DRAW IN GENERAL SHAPES TO REPRESENT HABITAT TYPES AND PLANTED AREAS.

- **Draw the shapes to scale.**
- **Start with the pathway shape and direction.**
- **Next, sketch in the pond. At this point, you can sketch in a basic shape to show the planned pond size. Or you can sketch in the actual shape you have planned, with curved, irregular edges.**
- **Then begin adding shapes for plant material. Represent the large vegetation, such as trees, first.**
- **Number the plant shapes so you can fill in a specific name later in the process.**

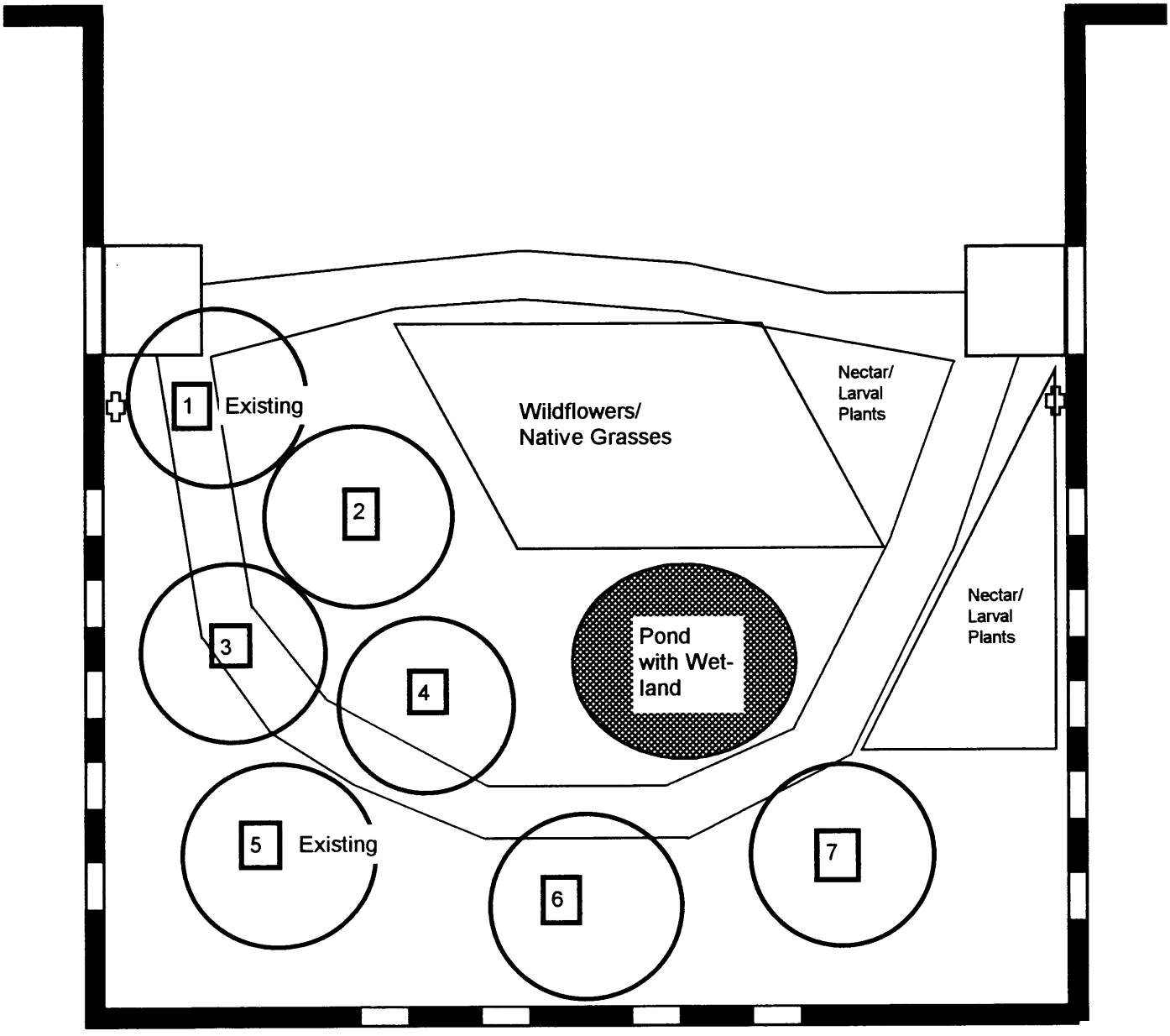


Figure (21). General shapes to start the master plan.

DRAW IN GENERAL SHAPES TO REPRESENT HABITAT TYPES AND PLANTED AREAS.

- **Add in shapes to represent the forest mid-story. These shapes represent small trees or large shrubs.**

