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Creating Urban Stormwater Control Ponds for Water Quality and Wildlife Habitat

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Wetlands are important wildlife habitats, and they provide numerous benefits and services to society. Natural wetlands help replenish groundwater supplies, act as natural pollution filters, purify water, control erosion, lessen the impact of flooding, provide food and fiber for humans, and offer countless opportunities for education and recreation. Because they are so important to wildlife, wetlands have been called "nature's cities." Unfortunately, people have not valued wetland systems, and more than 80 percent of Kentucky's wetlands have been drained, filled, or destroyed. Nationally, we have destroyed more than 50 percent of our wetlands.

Water is often a factor that limits the types, numbers, and abundance of wildlife in urban environments. In the past, we destroyed natural wildlife water sources, such as wetlands and ponds, to make way for development. Before land is developed, rainwater is intercepted by vegetation and infiltrates the soil. After development, driveways, rooftops, and other impervious surfaces reduce the infiltration capacity of the soil. Unable to percolate into the soil, rainwater moves over the area, with the potential to damage property and cause floods.

As water runs over roads, sidewalks, and parking lots, it picks up a number of pollutants including oil, grease, and heavy metals such as lead, zinc, copper, and mercury. Rainwater that flows over lawns picks up nitrogen, phosphorous, and pesticides from lawn care products. Stormwater runoff with its load of pollutants eventually reaches local streams where it deposits pollutants and increases the volume and velocity of stream water, resulting in greater stream contamination, channelization, erosion, and sedimentation. As a result, fish and other aquatic life inhabiting these streams are often reduced in numbers or eliminated altogether.

In response to these problems, thousands of structures have been built throughout the United States for the purpose of controlling stormwater. However, in the past, little consideration was given to structural designs that would also benefit wildlife and improve water quality. The challenge to planners, engineers, and surveyors today is to design structures that will control stormwater and also improve water quality and provide wetland and wildlife habitat.

The purpose of this publication is to provide information for developers and government policy makers on creating a type of water source that will benefit wildlife and control stormwater discharge. This information can also be used by developers when creating ornamental ponds at the entrances to new subdivisions and other public areas. For specific engineering and hydrologic information, contact the local Natural Resources Conservation Service and ask for a copy of their publication, *Ponds—Planning, Design, Construction*. You may also want to obtain a copy of *Guidelines for Stream and Wetland Protection in Kentucky* from the Kentucky Division of Water (14 Reilly Road, Frankfort, KY 40601). This publication compares detention and retention ponds, two of the most common stormwater control structures used today, and provides information on how to design these structures to benefit waterfowl and other wildlife.

Stormwater Control Structures

The two types of structures most commonly used to control urban stormwater are "dry" ponds, also known as detention ponds, and "wet" ponds, also known as retention ponds. As their names imply, the major difference is the length of time water stands in the pond. Dry ponds are designed to collect water during a storm and then release this water at a predetermined rate to a nearby body of water. They are generally dry between storms. Wet ponds are designed to contain water on a year-round basis. Although both types of structures control stormwater and reduce the risk of flooding, wet ponds are much better at improving water quality and providing wildlife habitat.

Some of the costs and benefits of creating a detention or retention pond are discussed below.

Feasibility for the Site

The first step in choosing and designing a stormwater structure is to determine which designs are feasible for the site description, soil type, and local geology. Wet ponds generally require more space than dry ponds, so they are not recommended for small areas.

Soil permeability also influences which structures will be most successful. For example, dry ponds work best in areas with extremely permeable sandy soils, but wet ponds are the better choice in areas with heavy clay soil where drainage is poor.

The local geology can also influence the design choice. Wet ponds require extensive excavation and are more difficult to create in areas where the underlying bedrock is close to the surface.

Water Quality

Stormwater may contain many pollutants, including sediment and heavy metals that exist in particulate form and soluble pollutants such as nitrogen and phosphorus. For a variety of reasons, wet ponds are much better than dry ponds at removing both types of pollutants and thereby improving water quality. Sediment and particulate pollutants are removed from water when they are allowed to settle to the bottom of the pond. Because water is present in dry ponds for relatively short periods of time, most of this sediment remains suspended in the water released from the pond. However, wet ponds hold water for longer periods of time, allowing for greater settling of suspended sediments and nonsoluble pollutants, thus improving water quality in water bodies receiving this flow. In addition, aquatic plants present in wet ponds are able to further improve water quality by using some of the soluble pollutants and incorporating them into plant tissue.

