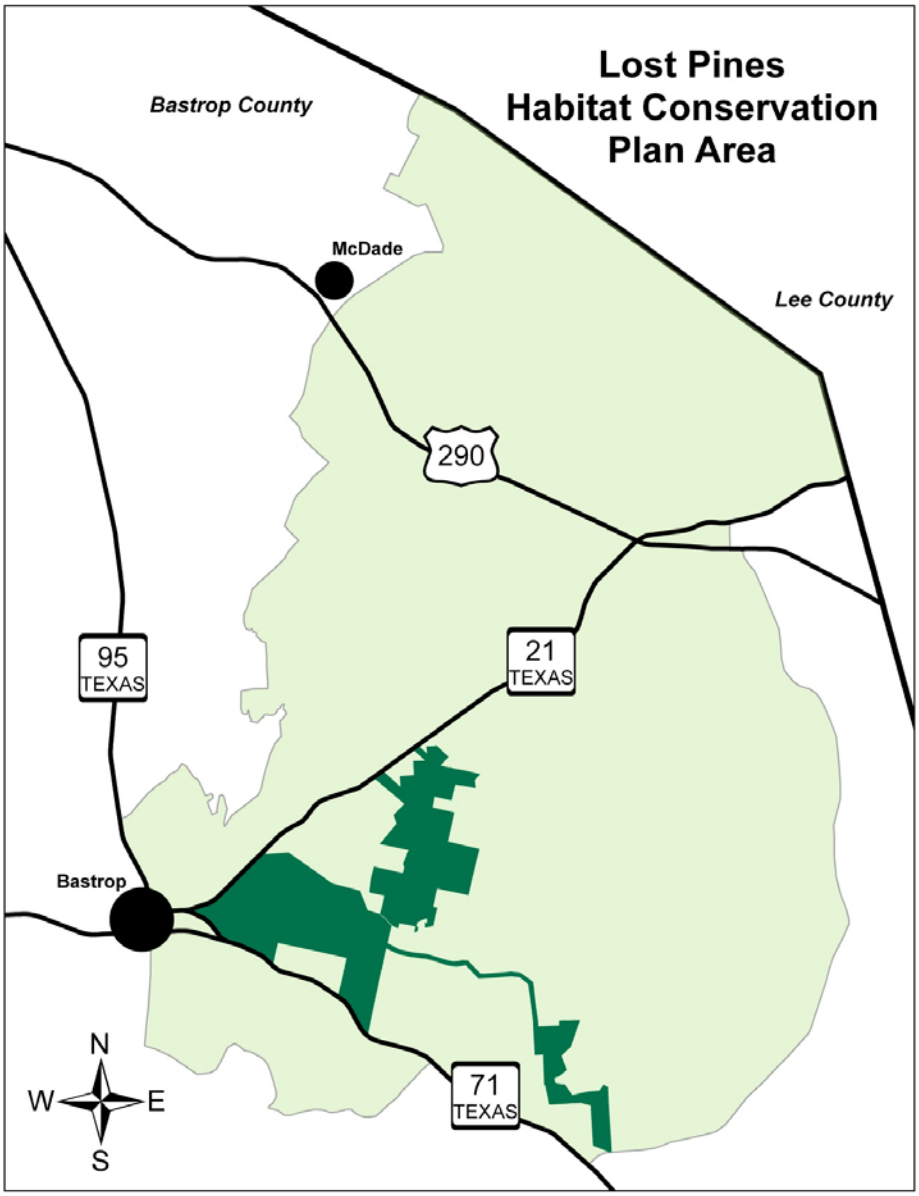
INTEGRATED PEST MANAGEMENT PLAN

FOR THE LOST PINES HABITAT CONSERVATION PLAN AREA



September 9, 2010

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Introduction[1]

This Integrated Pest Management Plan addresses those pests identified as occurring within the 124,000-acre Lost Pines Habitat Conservation Plan area. This is a "living" document. It will be updated as new information for treatment of area pests becomes available and it will also incorporate additional pests as they are identified.

General Information

Integrated Pest Management (IPM) ideally combines biological, cultural and mechanical controls with limited pesticide use to keep pest populations below economically damaging levels, prevent future pest problems, and minimize the harmful effects of pesticides on humans and natural resources, including wildlife. Practitioners of IPM can reduce pest damage and economic loss by recognizing and using natural controls such as weather conditions, pest diseases and predators, pest life cycles, and modified agricultural practices.

Pest elimination is typically not a goal of IPM, however, prevention of crop damage is an integral component. If and when pesticides are used, they are used at lower application rates and lower toxicities in combination with other control methods. IPM can increase profits in the long run by reducing chemical pest control costs, reducing environmental and human health risks associated with pesticide use, improving soil health and productivity, and increasing revenues from land leased for recreational use. Although generally associated with cropland, IPM is implemented by a variety of private landowners and managers including farmers, ranchers, foresters, homeowners, and groundskeepers.

Pesticides and herbicides are, simply put, detrimental to all amphibians including Houston toads. You can minimize their use by relying on IPM, organic gardening methods or practices and by encouraging native vegetation. If pesticides and/or herbicides are used, landowners and managers should be familiar with their proper use and restrictions, as well as any licensing requirements for pesticide applicators.

Beneficial insects, birds, and mammals are natural enemies of many crop pests and can play an important role in IPM. Landowners and managers spend a considerable amount of time and money to control pest populations where natural pest inhibitors are lacking. Modified farming techniques, increased crop diversity, use of cover crops and conservation buffers can increase

[1] Portions excerpted from "Integrated Pest Management (IPM) and Wildlife," Fish and Wildlife Management Leaflet, April 2004, Number 24, Natural Resources Conservation Service and Wildlife Habitat Council.

food and cover on croplands for many species, including those beneficial in controlling pest populations.

IPM incorporates the flowering patterns of native plants and crops and the life history and movements of beneficial insects and wildlife.

IPM limits pesticide use, which affects non-target species such as beneficial insects and wildlife. Estimates of wild birds killed in the United States every year by exposure to legally-applied pesticides range in the tens of millions. Aquatic invertebrates, fish, amphibians, mammals, and others are also at risk. Insects are a major vehicle for pollination in orchards and vineyards, but their populations decrease after pesticide misuse. Herbicides can reduce or eliminate potential wildlife food and cover plants. Use of insecticides can reduce beneficial invertebrate populations that help control pests and are important food sources to many wildlife species. By using insecticides to address pest problems only where other measures fail to achieve the desired level of control, IPM seeks to minimize the negative effects of pesticide use on wildlife and other natural resources.