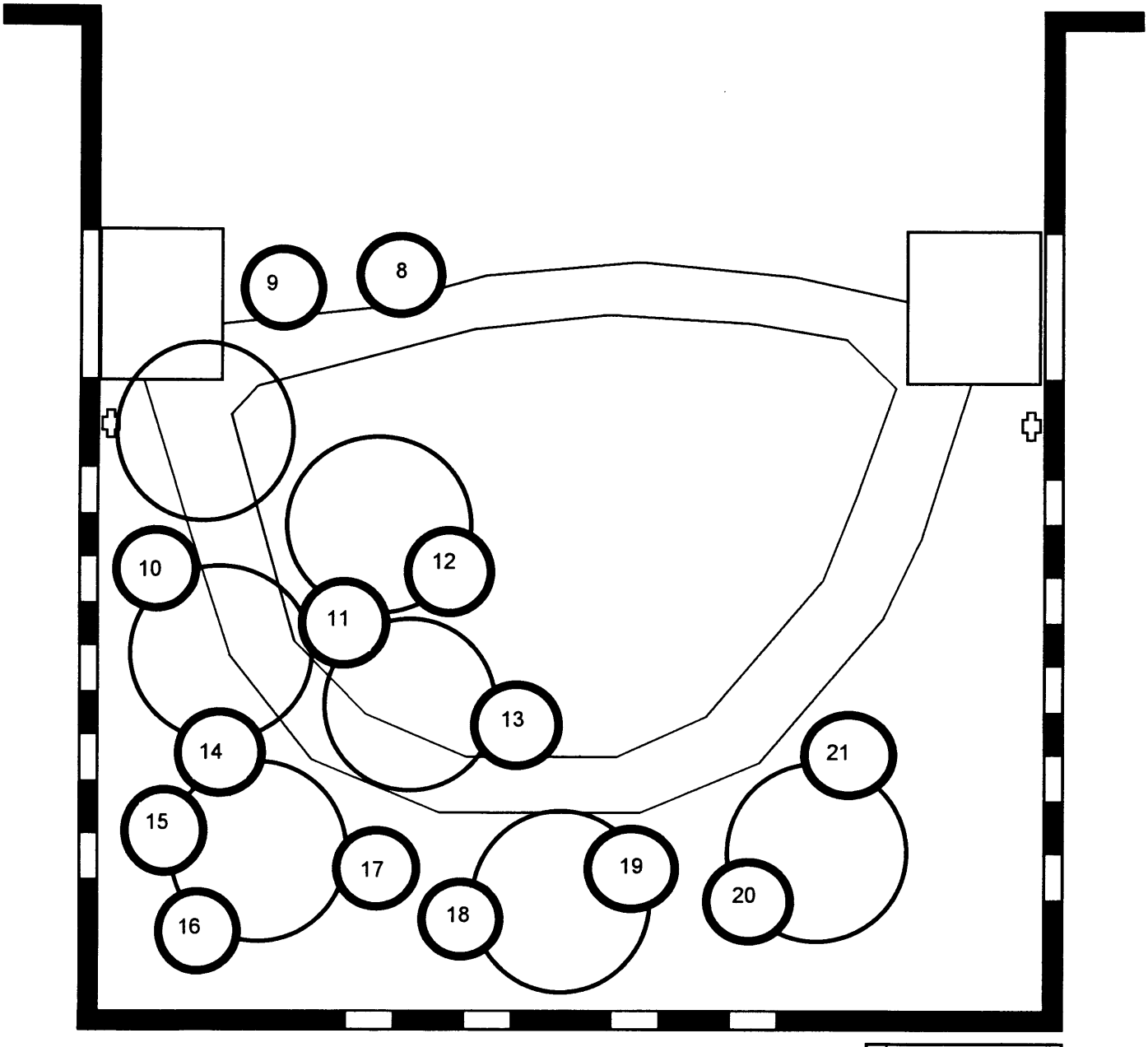


Figure (22). General shapes to represent small trees or large shrubs.

DRAW IN GENERAL SHAPES TO REPRESENT HABITAT TYPES AND PLANTED AREAS.

- **Add in the shrub layer beneath the small and large tree shapes.**
- **Perennials and ground covers would be added next. If the space for ground covers and other planted areas is too large, label the area as needed.**
- **After the vegetation, add in the shapes to show student activity areas.**

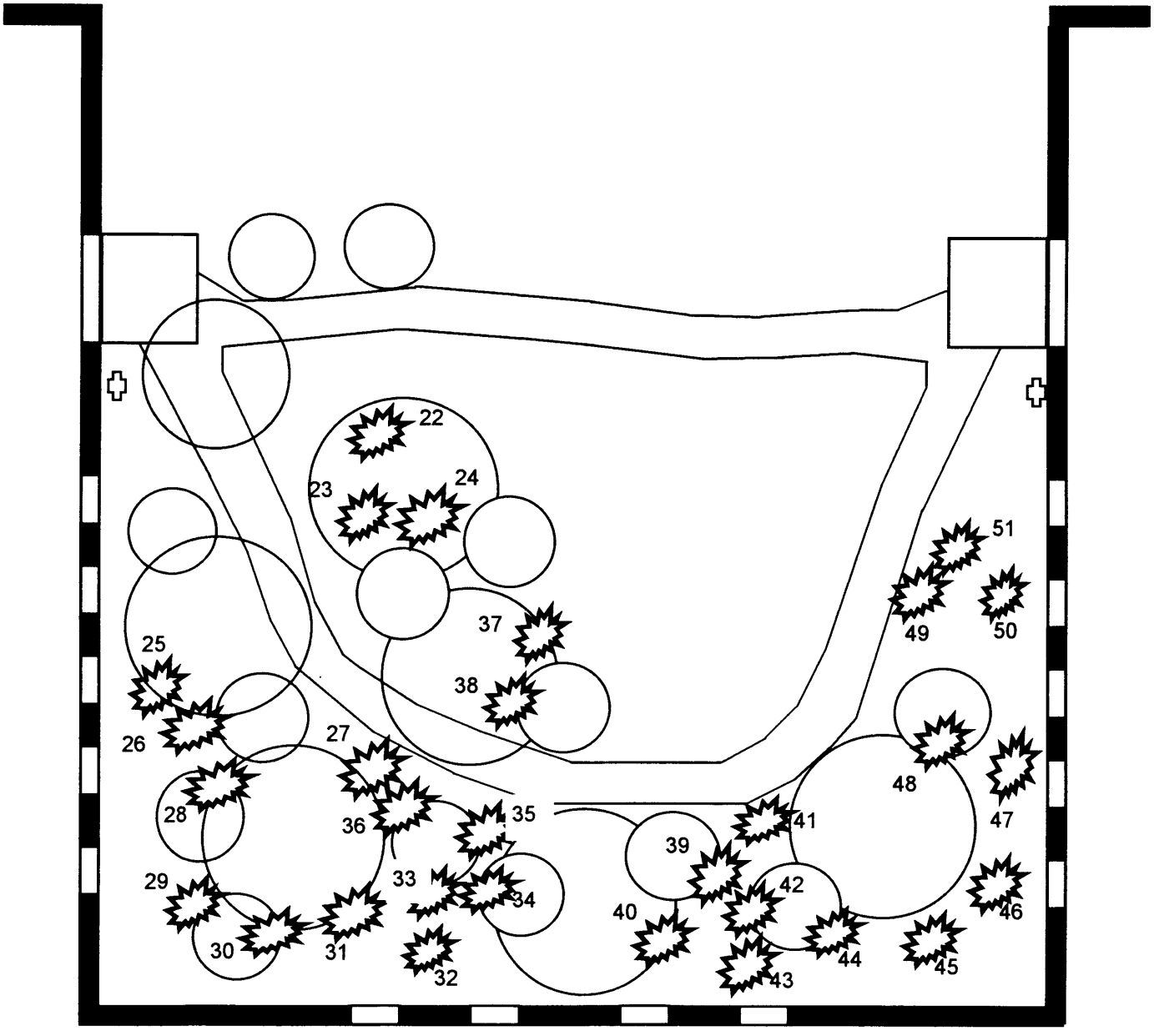


Figure (23). General shapes to represent the shrub layers. Number them for easy identification and planting later.