Groundwater Recharge

Groundwater recharge refers to water that infiltrates the soil surface and percolates into the groundwater reservoir. Part of the water present in retention ponds infiltrates through the bottom and sides of the pond into the groundwater reservoir. Detention ponds, on the other hand, usually allow less groundwater recharge because the water is only present a short period of time before moving into a receiving body of water.

Wildlife Habitat and Recreation Benefits

Properly designed wet ponds can provide habitat for a number of species of wildlife and native plants that are dependent on wetlands. Dry ponds, on the other hand, provide little opportunity for enhancing wildlife habitat. Wet ponds will be used by various waterfowl species, furbearing animals, songbirds, and reptiles and amphibians.

Depending on their size and design, wet ponds can provide a number of recreational opportunities including birdwatching, fishing, boating, and ice skating. Dry ponds do not typically provide such recreational values.

Construction and Maintenance Costs

Construction costs are generally 30 to 60 percent higher for wet ponds than for dry ponds. However, many studies have shown that homeowners are willing to pay more for houses near landscaped ponds, and developers are often able to make up this initial deficit. In addition, landscaped ponds provide numerous other benefits that cannot be translated directly into dollar values, such as improved water quality and wildlife habitat.

Maintenance needs differ between the two structures. For instance, dry ponds maintained as the law requires need more frequent mowing and removal of trash. In addition, fertilizer used on the lawn contributes to the already excessive nutrient loads in downstream water. Wet ponds require less routine maintenance; however, sediment removal is needed approximately every ten to twenty years, and this can be expensive. Dry ponds require sediment removal much less frequently because they accumulate less sediment per storm. Both types of structures should be inspected on a regular basis to ensure they are functioning correctly.

Wet Ponds as Community Assets

In the past in the Northeast, dry ponds have been built more frequently than wet ponds. This trend is beginning to change as citizen concern over water quality and availability continues to escalate and land planners and engineers become aware of the multiple values and benefits associated with well-designed and landscaped wet ponds. Because wet ponds are far superior to dry ponds in improving water quality, providing wetland and wildlife habitat, and providing recreational and educational opportunities, these ponds should be built whenever they are feasible for available sites. Wet ponds can be assets to a community because of these multiple benefits. In addition, they enhance the quality of life by providing attractive and tranquil refuges in the midst of an urban environment.

Designing Stormwater Structures for Wildlife

The opportunity exists for creating wetland and wildlife habitat in conjunction with stormwater management. Design features that make a pond specifically attractive to wildlife are described below. Each pond and site will be different, and not all of these recommendations will be possible for every pond. However, the recommendations are guidelines to assist planners in designing multi-purpose ponds that not only control stormwater and improve water quality, but go one step further by providing wetland and wildlife habitat. Stormwater regulations vary from location to location and should be consulted before developing a management plan. In addition, it is beneficial to consult with a wildlife biologist for additional input on specific projects.

Water depth and bank slope

To maximize wildlife habitat and pollutant removal, wet ponds should be shallow with gently sloping sides. In general, 25 to 50 percent of the water surface area should be between two and three feet deep. The shallow water areas provide habitat for tadpoles, small fish, and aquatic insects like dragonflies and mayflies. These in turn provide food for waterfowl, wading birds such as great blue herons, and other

wildlife. Shallow areas are also necessary to establish aquatic plants that provide both food and cover for waterfowl and other wildlife. A slope of 10:1 (1 inch elevation gain every 10 inches) along the edge will provide shallow water habitat where aquatic plants can be established.

Studies have shown that shallow ponds beneficial for wildlife are also better for improving water quality and are safer for children. If one objective of the pond is to maintain fish populations, part of the pond should be at least eight feet deep.

Shoreline

The edge between the terrestrial environment and the water is the shoreline. This edge can be an extremely productive habitat for prey species such as insects, frogs, and crayfish, which in turn attract a diversity of birds and mammals. When possible, the length of shoreline should be maximized. This can be done by building ponds with irregular instead of circular shapes.