Terms and Definitions Associated with IPM

Pest

- An organism, plant or animal, which is undesirable or is detrimental to the interests of humans and capable of causing injury or damage.
- Major pest types include insects and other arthropods, nematodes, pathogens, vertebrates, and weeds.

Pesticides

- Chemical compounds used to control individuals or populations of pests.
- *Herbicides* are pesticides used to control undesirable vegetation, such as weeds or invasive woody plants.
- *Insecticides* are used to control undesirable insects on plants or on/in the soil.
- *Fungicides* are used to control fungus growth and spore dispersal.
- Individuals applying pesticides must comply with federal and state laws and regulations.

Resistance

- Genetically inherited ability of organisms to evolve strains that can survive exposure to pesticides formerly lethal to earlier generations.

Resurgence

- Occurs when insecticide application initially reduces an infestation, but soon afterwards the pest rebounds (resurges) to higher levels than those before treatment.

Economic Injury Level (EIL)

- This is the economic break-even point where the cost of pest damage equals the cost of control.

Economic/Action Threshold Level

- Population level at which control measures are needed to prevent pest populations from reaching economic injury levels (EIL); action threshold is lower than EIL to allow for control measures to take affect before the pest population reaches the EIL levels.

IPM Strategies

IPM follows a sequence: pest identification, scouting, management treatments, and post-treatment monitoring. Together, these actions form the key to IPM, which is long-term pest *prevention*. Preventing pest problems is the most effective and efficient pest control method.

Prevention contributes to the long-term protection and productivity of crops, as well as wildlife habitat and other natural resources. Local Extension agents can help landowners and managers develop a scouting schedule, correctly identify pests and symptoms, and determine economic thresholds and management actions. Cooperative relationships and information sharing between adjacent crop growers can further reduce pest problems.

Pest Identification

Pest identification is an important component of IPM. Whether pests are insects, vertebrates, diseases or weeds, landowners and managers should be familiar with pests associated with their land and crops. Landowners and managers should be able to recognize seasonal conditions that favor pests, potential hosts, and signs of pest damage. Local Extension agents may be able to assist in pest identification.

Scouting

Scouting is used to monitor pest densities. Landowners can use scouting data to determine the pest population size and correct method for controlling pests before the economic threshold is reached. Scouting tools include: 10x hand lens for viewing insects, larvae, or eggs; notebook and pen for recording notes; sweep net or other device for catching insects on the wing; and a vial or other closed container for insect samples. Accessory equipment might include a digital camera capable of macrophotography, enabling digital records of pests or pest damage to be maintained alongside other archived materials. The archived materials and field notes are valuable as long term reference materials for a particular site or acreage.

Regular, systematic sampling is crucial to estimate pest populations and prevent future outbreaks. Notes should be taken during each scouting run and permanent records kept to track trends. During weekly scouting trips, each crop location should be sampled for pests. Landowners and managers should take samples from the field interior, not just around the field border. Record the crop stage and condition, the date and time of day, moisture conditions, the number and type of pests, and other insects or wildlife observed. Also note nearby buildings, vegetation, buffers, water sources, or other features that might serve as overwintering or

migrating grounds for pests, beneficial insects, and wildlife. Collect samples of pests and other insects that cannot be positively identified, as well as samples of plant materials.

Management Treatments and Their Effects on Habitat

Whenever possible, landowners and managers should avoid disturbing high-use wildlife areas, especially during the breeding and nesting season (January through June). Many ground-nesting birds, small mammals, and reptiles and amphibians may use croplands and ground cover crops for breeding and raising young. When possible, avoid treating frequently used foraging areas. Woody draws, riparian vegetation, wetlands, native grasslands, and other sensitive habitats should be preserved.[2]

Cultural control

Cultural controls can help create, maintain, and enhance habitats that harbor beneficial insects and wildlife. Cultural controls generally target some weak point in the pest's life cycle through physical or genetic treatments. Physical controls modify the growing environment to help control pest populations. Some physical controls are actual barriers, such as buffers, hedgerows, or windbreaks that help prevent pests from entering lands and serve as habitat for beneficial insects and wildlife.

Crop rotation is a physical control mechanism that can significantly reduce pest populations, especially those that are crop-specific or overwinter on-site. In order for crop rotation to be effective, the alternate host crop must be unacceptable to the pest. For example, corn rootworm populations are reduced or eliminated by rotating from corn to just about any other crop. Rotating crops to native grasses or legumes, small grain cover crops, and winter cover crops can provide food and cover for some wildlife species while disrupting the corn rootworm life cycle and reducing their numbers. Landowners and managers should avoid continuous crop monocultures, which can increase reliance on pesticides and reduce soil fertility. In some cases, adjusting planting or harvesting dates is an effective control method. For example, early alfalfa harvest dates can help reduce alfalfa weevil populations by eliminating their overwintering source (alfalfa stalks).

Tillage is the primary cultural control method, and is particularly effective when used in combination with spot herbicide treatments. However, tillage can increase soil erosion and if conducted during the breeding season, can destroy eggs, young, and adult ground-nesting birds and other wildlife.

Conservation tillage practices reduce or eliminate plowing, and newly planted croplands are protected by at least 30 percent residue cover. Crop stubble can provide winter cover for wildlife. Over time, conservation tillage can also improve soil and water quality by increasing organic

[2] The Lost Pines Habitat Conservation Plan Agricultural, Forest and Wildlife Management Guidelines provide additional guidance on the use and timing of pesticides/herbicides in Houston toad habitat.

matter, reducing soil erosion and pesticide runoff, and increasing soil clumping, which promotes root establishment.

Other cultural controls like mowing, disking, sanitation, and increased row spacing (to increase airflow and reduce dampness) can be used in various combinations to control pest populations. Genetic controls use resistant plant strains to help prevent pest outbreaks. Weed- or disease-free certified seeds can be planted to help reduce herbicide and fungicide use.

Biological control

Predators, parasitoids, and pathogens are the three main agents of biological control. Common predators include insects, birds, and bats and other mammals. Parasitoids are typically tiny wasps that lay eggs on insect hosts. The wasp larvae then feed on and kill the hosts. Parasitoids are not dangerous to humans, livestock, or poultry. Pathogens are selective organisms that cause disease and include viruses, bacteria, fungi, and nematodes.