Sample Master Plan

Dragonfly Elementary School, Houston, Texas

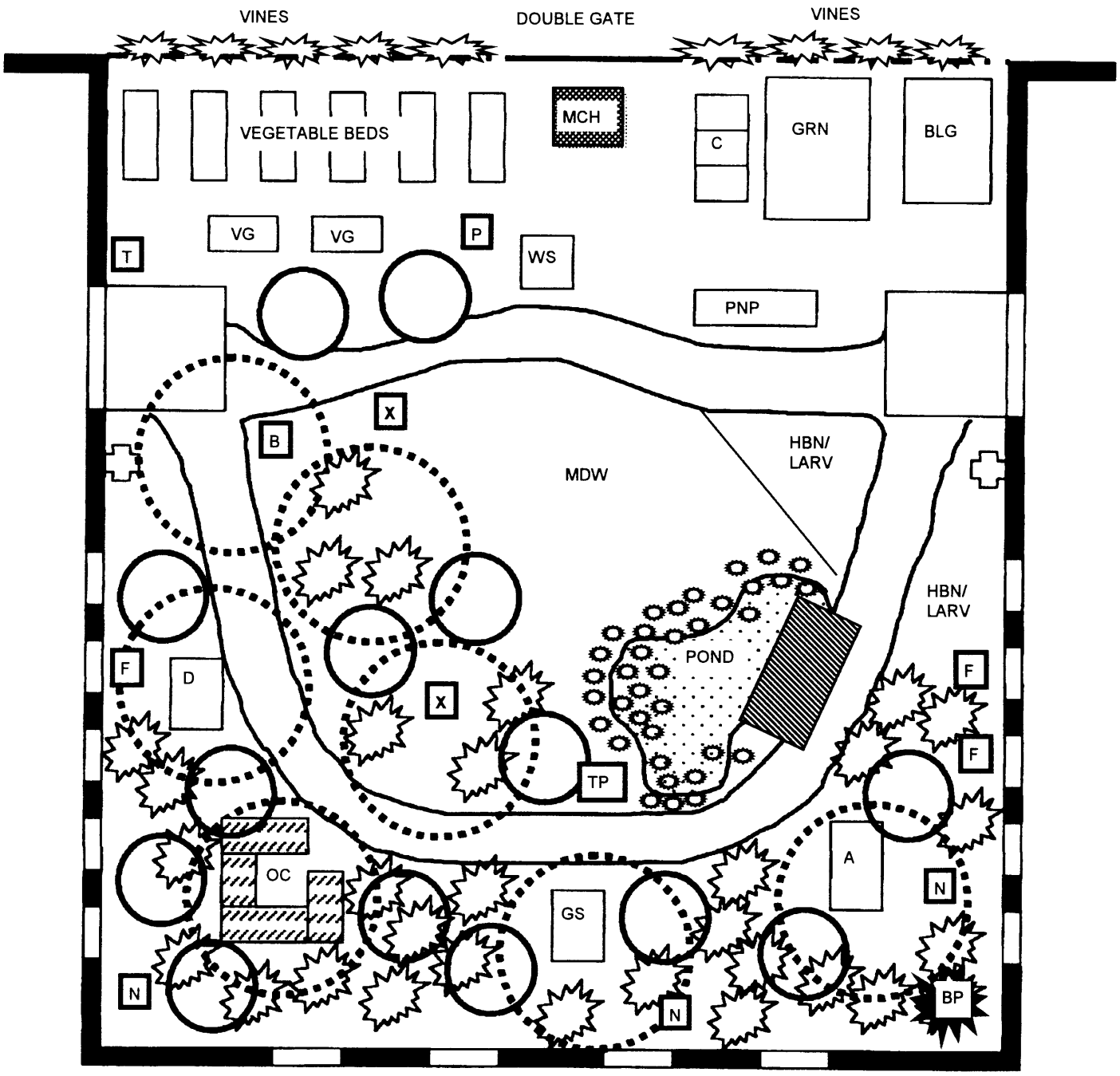


Figure (24). Master plan design for a school habitat in southeast Texas. This plan also provides layered vegetation, year-round food, water, and shelter for wildlife, as well as activity stations for students. The plants listed in this plan will NOT work for some of the other regions. The plant list must be modified for use in other parts of the state.

Sample Master Plan Key

The plants listed below are designed for use in Southeast Texas. The plants shown here would need to be changed to suit other portions of the state.

WILDLIFE FEATURES:

B	Bird Bath
BP	Brush Pile
F	Hummingbird Feeder
HBN	Hummingbird/ Butterfly Nectar Gardens
LARV	Butterfly Larval Plant Area
MDW	Wildflower Meadow/ Prairie Area
N	Nest Box
P	Purple Martin House (on pole)
T	Bat House (on wall)
X	Bird Feeder

STUDENT ACTIVITY AREAS:

A	Archaeology Station
BLG	Equipment Storage Building
C	Compost Bin
DS	Decomposition Station
GS	Geology Station
GRN	Greenhouse
MCH	Mulch Storage Area
OC	Outdoor Seating Area
PNP	Perch 'n Plant Area
TP	Track Plot
VG	Vegetable Garden
WS	Weather Station

VINES (on fence):

chv	Coral honeysuckle
pv	Passionflower vine

TREES AND SHRUBS:

1. Live Oak (existing)
2. Eastern Red Cedar
3. Black Gum
4. Bald Cypress
5. Live Oak (existing)
6. Fruiting Mulberry
7. Pecan
8. Citrus, Satsuma Orange (larval food)
9. Citrus, Meyer Lemon (larval food)
10. Sumac, Flameleaf
11. Possumhaw (Deciduous Holly)
12. Mexican Plum
13. Snowbell
14. Parsley Hawthorn
15. Roughleaf Dogwood
16. Scarlet Buckeye
17. Texas Persimmon
18. Yaupon
19. Mexican plum
20. Elderberry
21. Rusty Blackhaw Viburnum
22. Hummingbird Bush
23. American Beautyberry
24. American Beautyberry
25. Strawberry Bush
26. Turk's Cap
27. Turk's Cap
28. Southern Wax Myrtle
29. Southern Wax Myrtle
30. Southern Wax Myrtle
31. American Beautyberry
32. American Beautyberry
33. Dwarf Wax Myrtle
34. Dwarf Wax Myrtle
35. Dwarf Barbados Cherry
36. Dwarf Barbados Cherry
37. Lantana
38. Lantana
39. Virginia Sweetspire
40. Strawberry Bush
41. Virginia Sweetspire
42. Coralberry
43. Coralberry
44. Coralberry
45. Southern Wax Myrtle
46. Southern Wax Myrtle
47. Compact Cherry Laurel
48. Turk's Cap
49. Lantana
50. Hummingbird Bush
51. Lantana

LARVAL PLANT AREA (LARV):

Purple aster
Dill
Fennel
Milkweed (native) Yarrow
Milkweed (Mexican)
Parsley
Pipevine
Rue

HUMMINGBIRD/ BUTTERFLY NECTAR (HBN):

Barbados cherry
Black-eyed susan
Butterfly bush
Cut-leaf daisy
Gayfeather
Hummingbird bush
Indian blanket
Indigo amorpha
Maximilian sunflower
Mealy blue sage
Mexican bush sage
Penta
Plains coreopsis
Purple coneflower
Ruellia, Katie's
Scarlet sage
Turk's cap
Wild ageratum

POND/ WETLAND AREA:

Arrowhead
Cardinalflower
Floating heart
Fragrant water lily
Gulf coast penstemon
Horsetail
Lizardtail
Louisiana iris
Obedient plant
Pickerelweed
Rushes
Sedges
Spider lily
Swamp lily

WILDFLOWER MEADOW/ PRAIRIE AREA (MDW):

Black-eyed susan
Clasping-leaf coneflower
Eastern gamagrass
Evening primrose
Gulf muhly grass
Horsemint
Indian blanket
Indian paintbrush
Inland sea oats
Lanceleaf coreopsis
Little bluestem
Milkweed, native
Plains coreopsis
Sideoats grama
Standing cypress
Texas bluebonnet
Winecup

Plan Phases, Priorities, Budget and Time Line
SAMPLE

The sample master plan can be broken down into multiple phases and prioritized. The phases may be ranked after considering each project's importance to the habitat, need for large equipment during construction, appropriate planting season, etc. Individual projects within each phase should have a separate budget and detailed materials/ equipment list so that materials and labor can be obtained or donated. Some companies may offer to fund or provide labor for a specific project within that phase.

School habitat projects usually take YEARS to complete. Be realistic in your planning and prioritizing. If your habitat site is large, you may need to divide the planted areas and spread out the installation of vegetation over several months or years. Some of the dates for the sample projects will vary according to your region of the state. This is a simple example for a small site. Costs are examples only and should not be used to determine the costs for your site.

PHASE ONE:	COMPLETION DATE	PROJECT COST
1. Raise initial funding, consult resource professionals, gather materials, gather labor forces	August	
PHASE TWO:	**COMPLETION DATE**	**PROJECT COST**
1. Dig pond. No liner needed.	September	460.00
2. Install water line & float valve.	September	45.00
3. Install fence and double gate.	September	1350.00
PHASE THREE:		
1. Kill bermuda grass.	October	30.00
2. Mark pathways to show designated planting areas.	October	5.00
3. Drag large log or tree stump to decomposition station area.	October	0.00
4. Construct deck/study platform and benches (4).	October	1000.00
5. Install large (15 gallon or larger) trees (5).	October	225.00
PHASE FOUR:		
1. Plant small trees (14), shrubs (30), and vines (9).	November	336.00
2. Plant wildflower and native grass seed.	November	306.00
3. Put up bird feeders (2).	November	40.00
PHASE FIVE:		
1. Build nest boxes, bat house, buy poles.	January	80.00
2. Install storage building.	January	800.00
PHASE SIX:		
1. Install pathways.	February	1200.00
2. Put up purple martin house on telescoping pole.	February	100.00
3. Prepare and weed other planting areas.	February	0.00
PHASE SEVEN:		
1. Plant perennials, nectar area, larval area.	March (after last frost)	
2. Install nest boxes and bat box on telescoping poles.	March	0.00
3. Install weather activity station.	March	40.00
4. Install brush pile activity station.	March	0.00
5. Install bird bath near windows.	March	60.00

Plan Phases, Priorities, Budget and Time Line SAMPLE (continued)

PHASE EIGHT:	COMPLETION DATE	PROJECT COST
1. Conduct in-service training for teachers.	Summer months	200.00
2. Develop integrated curriculum.	Summer months	TBA
3. Monitor and maintain plant material. Control invasives.		
PHASE NINE:		
1. Construct activity stations – archaeology, geology, track box, perch n' plant	September	200.00
2. Construct 16' X 32' greenhouse.	September	30,000.00
PHASE TEN:		
1. Construct vegetable gardens.	October	500.00
3. Construct mulch storage area.	October	0.00
4. Install wooden compost bins (3).	October	25.00

NOTE: ALL THROUGH THE PHASES, YOU SHOULD:

- Involve students in each project and phase.
- Continue to raise funds for the next phase.
- Maintain what you have installed and constructed.
- Offer teacher in-service training as opportunities arise.
- Develop the integrated curriculum, design activity stations, and create partnerships among the school subjects.