In large ponds, irregular shorelines having many coves enable pairs of birds to become visually isolated from one another. That is, a pair of birds can set up a territory in one cove and not be seen by their neighbors in the next cove. Research has shown that for many species the number of individuals that will breed on a pond is greatly increased when pairs are visually isolated from one another.

Mudflats, sandbars, and islands

Providing exposed mudflats or sandbars is one of the best ways of making a pond attractive to shorebirds, wading birds, and waterfowl. Shorebirds and wading birds feed in these nutrient-rich areas while the waterfowl use them for resting and loafing. Mudflats or sandbars are established and maintained by fluctuating water levels that deposit nutrients into the soil and keep permanent vegetation from becoming established. Mudflats and sandbars will develop naturally in shallow ponds with gradually sloped sides. The sloped sides will be underwater during periods of heavy rainfall and exposed during dry periods.

Islands within the center of the pond provide a place for waterfowl to nest where they are protected from predators such as racoons or local dogs and cats. This is particularly important in suburban and urban areas where populations of these predators are high. Even if the pond is small, try to establish at least one island. An island as small as 30 square feet will provide a nest site for a pair of ducks. These islands should be above the high water mark and should have sloped sides so water will drain. Establishing grass on the island will prevent erosion and provide nesting cover.

Landscaping

Shrubs and trees along the edge of ponds and islands provide nest sites, perching sites, and cover for a variety of wildlife. Aquatic plants within the pond provide food and cover for waterfowl and other wildlife. Although a completely barren pond will eventually develop vegetation, it will do so faster and become an attractive pond with both aesthetic and wildlife value when a landscape plan is developed and implemented.

The types of vegetation that can be established depend on the water depth and also on how frequently the area is inundated with water. For landscaping purposes, Schueler (1987) has divided stormwater ponds into six zones that relate to soil moisture and the types of vegetation that can be established (Figure 1). The tables on pages 4-5 provide a representative list of plant species that can be planted in most zones.

Nest boxes

Nest boxes along the edge of the pond and nesting platforms within the pond can be used to attract a variety of wildlife and will increase the visibility of wildlife to people visiting the pond. Species that use nest boxes include the eastern bluebird, house wren, tree swallow, and purple martin. A pond near woods may also attract wood ducks. Canada geese, and mallards will nest on platforms in the pond, and turtles and ducks will use loafing platforms. Nest boxes and platforms can be built or purchased from local lawn and garden stores or nature centers, or you can contact your local county Extension office or the Kentucky Department of Fish and Wildlife Resources for plans to construct your own.

Summary of Planning for Stormwater Control Ponds

A summary of planning and design guidelines for optimizing the value of constructed urban stormwater control ponds as wetland reserves for wildlife is presented below.

- Where possible, impoundments for stormwater control should retain water rather than merely detain it.
- Pond design must meet applicable stormwater control criteria, including legal requirements.
- Natural resources personnel, including biologists, should be consulted during the planning and design stages.
- All potential pond locations should be evaluated to select the most suitable site in relation to the developed area and surroundings, and in recognition of physical, social, economic, and biologic factors.
- There should be an adequate drainage area to provide a dependable source of water for the intended year-round use of the pond, considering seepage and evaporation losses.
- The soil on site must have sufficient bearing strength (at least 20 percent clay) to support the dam without excessive consolidation and be impermeable enough to hold water.
- The pond site should be located in an area where disturbances to valuable existing wildlife habitat by construction activities will be avoided or minimized.
- Impoundments with gently sloping sides (on the order of 10:1) are preferable to impoundments with steep slopes. Gently sloping sides will encourage the establishment of marsh vegetation. Vegetation will provide food and cover for wildlife and help to enhance water quality. Impound-

ments with gently sloping sides are also safer than steep-sided ponds for children who might enter the impoundments, and gently sloping sides facilitate use by terrestrial wildlife.
- Water depth should not exceed 2 ft. for 25 percent to 50 percent of the water surface area, with approximately 50 percent to 75 percent having a depth not less than 3 ½ ft.
- An emergent vegetation/open-water ratio of about 50:50 should be maintained.
- For larger impoundments (>1 acre), one or more small islands should be constructed. The shape and position of islands should be designed to help direct water flow within the impoundment. Water flow around and between islands can help to oxygenate the water and prevent stagnation. Water quality can be enhanced by a flow-through system where water is continually flushed through the impoundment. Islands should be gently sloping, and the tops should be graded to provide good drainage. Appropriate vegetative cover should be established to prevent erosion and provide bird nesting cover. Consideration should be given to including an overland flow area in the design of large impoundments.
- Impoundments should be designed with the capacity to regulate water levels, including complete drainage, and with facilities for cleaning, if necessary.
- Locating permanent-water impoundments near existing wetlands generally will enhance the wildlife values of impoundments.