Biological control agents, particularly predators, need suitable habitat near or adjacent to crops. There are several habitat management practices that landowners and managers can implement that create, maintain, or enhance habitat for beneficial species. Agroforestry, a combination of agriculture and forestry, is a land use system that retains or introduces a mix of trees and other woody perennials in crop and animal production systems to take advantage of economic and ecological interactions, providing habitat for beneficial animals and other wildlife. Some agroforestry practices include:

> *Windbreaks* — multiple rows of trees and shrubs planted and managed to protect farmsteads or incorporated as part of crop or livestock operations to enhance production.
>
> *Alley cropping* — growing food, forage, or other crops between rows of planted trees or shrubs.
>
> *Riparian forest buffers* — Natural or re-established forests along waterways that are composed of trees, shrubs, and grasses designed to filter non-point source pollution from adjacent croplands.

Agroforestry and other habitat enhancing practices often benefit wildlife that use edge habitats. Establishment of non-native or woody plants in areas of *native* prairie grassland is generally not recommended. Many grassland wildlife populations, especially birds, are rapidly declining; introduction of woody vegetation to native grasslands may accelerate this decline.

When maintaining or enhancing habitat for beneficial species, there are treatments that improve habitat quality. As a general rule, the wider the windbreak or buffer, the more beneficial it is for wildlife. Choose native trees, shrubs, grasses, and legumes for planting conservation buffers and ground cover crops that best support beneficial species without harming crop growth. Fruit- and seed-producing vegetation provides a rich food source for many wildlife species. Diverse,

vertical vegetation structure provides for various nesting, roosting, and foraging needs. Snags (standing dead trees) should be preserved when possible for cavity-nesting birds and small mammals. Leaving a vegetated buffer strip between crops and high-use wildlife areas (e.g., riparian zones) can be beneficial to beneficial predator insects and animals during tillage operations and chemical treatments. Windbreaks and other conservation buffers should connect habitat patches on the landscape where possible.

Beneficial insects— predators and parasitoids

Introducing beneficial insects can be expensive, and there is no guarantee that beneficial species will stay in a particular field, especially if suitable habitat is not available. Perhaps the best way to integrate beneficial insects into an IPM plan is to ensure that attractive habitat is available to these animals near crop fields in need of protection. Field borders and other conservation buffer practices containing a diversity of native vegetation is one way to provide this habitat near and between crop fields. Beneficial insects and other arthropods include predators and parasitoids.

Predators feed on the eggs, larvae and adults of insect pests. Beetles, mites, and spiders are common predators. Lady beetle larvae feed on aphids and the eggs of other pest insects. Green lacewings consume aphids, mites, and other pests. Predatory mites consume spider mites. Damsel bugs, big-eyed bugs, mantids, minute pirate bugs, assassin bugs and others are important pest predators in various seasons.

Parasitoids are insects that attack and lay eggs inside the pupa case of another species. After hatching, the parasitoid larva consumes the host pupa before emerging as an adult. *Encarsia* spp., *Muscidifurax raptor*, *Nasonia vitripennis*, and *Spalangia cameroni* are a few important parasitoid species. Parasitic nematodes also consume grubs, beetles, grasshoppers, and other pests.

Pathogens

Pathogens are micro-organisms, including bacteria, fungi, protozoa, and viruses, that cause disease and live on and in the bodies of insects. Pathogens occur naturally and can substantially reduce pest populations. They are highly selective, so they have limited negative effects on humans and non-target organisms.

The most commonly used pathogen is Bt (*Bacillus thuringiensis*), which is a bacterium that controls a variety of plant pests from caterpillars (Lepidoptera) to mosquito and small fly larvae (Diptera) to beetles (Coleoptera). As a biological pesticide, Bt also controls simuliid blackflies, which are vectors for river blindness in Africa. Landowners and managers can use variations of Bt that are used to control particular families or species of insects without harming non-target insect species. Varieties of some crops, such as Bt corn and Bt cotton, have been genetically altered to contain the Bt bacterium toxin to kill susceptible insect pests. However, there is controversy regarding the ability of pests to develop resistance to Bt crops.

Different kinds of pathogens control different types of pests. For example, Japanese beetle grubs can be controlled using milky spore disease (*Bacillus popilliae*), which occurs naturally in some grubs. Milky spore disease bacteria are cultured in living hosts and used for long-term control of chafer beetles, particularly Japanese beetles. Fungi can also act as important pest controls. Pine root rot (*Heterobasidion annosum*), one of the most damaging root pathogens of coniferous trees, spreads quickly from infected roots to healthy roots and also colonizes freshly cut stumps. Another fungus, *Phlebiopsis gigantea*, helps prevent invasion of pine root rot when applied to freshly cut stumps.

Bats and IPM

Bats are a recently recognized form of biological control useful in IPM. Bats play key ecological roles in many plant communities, eating insects, pollinating flowers, and dispersing seeds. Bats are useful in controlling pest populations in agricultural fields and orchards, and are the only major predator of night-flying insects. The food items consumed by bats depend on the bat species, season, and available prey. Listed below are some under appreciated bat facts.

- An average-sized maternity colony of 150 big brown bats can consume 38,000 cucumber beetles, 16,000 June bugs, 19,000 stink bugs, and 50,000 leafhoppers in one summer.
- One endangered gray bat can eat 3,000 insects per night, including moths, flies, and midges.
- One little brown bat can catch 600 mosquitoes per hour.
- In a Georgia pecan orchard, Mexican free-tailed bats took up residence in bat houses installed by the landowners. The colony contained about 600 individual bats and virtually eliminated problems and pesticide use associated with tent caterpillars, hickory shuckworms, and other pests.
- A Willamette Valley, Oregon organic farmer nearly eliminated pesticide use for corn earworm moths by attracting local bat colonies to the orchards. The Oregon farmer reduced pesticide use from 13 to two applications per year, and did not need to spray until after birds and bats had migrated south for the season.

Attracting bats to croplands and orchards requires proper bat house construction and placement in proximity to reliable food sources. If there is a local colony of bats nearby, bats will likely take notice of bat houses more readily. For more information on bat habitat and building and installing houses for bats in North America, see Fish and Wildlife Habitat Management Leaflet No. 5, *Bats*.