ITEMIZED LISTS:

For each phase of development, you should have an itemized budget that lists in detail, with cost, what you will need to complete the individual projects.

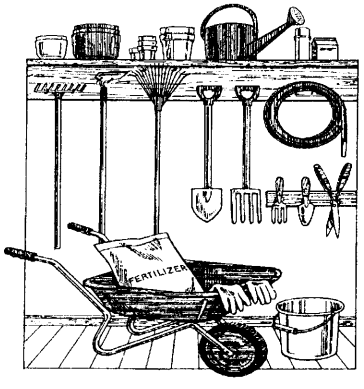
Example: **PHASE FOUR**

1) Plants needed:

5 gallon trees	14	@ $10.00	$ 114.00
5 gallon shrubs	15	@ $10.00	$ 150.00
1 gallon shrubs	15	@ $ 3.00	$ 45.00
1 gallon vines	9	@ $ 3.00	$ 27.00

2) Based on a 1,000 sq. ft. area, will need 8 pounds of Native Coastal Prairie Mix @ $ 6.95 per pound, Total = $ 55.60. Based on same, will need 10 pounds of wildflower mix @ $ 25.00 per pound, Total = $ 250.00.

3) Two bird feeders @ $ 20.00 each = $ 40.00.



Step 9. Assign Project Priorities

- Examine your master plan (Step 8) and divide it into phases or smaller projects. Then assign priorities to the projects. List the habitat projects in the order they should be completed.

- Consider the cost and availability of the plants you selected. Those choices may help determine a few of your priorities. Some plants may not be available at certain times of year, so you may need to order your plants during different seasons. Planting times vary across the state. In general, the best time to plant trees is late fall while the trees are dormant. Plant most wildflower seeds in the fall. Consult a local resource professional, native nursery or wildflower seed catalog for specific planting dates. (See Appendices.) Remember that schools may be able to purchase plants from wholesale nurseries and should not pay sales tax.

- Assign a tentative completion date to each phase. Be as realistic as possible with the completion dates, taking into consideration seasonal and weather conditions that may occur. For example, you would not want to schedule a major planting day right before school ends for the summer, unless you also organize teams of volunteers to water the plants each week during the summer months.

- Determine the estimated cost to complete each phase. (Refer to the "Project Priorities Worksheet" and "Cost Estimate Worksheet" in the Appendices for assistance.)

This prioritizing process is important when seeking grants or community funding because one business may not want to fund the entire project, but may be willing to donate materials for a specific phase.

Step 10. Seek Funding

Sources of funding for school habitats do exist across the state. It's just a matter of finding a source and stating your request in the appropriate manner.

Before you request funding from a source:

- Make sure your project fits their criteria and that you will meet their deadline for proposals.

- Be prepared to answer the questions most agencies or foundations will ask. Have a written report about the school habitat project ready. Be brief but include details. In this report, describe the project, project goals and student objectives. Provide a list of committee members, time frame for completion of each phase, budget, list of in kind donations of labor or materials, and list of other community supporters, when appropriate.

- Make sure you answer all the questions they ask in the format they require.

- Proofread for errors before you send in your grant request.

- Include photographs of the site, if allowed.

For highest success, find businesses and community organizations close to your school. Remember that even if a local business cannot provide money for the project, they may be willing to provide materials or labor. Charitable foundations and governmental agencies may have funding available.

Parent Teacher Organizations, student fund-raisers, and activities are other sources for funds. Activities, such as a "Garden Shower" can provide materials and plants for the habitat. Students, parents, and community partners attend the party and bring a gift for the garden. Gifts must be selected from a list provided to all invited guests. Schools could even "register" at local hardware stores, nurseries, and bird stores.

Step 11. Prepare BEFORE Planting

ESTIMATION OF PLANT MATERIALS NEEDED:

The number of plants that can fit into a space is determined by the individual plant's width at maturity. This is called spacing. See Figure 25. Make a list of the number of plants, by species, you will need for each space on your master plan.

The size of the plants you purchase will be determined by the amount of plants needed, their cost and availability, and your budget. Four-inch pots are the cheapest, but the plants are smaller, will take longer to reach maturity, and will require more care at the beginning. Healthy, older plants endure insect and disease damage better than younger plants.

Annuals and perennials are usually sold in four inch to five gallon containers, with one gallon being the most common. Larger shrubs and trees are usually sold in three gallon and larger pots.

PRE-INSTALLATION CHECKLIST

- _____ **Mark the plan on the ground, taking note of elevations and drainage areas. Note any need for raised areas or drain pipes. Make sure the finished design will drain in the desired location.**
- _____ **Mark utility lines prior to digging. If any exist in your habitat site.**
- _____ **Accomplish heavy construction at this point. (Example: install a pond)**
- _____ **Install water lines, electrical outlets, as needed.**
- _____ **Kill grass and other vegetation where needed.**
- _____ **Complete soil improvements and create raised beds, if needed. (See Appendix P for assistance.)**
- _____ **Install pathways and edging material, if desired.**
- _____ **Purchase plants and other materials. Arrange for pick up or delivery.**
- _____ **Schedule volunteers.**
- _____ **Arrange for all tools needed. (may include wheelbarrows, shovels, trowels, gloves, mulch, buckets, hammers, etc.)**