Plants for Stormwater Control Pond Vegetation Zones

Every effort has been made to fit wetland plants into appropriate zones. However, many plants can be quite adaptable to a variety of zones and may spread or move after initial planting. The following woody species may not need to be seeded because they may invade naturally: red maple (*Acer rubrum*), silver maple (*Acer saccharum*), box elder (*Acer negundo*), green ash (*Fraxinus pennsylvanica*), sycamore (*Platanus occidentalis*), river birch (*Betula niger*), and cottonwood (*Populus deltoides*).

Zone 1: Deep Water (permanent water 1 to 8 ft. deep: mostly 2 ft. to 3 ft. deep)

Common Name	Scientific Name
Herbaceous Plant Material	
Duckweed	*Lemna* spp.
Coontail	*Ceratophyllum* spp.
Water Milfoil	*Myriophyllum* spp.
American Lotus*	*Nelumbo lutea*
Spadderdock*	*Nuphar advena*
White Water Lily	*Nymphea odorata*

* These species are invasive and can cover the entire open water portion of a pond. To control the invasive nature of these plants. grow them in containers.

Zone 2: Shallow Water (permanently wet or semipermanently inundated up to 1 foot deep)

Herbaceous Plant Material	
Cooper Iris	*Iris fulva*
Southern Blue Flag Iris	*Iris versicolor*
Pickerel Weed	*Pontederia cordata*
Sweet Flag	*Acorus calamus*
Arrowhead	*Sagittaria latifolia*
Lizard's Tail	*Saururus cernuus*
Spiderlily	*Hymenocallis occidentalis*
Water Plantain	*Alisma subcordatum*
Creeping Primrose	*Ludwigia repens*
Marsh Millet	*Zizaniopsis miliacea*
Shrubs	
Buttonbush	*Cephalanthus occidentalis*
Swamp Privet	*Forestiera acuminata*
Swamp Haw	*Viburnum nudum*
Winterberry	*Ilex verticillata*
Common Alder	*Alnus serrulata*
Swamp Rose	*Rosa palustris*
Rose Mallow*	*Hibiscus moscheutos*
Swamp Mallow*	*Hibiscus militaris*
Trees	
Bald Cypress	*Taxodium distichum*
Water Tupelo	*Nyssa aquatica*
Water Hickory	*Carya aquatica*
Swamp White Oak	*Quercus bicolor*
Overcup Oak	Quercus lyrata

Zone 3: Pond Shoreline (water tolerant but can be exposed for extended dry periods).

Common Name	Scientific Name
Herbaceous Plant Material	
Marsh Violet	*Viola cucullata*
Tickseed Sunflower	*Bidens* spp.
Cardinal Flower	*Lobelia cardinalis*
Great Blue Lobelia	*Lobelia siphilitica*
Monkey Flower	*Mimulus ringens* or (*alatus*)
Joe-pye-weed	*Eupatorium fistulosum* or (*maculatum*) or *(purpureum*)
Meadowbeauty	*Rhexia verginica*
Red Milkweed	*Asclepias incarnata*
Soapwort Gentian	*Gentian saponaria*
Jewelweeds	*Impatiens pallida* or (*capensis*)
Turtlehead	*Chelone glabra*
Boneset	*Eupatorium perfoliatum*
Cinnamon Fern	*Osmunda cinnamomea*
Royal Fern	*Osmunda regalis*
Horsetail	*Equisitum* spp.
Cattail*	*Typha latifolia*
Soft Rush	*Juncus effusus*
Frank's Sedge	*Carex frankii*
Fox Sedge	*Carex vulpinoidea*
Softstem Bulrush	*Scripus atrovirens*
Dark Green Rulrush	*Scripus validus*
Burreed	*Sparganium americanum*
Spikerushes	*Elocharis* spp.
Cutgrass	*Leersia* spp.
Shrubs	
Sweetshrub	*Clethra alnifolia* or *(acuminata*)
American Elderberry	*Sambucus canadensis*
Gray Dogwood	*Cornus racemosa*
Silky Dogwood	*Cornus amomum*
Stiff Dogwood	*Cornus foemina*
Arrow-wood	*Viburnum dentatum*
Withe-rod	*Viburnum cassinoides*
Deciduous Holly	*Ilex decidua*
Steeplebush	*Spirea tomentosa*
Trees	
Pin Oak	*Quercus palustris*
Swamp Chestnut Oak	*Quercus michauxii*
Cherrybark Oak	*Quercus pagoda*
Bur Oak	*Quercus macrocarpa*
Willow Oak	*Quercus phellos*
Swamp White Oak	*Quercus bicolor*
Sugarberry	*Celtis laevigata*
Sweetgum	*Liquidambar styraciflua*
Shellbark Hickory	*Carya laciniosa*
Blackgum	*Nyssa sylvatica*
American Elm	*Ulmus americana*