Birds and IPM

Birds are another recently recognized addition to the list of biological pest control agents. When used in combination with other pest control treatments, birds may help reduce populations of insects and small mammals. Erecting perches and artificial nesting structures for raptors and

songbirds is an easy way to complement IPM efforts. Perches and nesting structures can be placed around the perimeter of crop fields or in nearby suitable habitat. Designs for nest boxes and other wildlife nesting structures are provided in Fish and Wildlife Habitat Management Leaflet No. 20, *Artificial Nesting Structures*.

A study in the Pacific Northwest found that hawks, kestrels, and shrikes were attracted to sites where artificial nesting structures were installed. Voles were a major diet component, but the results of the study concerning the effect of raptor predation on small mammal populations were inconclusive. In a separate study, barn owls consumed large numbers of gophers, mice, and other rodents that are potential pests to crops, tree plantations, orchards, and vineyards. These biological pest control agents are especially beneficial on agricultural lands when used in combination with other control methods.

Chemical control

Chemical control agents include pesticides, biopesticides, pheromones, and other chemicals used to suppress pest outbreaks. Under IPM, some level of pest activity is tolerated, and most crops survive some damage before economic loss occurs. IPM chemical controls, specifically pesticides, are used when routine scouting trips show that pest populations reach levels that reduce yields and breach economic thresholds. Chemical controls are applied as a last resort, and are still used in combination with other management treatments. Individuals applying chemical pesticides must do so in compliance with applicable federal and state laws and regulations. For more information contact your state pesticide regulatory agency, state department of agriculture, or state department of environmental quality.

Pesticides negatively affect non-target organisms and natural resources, including beneficial insects, natural pest enemies, fish, wildlife, humans, and soil, air, and water quality. Herbicides also reduce food and cover that is important to beneficial insects and fish and wildlife.

Choose the least toxic chemical to reduce the chance of harming beneficial organisms, fish, wildlife, and humans. Choose a less persistent chemical to increase the rate of chemical breakdown in the soil. Remember to consider the whole landscape when choosing pesticides. Some chemicals do not affect certain species, but can be detrimental to others, both on-site and elsewhere in the watershed.

Minimize spray drift during application by using the appropriate nozzle, pressure, and volume to regulate droplet size. Also consider: (1) adding a drift control agent, (2) using ground-booms, fitted with a skirt, instead of airplanes, (3) applying at a lower temperature and higher humidity, (4) not spraying during a temperature inversion, (5) using a soil incorporation method instead of spraying.

Avoid spraying if wind speeds are greater than 10 mph.

Avoid spraying over, or washing equipment near, lakes, ponds, streams, or other bodies of water. Immediately report any chemical spills to the proper authorities.

Conduct chemical controls through spot treatments if pest outbreak is limited to particular areas. Spot treatments reduce costs and save time by treating only the affected area, and conserve beneficial species and surrounding habitat in untreated areas.

Use less volatile pesticides to minimize volatilization, which occurs when a solid pesticide converts to a gas and is carried away from the target area by wind.

Post-treatment Monitoring

Post-treatment monitoring determines the short- and long-term effectiveness of management treatments. If management actions do not produce the desired results, then re-evaluate and adjust the treatments.

Organic Farming

Organic farming is an alternative to conventional farming that incorporates many principles of IPM. This type of farming does not use chemical control methods, but relies on techniques such as crop rotation, natural manures, composting, organic fertilizer, and biological pest controls. Some farmers are concerned with lower yields associated with organic farming, but low production costs usually compensate for lower yields. When properly conducted, organic farming techniques increase soil organic matter and soil tilth, minimize runoff and erosion, and provide quality fish and wildlife habitat. Overall, organic farming is an environmentally friendly, sustainable agricultural practice that can benefit producers and wildlife.

Landowner Assistance

There are many agencies and organizations experienced with IPM treatments and effects on fish and wildlife habitats. The USDA NRCS produced the CORE4 Conservation Practices Training Guide, which contains information about integrated pest management, conservation tillage, nutrient management, and conservation buffers. Extension agents and NRCS technicians can supply landowners with information about IPM. The National Information System for the Regional IPM Centers (http://www.ipmcenters.org/) lists contacts by region and state, gives technical information about specific pests and management treatments, and contains a directory of state IPM coordinators. The EPA Office of Pesticide Programs also has information and links to IPM information on-line at http://www.epa.gov/pesticides/. The Consortium for International Crop Protection (CICP) and IPMnet website contains IPM technical information and links at http://www.ipmnet.org/. Many universities also develop IPM handbooks through agriculture, forestry, or entomology departments.

Insects

Red Imported Fire Ant

The red imported fire ant, *Solenopsis invicta* Buren, is an introduced species that arrived in Mobile, Alabama from South America during the 1920s. This ant species has had an enormous effect on the southeastern United States, and continues to spread into areas of North America with mild climates and adequate moisture and food. Approximately 270 million acres in the southeastern United States are currently infested.

Fire ants prey on a number of other insects and arthropods, including boll weevils, many species of caterpillars, flea larvae, ticks and chiggers, as well as beneficial insects such as green lacewing larvae. They will also "tend" some species of sucking insects (aphids, mealy bugs) to obtain the sugary solution (honeydew) these insects excrete. The red imported fire ant has displaced many native ant species and reduced food used by some wildlife. The establishment of native vegetation assists native ants in competing successfully with fire ants, thus reducing their numbers.

Fire ants are a threat to newborn livestock and wildlife, especially animals on the ground or those nesting in low trees. Their multiple stings can cause serious injury or even death. Although the research is not conclusive, populations of some wildlife species may be dramatically reduced.

Like other ants, the fire ant is a social insect. Colonies live in mounds of dirt that may be more than 18 inches high. Mounds are often found in open, sunny areas. Periodically, winged reproductive male and female ants leave colonies on mating flights. Mated females (queens) can fly or be carried by winds for miles. When they land they start new colonies.

Ants develop from egg to adult in about 30 days, going through four larval stages and a pupal stage. There may be hundreds of thousands of worker ants (sterile female ants capable of stinging) in a mature colony. There are both single queen (monogyne) and multiple queen (polygyne) colonies. The single queen form may build 40 to 80 colonies per acre, while the multiple queen form can build 200 to 800 or more mounds per acre. Worker ants from multiple queen colonies are not territorial and move freely from mound to mound. The opposite is true of workers from single queen colonies.