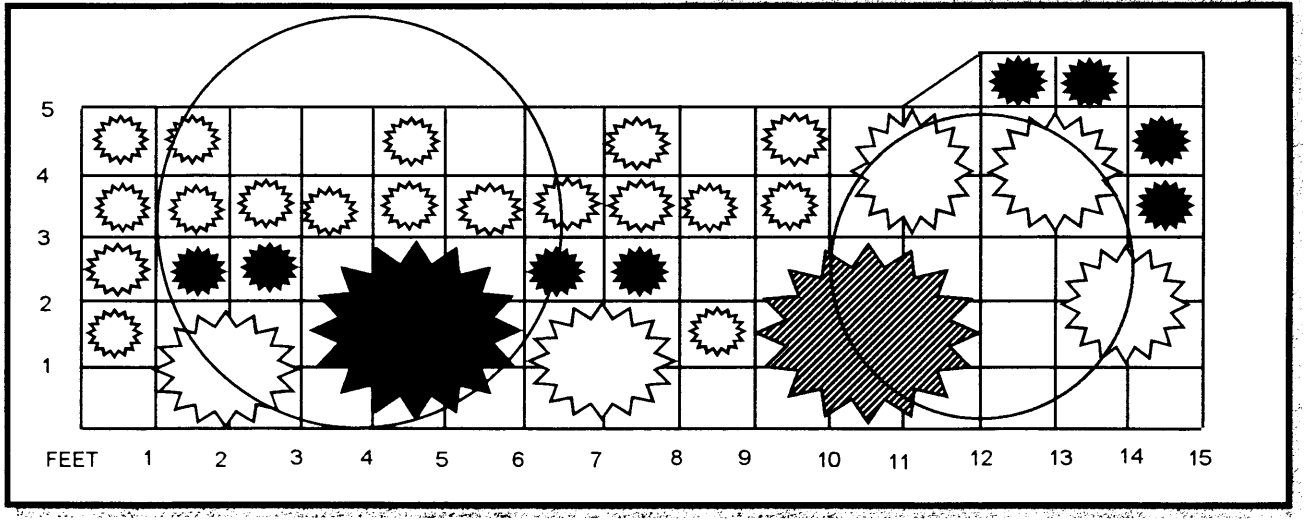


Figure (25). Use the plant's mature width to estimate the amount of each plant species needed for a particular space. NOTE: A habitat consists of many layers. Notice that the trees (large circles) overlap the understory shrubs and groundcover plants.

Step 12: Install the Habitat

- Involve everyone! Perhaps ask each class or teacher to install a specific portion of the habitat that they will later maintain.
- Place all potted plants in their correct planting location. Emphasize the need to plant things exactly where they have been placed. Look over the arrangement. Do you like it? Now is the time to change anything you dislike. See Figure 26 as an example.
- Gather volunteers together and explain the plan. Demonstrate the proper planting methods and the sequence of planting. Planting methods will vary according to the plant you are installing.
- Plant in small sections at a time.
- Start with large trees and shrubs or the plants in the back of a bed against a wall. Continue the process, working your way to the front, until you have planted every plant. You will notice areas of bare soil. Don't despair. The plants will fill this space as they mature.
- Place plants at the correct depth. Double-check as planting progresses.
- Carefully place a layer of mulch around each plant. Avoid heaping mulch on top of your plants or placing mulch directly against tree trunks.
- When mulching has been completed, gently water each plant, regardless of the weather forecast. ALWAYS!

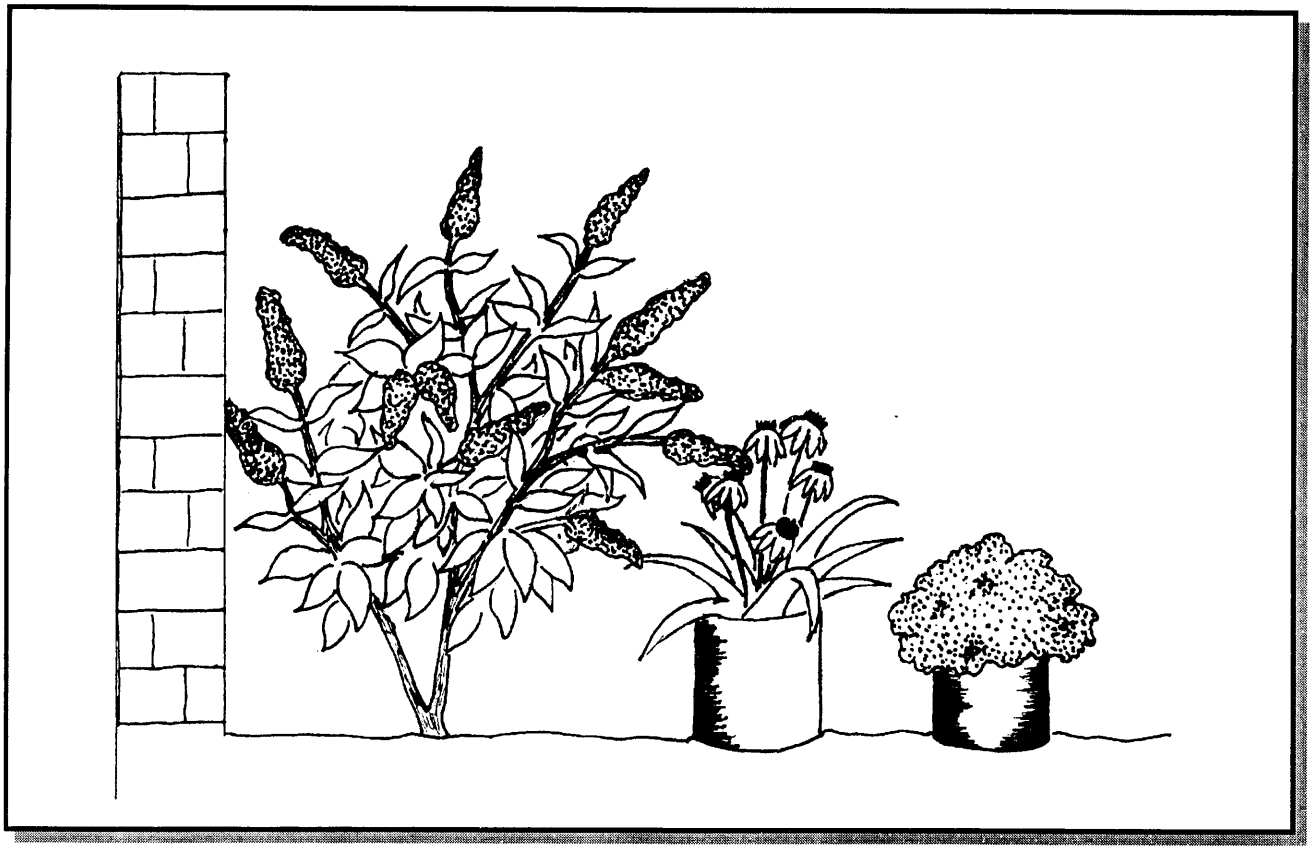


Figure (26). Place plants in the actual spot where they will be planted. Review the arrangement. Change the layout if desired. Illustration by Michele G. Foss.