Zone 4: Riparian Fringe (must be able to tolerate both wet and dry conditions)

Common Name	Scientific Name
Herbaceous Plant Material	
Grasses	
Eastern Gamagrass	*Tripsacum dactyloides*
Prairie Cordgrass	*Spartina pectinata*
Switchgrass	*Panicum virgatum*
Big Bluestem	*Andropogon gerardii*
Wild Rye	*Elymus virginicus*
Wildflowers	
New England Aster	*Aster novae-angliae*
Dense Blazingstar	*Liatris spicata*
Sweet Black-eyed Susan	*Rudbeckia subtomentosa*
Branched Coneflower	*Rudbeckia triloba*
Golden Alexanders	*Zizia aurea*
Ironweed	*Veronia altissima* or (*noveboracensis*)
False Dragonhead	*Physostegia virginiana*
Shrubs (shrubs listed in Zone 3 will work in addition to the following species)	
Smooth Sumac	*Rhus glabra*
Blackhaw	*Viburnum prunifolium*
Spicebush	*Lindera benzoin*
False Indigo	*Amorpha fruiticosa*
Trees (all the trees listed in Zone 3 will work in addition to the following species)	
Northern Red Oak	*Quercus rubra*
Shumard Oak	*Quercus shumardii*
Black Walnut	*Juglans nigra*
Red Elm	*Ulmus rubra*
Yellow Poplar	*Liriodendron tulipifera*
White Ash	*Fraxinus americana*
American Basswood	*Tilia americana*
American Hornbeam	*Carpinus caroliniana*
Eastern Hophornbeam	*Ostrya virginiana*
Buckeye	*Aesculus glabra*
Downy Hawthorn	*Crataegus mollis*

Zone 5: Floodplain Terrrace and Zone 6: Upland Slopes

For woody plants suitable for Zones 5 and 6 (upland sites), ask your county Extension office for a copy of the publication, Trees, Shrubs, and Vines That Attract Wildlife (FOR-68).