Fire ants disperse naturally through mating flights and mass movement of colonies. When land is flooded, colonies form a mass of floating bodies and float to new locations in flood water. Fire ants are a “weedy” species, often infesting recently disturbed areas and then maintaining colonies thereafter. They can travel long distances when newly mated queens land on cars, trucks or trains. Shipments of hay, nursery stock or soil from an infested area may relocate entire colonies or nests. (The University of Tennessee Agricultural Extension Service PB 1740)

For the latest on research and management of the red imported fire ant, visit http://fireant.tamu.edu/

FIRE ANT MANAGEMENT

Land Use	Cultural/Mechanical Control	Biological Control	Chemical Control* **
Residential/ commercial	Plant shade trees. Plant pest-free plants. Application of boiling water to mounds. Application of diatomaceous earth to mounds.	Preserve native ant colonies. Phorid fly introduction	Commercially available spinosad, hydramethylnon or fenoxycarb insecticides applied per product label instructions
Improved pasture	Plant pest-free plants. Application of diatomaceous earth to mounds.	Preserve native ant colonies. Phorid fly introduction	Commercially available spinosad or methoprene insecticides applied per product label instructions
Native range/ brush	Application of diatomaceous earth to mounds.	Preserve native ant colonies. Phorid fly introduction	Commercially available spinosad, methoprene or hydramethylnon insecticides applied per product label instructions
Forestland	Application of diatomaceous earth to mounds.	Preserve native ant colonies. Phorid fly introduction	Commercially available spinosad or fenoxycarb insecticides applied per product label instructions
Orchards/ gardens	Plant pest-free plants. Application of boiling water to mounds. Application of diatomaceous earth to mounds.	Preserve native ant colonies. Phorid fly introduction	Commercially available spinosad or hydramethylnon insecticides applied per product label instructions

* Contact the LPHCP Administrator for commercially available products containing the chemical(s) listed. Pesticides used improperly can be injurious to humans, animals and plants. Follow the directions and heed all precautions on labels. Apply pesticides so that they do not endanger humans, livestock, crops, beneficial insects, fish and wildlife. Do not apply pesticides when there is danger of drift, when honeybees or other pollinating insects are visiting plants, or in ways that may contaminate or leave illegal residues.

** Treatment of imported red fire ant mounds near water features, and year round, is encouraged to reduce predation on Houston toadlets.

Armyworms

Armyworm outbreaks are difficult to predict but infestations seem to occur in portions of the state every year, especially after rains in the early fall. Common species of armyworms present in Texas include the fall armyworm, *Spodoptera frugiperda*; the yellowstriped armyworm, *Spodoptera ornithogalli*; the beet armyworm, *Spodoptera exigua*; and the armyworm, *Pseudaletia unipuncta*. The fall armyworm is usually the species that causes the most problems in pastures, small grains and turfgrass.

All armyworms have four life stages: egg, larva, pupa and adult. Eggs are very small, white, laid in clusters of 50 or more and are covered with grayish, fuzzy scales from the body of the female moth. The eggs are seldom seen in grasses and are usually laid at the base of host plants. Lush plant growth is preferred by the adults for egg laying. Larvae (caterpillars) are very small when they emerge from the egg. Larvae will feed for 2-3 weeks and can be 1 to 1 1/2 inches long with various color patterns depending on the species. The larvae have five instars (stages when molting occurs) and sometimes hide in debris on the soil surface in the middle of the day. When full grown, larvae enter the soil and form the pupal stage. Adult moths emerge from pupae. Moths mate and lay eggs, thus starting the life cycle over again.

Several generations (a generation is the development from egg to adult stage) occur each year and typically take about 28 days to complete. Generation time can be extended if cooler temperatures occur and can last up to several months. Armyworms in the spring and summer occur in more distinct groups than later in the season. Fall populations of larvae often blend together several generations and may appear to be continually occurring.

When feeding, larvae strip foliage and then move to the next available food. High populations appear to march side by side to the new food. Thus, the name armyworms is derived.

Armyworms attack many different kinds of plants. When food is scarce, they will move to plants that are not normally attacked. Thus, armyworms can be found on nearly any plant as they migrate in search of edible foliage. Plants attacked by armyworms include bermudagrass, fescue, grain and forage sorghum, corn, small grains, sweet potato, beans, turnip, clover, spinach, cucumber, potatoes, tomatoes, cotton and cabbage. Damage consists of defoliation. The small larvae will chew the green layer from the leaves, creating a “window pane” effect. The first three instars cause very little feeding damage while the last two instars consume 85% of the total foliage consumed.

Although armyworm outbreaks are memorable when they occur, in reality, the outbreaks are usually small in scope. Weather and natural enemies usually act together to keep populations under control. Parasites, such as wasps and flies, are very effective against armyworms. Predators, such as ground beetles, are also effective in limiting outbreaks. Birds, skunks and rodents also consume large numbers of larvae and pupae. Diseases such as insect viruses and fungi can also be important.

However, conditions can occur that favor armyworms. High egg survival of fall armyworms is favored by above average rains in August and September. Beet armyworm outbreaks are likely in hot, dry conditions or when multiple applications of insecticides reduce natural enemies. Because armyworm moths are strong fliers, outbreaks can also occur when storms move the moths and allow them to escape natural enemies. Armyworms should be controlled only when they occur in large numbers or plant damage is becoming excessive.

The fall armyworm outbreaks usually occur late in the summer and early fall. Preventive treatments normally are not justified because attacks are sporadic and egg mortality is usually high. A variety of natural enemies keep fall armyworm larvae down to moderate numbers. Early detection of larvae is the best management tool and is achieved by frequent, thorough inspection of plants. Outbreaks seem to occur shortly after a rain or supplemental irrigation.

Fall armyworms feed any time of the day or night, but are most active early in the morning or late in the evening. Susceptible fields or lawns should be scouted by counting the number of armyworms in a square foot area in 8 different sites. Divide the total worm count by 8 to find the average number of armyworms per square foot. Be sure to take samples in the interior of the field because this pest is often heaviest near the field margins. Sometimes, only the field margins require treatment.

The threshold level ranges from two to three larvae per square foot for seedling wheat. For older plants, three to four larvae and obvious foliage loss justify control measures. Thresholds in improved pastures and lawns vary with conditions but treatment should be considered when counts average three or more worms per square foot. (Texas A&M AgriLife Extension EEE-0009, Sep 2004).