Step 13. Maintain the Habitat Naturally

The ultimate, long term success or failure of a school habitat depends upon the maintenance it receives from the very beginning. By selecting native plant species, you are already reducing the amount of maintenance required. However, natural landscapes still require a small amount of pruning, weeding, and watering to maintain the desired look.

INTEGRATED PEST MANAGEMENT:

Integrated pest management combines the use of natural predators, proper plant selection, and other biological and chemical methods to discourage pests.

- Encourage the overall health of your plants by maintaining healthy soil. In a healthy soil, earthworms and beneficial microbes are "on duty" and will outcompete harmful microbes.
- Select your plants with emphasis on hardy species. Plants native to your area are less susceptible to local insect damage.

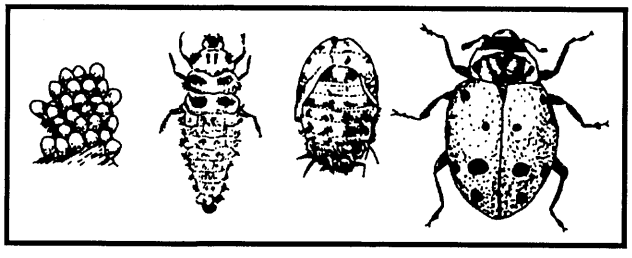


Figure (27). Stages of the life cycle of the lady bug. Each stage, except egg, can be seen eating aphids on plants.

BENEFICIAL WILDLIFE:

Encourage respect for all aspects of nature in your school habitat. The presence of insects in your habitat shows that you have been successful in attracting a key component of the food web. Birds, such as the mockingbird, purple martin, and woodpecker, feed on these insects. Other animals, including ladybugs, frogs, lizards, spiders, and bats, also eat insects. By leaving the insects in your habitat, you are maintaining a reliable food source for those insectivorous wildlife species. By avoiding the use of chemical insecticides, you are also protecting the butterflies and caterpillars residing in your habitat. Learn to recognize the caterpillars, ladybugs, and other desirable invertebrates visiting your habitat.

EQUIPMENT:

A collection of maintenance tools, such as pruning clippers, hand pruners, rakes, hand trowels, wheelbarrows, shovels, sprinklers, and hoses, will be needed. Some of these tools should be "student sized" to promote student participation. Clean, plastic cat litter containers with handles or milk jugs can be cut and converted into "mulch transport containers." Note: Do not buy more equipment than you need for the maintenance of the site. You will need more equipment during the initial construction phase, but may not need all of that equipment later for normal maintenance of the site. Save money by borrowing or renting the extra equipment initially, rather than storing unused equipment later. Keep gardening supplies in a central, locked location. Arrange for several keys to be available in an agreed upon location for teacher use.

WATER:

Plants must receive water to survive. Your habitat will need watering for the first one to two years until the plant's root system become established. **Water your plants to encourage the growth of deep root systems.** Plants grow shallow roots close to the soil surface to gather light rainfall and nutrients. They also grow deep roots to anchor themselves in the ground and to reach water when the top soil surface is dry or cold. If plants receive water several times a week, they never develop deep root systems. Those shallowly-rooted plants suffer during droughts or hard freezes.

Watering Tips:

- Monitor your plants and water as needed.
- For clay-based soils, infrequent but deep watering is needed to maintain sufficient soil moisture.
- For sand-based soils, more frequent watering may be necessary.
- Water more often during the hot summer months.
- Remember to water below the flower level of your nectar-producing plants to avoid washing away the nectar.
- Your pond or bird bath will lose water through evaporation and will need periodic refilling. For information on automatic refilling systems, refer to the float valve section in the "Constructing a Pond or Wetland" section.

MULCHES:

Mulches help the soil conserve water, add humus and nutrients to the soil, and discourage weeds. In a natural system, mulching occurs as leaves and other material are decomposed and added to the soil. Allow this natural process to occur by leaving dead leaves, twigs, and other detritus in your habitat so that it will provide food for earthworms, insects, snails, and other decomposers.

You can assist the natural process by periodically adding a layer of composted mulch to the soil around your plants and around the bases of trees. Avoid placing freshly shredded mulch against the plants because this fresh mulch may be too acidic and actually burn your plants. Allow the fresh mulch to compost in a pile for a few months before adding to the habitat. Mulch that has been composted contains fewer viable weed seeds, so you are not introducing new weeds into your habitat.

FERTILIZERS:

A good application of mulch should take care of the soil nutrients required and therefore reduce or eliminate the need for additional fertilizers. In fact, many native plants do not tolerate chemical fertilizers. If you determine your plants need fertilizing, select an organic fertilizer and apply at the rate recommended on the container.

WILDFLOWER AREAS:

Wildflower patches and meadows look beautiful while blooming, but may look "weedy" when the flowers have gone to seed. Birds rely on the flower seeds as a food source over the winter, so allow some of the spent flower heads to remain in the fall and winter. Refer to Appendix M for additional information about maintaining such areas.

PRUNING:

Pruning is usually not a necessity in a natural habitat system. However, in a school situation, native plants may need occasional gentle trimming to remove a damaged branch or to return a plant to its natural shape. Consider the needs of each plant species and your own personal preference prior to pruning. Remember that harsh trimming and strict ball and box shapes do not belong in a natural landscape.

Consult native plant professionals or reference books to determine the appropriate season to prune a certain species. The majority of native trees can be pruned during November and December. Avoid pruning trees during the first year to give them time to become established. Some native perennials die back to the ground each fall. Simply trim off the dead stalk in late February or early March and wait for the plant to resprout from the roots in the spring. By leaving the dead stalk in place over the winter, you are allowing the seeds to scatter and supply birds with a winter food source. Other perennials die back to the ground and overwinter as small rosettes of green leaves. Try not to disturb these green clumps through the winter. A light mulch of crushed dry leaves can be scattered around these rosettes as a protective covering during the winter, if desired.