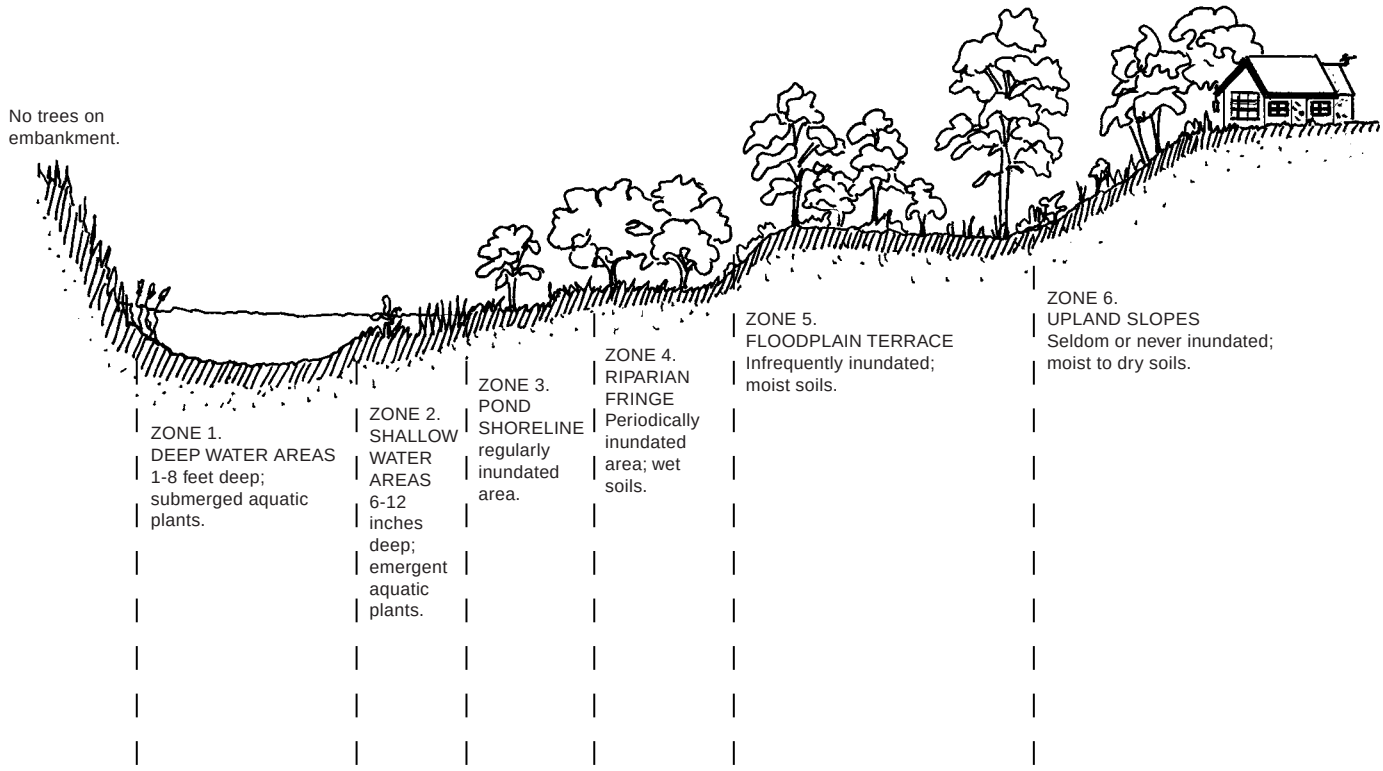

Figure 1. Landscaping zones in stormwater areas. Adapted from Wittans and Weiss, 1985, and Schueler, 1987.

Zone 1: Deep Water Areas

This is the wettest zone; these areas are permanently under one to eight feet of water. Plants in this zone require permanently saturated soils and are predominated by submergent aquatics (wild celery, coontail, water milfoil, sago pondweed) and floating plants such as duckweed, water lotus, spadderdock, waterlily, and eelgrass.

Zone 2: Shallow Water Areas

This zone is permanently wet with an average water depth of less than one foot or semi-permanently inundated. Ecological communities typified by this zone include bottomland hardwood forests, wet prairies and marshes, seeps, ponds and sloughs, and the margins of lakes. Plants adapted to this zone prefer continuously wet soils and tolerate extended periods of flooding or inundation. Examples of plants would include cattails, rushes, burreed, sweet flag, copper iris, southern blue flag iris, and cinnamon fern.

Zone 3: Pond Shoreline

Plants in this zone must be tolerant of inundation during storms and exposure during dry periods. Vegetation that can be established here includes sedges, buttonbush, and cattail. Parts of the shoreline should be kept free of vegetation and maintained as mudflats or sandbars.

Zone 4: Riparian Fringe Area

Plants in this zone must be able to tolerate both wet and dry soil conditions and periodic inundation. Potential tree species include black willow, green ash, red maple, and sycamore.

Zone 5: Floodplain Terrace

This zone includes most of the pond embankments. Trees that grow in this zone prefer moist soil but can tolerate infrequent inundation. These species include silky dogwood, elderberry, and spicebush. When landscaping around the pond, avoid planting trees and shrubs on the embankment or along the dam because their roots can be destructive to the dam. In general, a pond designed for waterfowl has only about 50 percent of this zone planted with trees and shrubs.

Zone 6: Upland Slopes

This area is seldom inundated with water. Trees that can be planted here include chokeberry, elderberry, and dogwood. For woody plants suitable for Zones 5 and 6 (upland sites), ask your county Extension office for a copy of the publication, *Trees, Shrubs, and Vines That Attract Wildlife (FOR-68).*