ARMYWORM MANAGEMENT

Land Use	Cultural Control	Biological Control	Chemical Control* **
Residential/ commercial	Encourage birds to visit by setting out feeders, birdbaths or nesting material in the area where the worms are feeding. Attract predatory wasps by planting dill, fennel, coreopsis and brightly colored flowers near armyworm-prone plants. Pick armyworms off desired plants and drop them into a bucket of soapy water. Rake up fallen leaf debris to eliminate daytime hiding places.	Release trichogramma wasps during main flight period of moths. Spray Bacillus thuringiensis, an organic control for caterpillars, in the late afternoon or early evening hours when you see the first signs of armyworm damage in your garden.	Commercially available spinosad insecticide applied per product label instructions
Improved pasture	Encourage birds to visit by setting out feeders or nesting material in the area where the worms are feeding.	Spray Bacillus thuringiensis, an organic control for caterpillars, in the late afternoon or early evening hours when you see the first signs of armyworm damage.	Commercially available spinosad insecticide applied per product label instructions
Native range/ brush	Attract predatory wasps by planting dill, fennel, coreopsis and brightly colored flowers near armyworm-prone plants.	Spray Bacillus thuringiensis, an organic control for caterpillars, in the late afternoon or early evening hours when you see the first signs of armyworm damage.	Commercially available spinosad insecticide applied per product label instructions
Forestland	N/A – Note: armyworms will attack seedlings	N/A	N/A

Land Use	Cultural Control	Biological Control	Chemical Control* **
Orchards/ gardens	Encourage birds to visit by setting out feeders, birdbaths or nesting material in the area where the worms are feeding. Attract predatory wasps by planting dill, fennel, coreopsis and brightly colored flowers near armyworm-prone plants. Pick armyworms off desired plants and drop them into a bucket of soapy water. Rake up fallen leaf debris to eliminate daytime hiding places.	Release trichogramma wasps during main flight period of moths. Spray Bacillus thuringiensis, an organic control for caterpillars, in the late afternoon or early evening hours when you see the first signs of armyworm damage in your garden.	Commercially available spinosad insecticide applied per product label instructions

* Chemicals should not be used within 150' of water features or drainages that feed ponds/stock tanks.
** Contact the LPHCP Administrator for commercially available products containing the chemical(s) listed. Pesticides used improperly can be injurious to humans, animals and plants. Follow the directions and heed all precautions on labels. Apply pesticides so that they do not endanger humans, livestock, crops, beneficial insects, fish and wildlife. Do not apply pesticides when there is danger of drift, when honeybees or other pollinating insects are visiting plants, or in ways that may contaminate or leave illegal residues.

Grasshoppers

Grasshoppers are among the most widespread and damaging pests in Texas. Approximately 150 species of grasshoppers are known to exist in the state; however, the following five species cause 90% of the damage to crops, gardens, trees and shrubs:

1. Differential grasshopper, *Melanoplus differentialis*

   Adults are 1 1/8 to 1 3/4 inches long. Black chevron markings on the hind femur help identify this grasshopper. Black individuals may occur. Moving in from weedy borders, they are very destructive in cultivated crops. They are seldom found in grassland.

2. Red-legged grasshopper, *Melanoplus femurrubrum*

   Adults are 7/8 to 1 1/4 inches long. The hind tibia are red. They are especially damaging to alfalfa and other legumes, but can be an important pest in other crops. They are of very little importance in grassland.

3. Migratory grasshopper, *Melanoplus sanguinipes*

   Adults are 7/8 to 1 1/8 inches long. The migratory grasshopper is one of the most destructive grasshoppers in grassland as well as in cultivated crops. This grasshopper is a strong flier and is known to swarm over long distances.

4. Two-striped grasshopper, *Melanoplus bivitattus*

   Adults are 1 to 2 1/4 inches long. Two light colored stripes extend from the eyes to the wing tips. They are primarily weed feeders, but will readily move into cultivated crops.

5. Packard grasshopper, *Melanoplus packardii*

   Adults are 1 1/8 to 1 1/2 inches long. They prefer sandy soils with light grass cover. They are the least damaging of the species, but can be a problem in both grassland and cultivated crops.

These insects cause some damage every year, but become very destructive during outbreak periods. Weather is the main factor affecting grasshopper populations. Outbreaks are usually preceded by several years of hot, dry summers and warm autumns. Dry weather increases nymph and adult survival. Warm autumns allow grasshoppers more time to feed and lay eggs. Cool, wet weather slows nymphal development, reduces the number of eggs laid, and increases the incidence of diseases. Grasshoppers have a high reproductive capacity. The female can lay an average of 200 eggs during a single season. Under favorable conditions up to 400 eggs can be laid. Approximately 40 eggs can be laid even if unfavorable conditions exist. Thus, 10 times more eggs can be produced during favorable conditions. With an average of 200 eggs per female, 198 eggs or young grasshoppers would have to die if the population were to remain the same. If,

instead of only two adults surviving, there are four, six, eight, 10 or 50, then the adult population the following year will be increased two, three, four, five or 25 times, respectively.

Grasshopper eggs are laid 1/2 to 2 inches beneath the soil surface in pod-like structures. Each egg pod consists of 20 to 120 elongated eggs securely cemented together; the whole mass is somewhat egg-shaped and covered with soil. The egg pods are very resistant to moisture and cold and are affected very little by winter conditions if the soil is not disturbed. Eggs are deposited in a variety of non-crop areas including ditches, fencerows, shelter-belts and weedy areas. They are also laid in cropped areas including late season crops, weedy fields, hay fields and alfalfa. Grasshopper egg hatch normally begins in late April to early May. Peak hatch occurs about mid-June and is usually near completion by late June. Cool and extremely dry springs may delay hatch, allowing it to continue into July.

Young grasshoppers are referred to as nymphs. They are similar to adults in general appearance, but are smaller and have wing pads instead of wings. There are usually five or six nymphal stages and the length of time from egg to adult is 40 to 60 days.

Adults of crop-damaging grasshopper species become numerous in mid-July with egg laying usually beginning in late July and continuing into the fall. In general, only one generation of grasshoppers is produced per year (Agricultural Communications, The Texas A&M University System).

Grasshoppers have many natural enemies that help suppress populations. A fungus, *Entomophthora grylli*, often causes locally high mortality. Infected grasshoppers strike a characteristic pose at the top of a plant or other object. The grasshopper grasps the plant in a death embrace with front and middle legs while the hind legs are extended. It dies in this position. Fungal spores develop in and on the body of the infected grasshopper. These spores become airborne and infect other grasshoppers. Under warm, humid conditions, great numbers of grasshoppers have been destroyed by this fungus.