PRUNING TREES:

The purpose of pruning is to create a tree with strong branches and a dominant trunk for the first six to eight feet off the ground. Eliminate branches that rub against another branch or cross over several branches. Give each branch room to grow with minimal competition for sunlight. Trim off weak sprouts and suckers that grow from the trunk or main limbs. When pruning, avoid cutting a branch flush against the trunk. Instead, look for the slight swelling (called the branch collar) where the branch joins the trunk or main limb. Cut at an angle away from the trunk beyond the branch collar.

REFERENCE MATERIALS

Texas Organic Gardening Book by Howard Garrett Gulf Publishing, P. O. Box 2608, Houston, TX 77252-2608.

Texas Bug Book by C. Malcolm Beck and J. Howard Garrett, University of Texas Press.

The Organic Gardeners' Handbook of Natural Insect and Pest Control, Rodale Press, 33 East Minor Street, Emmaus, PA 18098.

The Life Cycle and Man and The Many Benefits of Mulching by Malcolm Beck, Garden-Ville Inc., 7651 E. Evans Road, San Antonio, TX 78266.

A Field Guide to Common Texas Insects by Bastiaan Drees and John Jackman, Gulf Publishing Company, Houston.

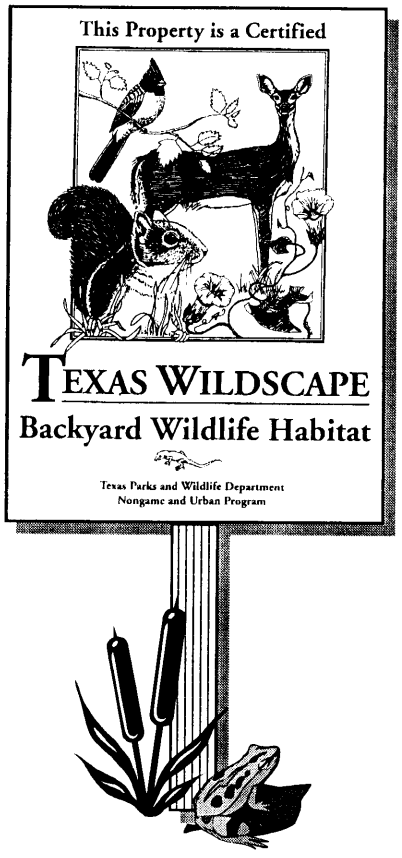
The Handy Bug Answer Book by Dr. Gilbert Waldbauer, Visible Ink Press, Gale Research, 835 Penobscot Building, Detroit, MI 48226.

SAMPLE MAINTENANCE SCHEDULE

GENERAL MAINTENANCE Each Month Repair trails. Turn compost pile. Mow grass. Remove weeds. Water plants. Fill bird feeders. Add water to pond or bird bath.	APRIL Add annuals, perennials, Or wildlife food plots.	SEPTEMBER Order field equipment or tools. Plant wildflower seeds outdoors. Trim dead stalks on wildflowers after seeds have dispersed.
JANUARY Build new feeders, nest boxes, and benches, as needed.	MAY Apply layer of mulch to discourage weed growth over summer, if desired. Take down hummingbird feeders before leaving on school break. Avoid planting new plants prior to summer break.	OCTOBER Plant wildflower seeds outdoors. Take down hummingbird feeders when birds are no longer using them.
FEBRUARY Mow prairie or wildflower area. Clean out nest boxes and prepare them for spring use. Put up purple martin house. Service pond equipment, if needed.	JUNE Water plants! Add water to pond or bird baths. Remove invasive vegetation. Repaint or repair wooden structures. Clean and repair student field equipment and tools.	NOVEMBER Plant wildflower seeds outdoors. Plant new trees and shrubs.
MARCH Trim off dead stalks, after last frost. Add annuals, perennials, or wildlife food plots.	JULY and AUGUST Water plants! Add water to pond or bird baths. Remove invasive vegetation. Put up hummingbird feeders (mid– to late August)	DECEMBER Plant new trees and shrubs. Move plants or trees while dormant.

Figure (28). The maintenance required in your school habitat will change through the year. Use this sample schedule as a guide. Adjust your schedule as needed to reflect the changing conditions in your habitat over time. Maintenance will vary according to your location in the state.

Step 14. Certify Your Habitat



Certify your habitat and reward your school with the recognition it deserves for creating habitat. The certification may help you gain funding or community support as the habitat matures. The following is a partial list of agencies and conservation groups that currently certify school habitats:

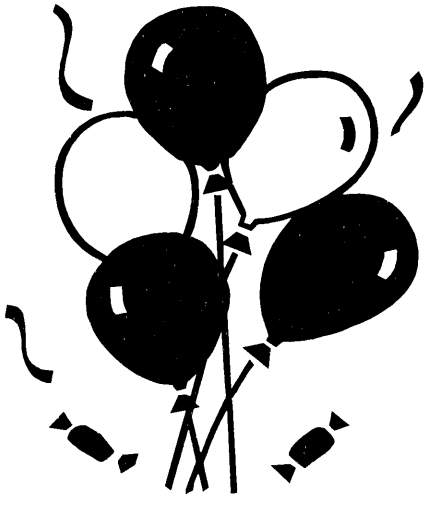
WILDSCAPES PROGRAM, Texas Parks and Wildlife Department, 4200 Smith School Rd., Austin, TX 78744, (800) 792-1112; statewide registry.

SCHOOLYARD HABITATS, National Wildlife Federation, 8925 Leesburg Pike, Vienna, VA 22184, (703) 790-4582; national registry.

Project WILD SCHOOL SITES, 5430 Grosvenor Lane, Suite 230, Bethesda, MD 20814-2142, (301) 493-5447; national registry.

Step 15. Celebrate!

Organize a dedication event, appreciation day, or project completion party. Use this opportunity to recognize all of the individuals and businesses who made the project possible. Recognize donations of materials, labor, or funding. Erect certification signage or habitat name sign. Schedule media coverage and record the event for your scrapbook.



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