Insects that feed on grasshoppers include the larvae of blister beetles (predators of the eggs), bee flies (parasites of eggs), robber flies, ground beetles, flesh flies and tangle-veined flies. Birds (quail, turkey, larks, Grackles, etc.) and mammals consume grasshoppers, but seldom have an impact in outbreak years. (http://insects.tamu.edu/extension/bulletins/l-5201.html)

GRASSHOPPER MANAGEMENT

Land Use	Cultural Control	Biological Control	Chemical Control*
Residential/ commercial	Eliminate tall grass and weeds from around those plants you wish to protect.	Nosema locustae	None recommended
Improved pasture	Tilling in mid- to late summer.	Nosema locustae	None recommended
Native range/ brush	N/A	Nosema locustae	None recommended
Forestland	N/A	Nosema locustae	None recommended
Orchards/ gardens	Eliminate tall grass and weeds from around those plants you wish to protect.	Nosema locustae	None recommended

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Leaf Cutting Ants

The Texas leaf cutting ant, *Atta texanus*, has several common names including the town ant, cut ant, parasol ant, fungus ant and night ant. The name comes from their habit of cutting leaves from a variety of plants. *Atta texanus* can be extremely destructive to landscape plants, gardens and some agricultural crops in Texas. During cooler weather, leaf cutter ants start to become a little more active. Leaf cutter ants will strip the leaves of any type of plant, but seem to prefer citrus and pine if given a choice.

Leaf cutting ants live in large colonies of up to 2 million. In Texas these ants damage weeds, grasses, plum and peach trees, blackberry bushes and many other fruit, nut and ornamental plants as well as several cereal and forage crops. The ants do not eat the leaf fragments they collect, but take them into their underground nest where they use the material to raise a fungus garden. As the fungus grows, certain parts of it are eaten by the ants and fed to the larvae. This fungus is their only known source of food. *Because leaf cutter ants only eat the fungus they cultivate, they do not respond well to most ant baits.*

Leaf cutting ants will attack pine trees but ordinarily they do little damage when other green plants are available. During the winter when green plant material is scarce, seedling pines are frequently damaged in parts of east Texas and west central Louisiana. Where ants are abundant, it is almost impossible to establish natural pine reproduction. In such sites, young pine seedlings often are destroyed within a few days unless the ants are controlled before planting.

Leaf cutting ants are rust to dark brown in color, and vary greatly in size. Worker ants range from 1/16 to 1/2 inch long. The queen is about 3/4 inch long. Leaf cutter workers can be distinguished from other ants by their three pairs of prominent spines on their back (thorax) and one pair of spines on the back of the head. The queen rules the colony from her underground chambers. Colonies may have as many as four or five fertile queens, each of which continually produces eggs. Eggs develop into cream-colored larvae that become 1/4 to 1/2 inch long when fully developed. Most larvae develop into sterile female workers ants; however, in the spring, some of the larvae develop into winged males and females. These reproductive ants can number into the thousands. They are so distinct from worker ants, being several times larger, that they are often not recognized as the same species. They are dark, rusty brown with long, black wings. Females can be distinguished from males by their larger heads.

Mating flights of Texas leaf cutter ant reproductives take place on clear, moonless nights during April, May and June. In areas of higher rainfall, swarms can occur at any time during the spring; however, in more arid areas swarms invariably occur after a heavy rainfall. Prior to her nuptial flight the virgin queen stores a small portion of the fungus garden in a small cavity inside her mouth. After mating the winged males die, while mated queens drop to the ground, lose their wings and attempt to establish small nests beneath the soil.

After digging a small gallery in the soil, the queen takes the fungus wad from her mouth and begins to culture it as food for her first eggs. Initially the fungus is nourished by fecal material. Approximately 90% of this first brood will be eaten by the queen. The first worker ants will be quite small because of their limited food intake; however these first workers bring back leaf fragments to enlarge the fungus garden, thus providing more food for later broods. As the colony grows, worker ant size increases.

Individual colonies can exist for years. Where adequate food is available, colonies may expand to contain over 2 million ants. Leaf cutting ant colonies are frequently seen along roadsides, in open fields, in brush land or forestland. The colonies are restricted to deep, well-drained sandy or loamy soils. They can be quite large, covering an area up to almost an acre. Colony size depends on its age and the availability of food. In heavily infested areas it is difficult to distinguish where one colony ends and another begins.

Above ground, the colony is marked by numerous crater-shaped mounds, 5 to 14 inches high and up to 1 to 1 1/2 feet in diameter. Each mound has a central entrance hole. Above the underground central nest cavity, several entrance holes will be marked by typical crater-shaped mounds and a buildup of soil. On flat land, this buildup of soil is very apparent. With older colonies, this central area is as much as 2 to 3 feet higher than surrounding land. Below ground, the nest consists of several chambers that may reach 15 to 20 feet deep. All chambers are interconnected by narrow tunnels. Vertical tunnels extend to mound openings, and lateral foraging tunnels may lead outward 500 feet away. These lateral exits are commonly referred to as "feeder holes." The complex structure of the cavities and tunnels allow the ants to escape predators underground, and provide an efficient air circulation system. *Coincidently, the large complex nest structure makes control with insecticides difficult.*

During the summer, leaf cutting ants forage almost exclusively at night. The rest of the year, foraging takes place during the day, when air temperatures range between 45 to 80 °F. Most mound building activities occur during the cool hours of the day. Leaf cutting ants are usually inactive on cold, wet or cloudy days.

On the soil surface, leaf cutting ants have clearly defined foraging trails. Ants commonly travel 600 feet or more to reach a suitable plant. Once located, the plants are attacked in large numbers, with worker ants cutting leaves and carrying the fragments in their mouths (mandibles). Leaf fragments are carried umbrella-like, over the head – hence the common name "parasol ant." Hundreds of ants can be seen picking up and carrying off the piles of leaf fragments that accumulate under the trees or bushes "under attack." At the nest entrance, ants chew the fragments into small pieces that are better suited for their underground fungus gardens.

Defoliation by leaf cutting ants can resemble damage produced by several other leaf chewing insects, particularly sawflies and leaf cutting bees. Trees defoliated by the leaf cutting ant usually are within sight of an ant nest and the ants themselves may be seen carrying leaves. Foraging

trails will be littered with pieces of leaf tissue that can be traced to a feeder hole. Considerable damage to a plant can occur in a few hours. Small- to medium-sized trees can be stripped in one night (Texas A&M University AgriLife Extension, Ent-1029).

LEAF CUTTING ANT MANAGEMENT

Land Use	Cultural Control	Biological Control	Chemical Control* **
Residential/ commercial	None known	None known	Commercially available hydramethylnon insecticides applied per product label instructions
Improved pasture	None known	None known	Commercially available hydramethylnon insecticides applied per product label instructions
Native range/ brush	None known	None known	Commercially available hydramethylnon insecticides applied per product label instructions
Forestland	None known	None known	Commercially available hydramethylnon insecticides applied per product label instructions
Orchards/ gardens	None known	None known	Commercially available hydramethylnon insecticides applied per product label instructions

* Because leaf cutter ants only eat the fungus they cultivate, they respond very poorly to most ant baits. However, Amdro Ant Block, which contains the active ingredient hydramethylnon as well as sugars to make it attractive to leaf-cutting ants, halts ant activity on approximately 30% of colonies. It is most effective in winter and less effective in the summer and fall.

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Wasps, Hornets, and Yellow jackets

Since yellowjackets, hornets and wasps are all considered to be beneficial insects, control should only be done where there is an imminent threat to people or their pets. These insects can (when provoked) inflict a painful, venomous sting and/or bite. Some people are so sensitive to the venom's complex amino acids, proteins and enzymes they develop severe allergic reactions known as anaphylaxis and may even die without an injection of an antidote.

Wasps, yellowjackets, and hornets can become a problem if they are found near humans and domestic animals. These insects may nest around homes, in commercial buildings, farm structures and equipment, in parks and in other areas where people live, work, and play. It is important to distinguish between the different types of stinging insects that are commonly called wasps, yellowjackets and hornets.

Wasps

We usually consider wasps as beneficial because of the number of caterpillars, beetle larvae, flies and other insects that some of these species feed upon or use to provision their nests. Others may play a minor role in plant pollination and thus benefit humans. Whenever they become too numerous, nest in close proximity to human activities, or become attracted to food being used by humans, some control is necessary.

Insects properly referred to as wasps have either social or solitary nesting behavior. Digging wasps and mud daubers are examples of solitary wasps, since individual females construct and provision their nests. As a general rule, solitary wasps are unaggressive even if disturbed and seldom defend their nests. Their sting and venom is used as an offensive weapon to paralyze their prey, which consists of many insects and their relatives. The venom of solitary wasps has anesthetic properties and usually is not a serious problem with humans.

On the other hand, social wasps such as yellowjackets, paper wasps and hornets use their jaws and legs to attack and subdue prey. Being social, their nests may contain up to thousands of individuals. Workers of the social wasps use their venom as a defensive weapon and often attack in large numbers any threatening animal or human. The venom is designed to produce intense pain and may cause a dangerous systemic reaction in allergic individuals.

Between 0.4 and 0.8 percent of humans are allergic to social wasp and bee venom. Nearly 80% of all serious venom-related deaths occur within one hour of the sting. If symptoms are more serious than localized swelling, reddening and pain or mild headache and fever, a physician should be consulted. Multiple stings are especially dangerous. Some people may develop sensitivity to venom after repeated stinging episodes over a short or long period of time.

Cicada killers are large (1 1/2 inches long) black and yellow wasps that become a nuisance in landscapes when cicadas are present in shade trees. Males cannot sting but buzz around humans

and appear dangerous because of their size and wasp appearance. Females will not sting unless forced to do so. Control is rarely necessary for this otherwise beneficial insect. The female may dig galleries in lawns, gardens or flower beds, where she lays eggs and provisions the young with paralyzed cicadas. This nesting activity may damage lawns or vegetable gardens.

Mud daubers are wasps that build small, tube-like nests of mud material under eaves, in attics and under roofs of outbuildings. Nests are generally provisioned with spiders, which the young larvae feed upon. Adults are about 1 inch long and blackish or iridescent blue-black in color. They have a longer and more slender waist than most other wasps. Nests can be removed easily by hand with a knife or other object since the attending female will not try to defend her nest.

Paper wasps are slender, narrow-waisted wasps about 1 inch long with long legs. They are reddish-orange to dark brown or black in color, often with yellow body markings. They produce small colonies that build tiny umbrellas of a paper-like substance. The nests are usually located in open areas, the small honeycomb of larval cells oriented downward. They are often found under eaves, or in attics and outbuildings freely accessible to the adult wasps. Care should be taken in removing the nests because these wasps are more aggressive than the solitary wasps.

Hornets

The common species of hornet we find in Texas is the large bald-faced hornet. It is about 1 inch long, a blackish species with white markings especially on the front of the head. These hornets construct large inverted pear-shaped, paper carton nests up to 1 foot wide and 3 feet long. The grayish or brownish nest contains 2 to 4 horizontally arranged combs with a round entrance hole at the bottom. Nests may be found hanging under porches, in outbuildings, in trees or even attached to the side of a structure. There are hundreds of individuals in a bald-faced hornet nest. The hornets become very aggressive when aroused or disturbed, and the sting can be very painful. For these reasons, control of this species is usually left to the professional pest control operator. Even with the proper protective clothing one should be very careful when removing the nests. Nests that pose no threat to humans should be left undisturbed since the hornets are beneficial predators of other insects.

Yellowjackets

Yellowjackets are closely related to the bald-faced hornets but usually build their nests underground. They are generally small, about 1/2 inch long, and colored black and yellow. Large colonies of up to 6,000 individuals build soccer-ball-sized paper nests similar to those of the bald-faced hornet. The nests are commonly associated with old rodent burrows and other cavities in the ground or under objects lying on the ground. Entrance holes may be in lawns, gardens, flowerbeds, creek banks or vacant fields. It is unfortunate that these colonies are often disturbed by walking, mowing and other innocent human activities. When disturbed, yellowjackets are aggressive and can inflict a painful sting repeatedly. (Utah State University Extension, Fact Sheet No. 19)

WASP, HORNET, AND YELLOW JACKET MANAGEMENT

Land Use	Cultural Control	Biological Control	Chemical Control*
Residential/ commercial	Remove food wastes from outdoors. Close trash containers tightly. Burn the nests.	N/A	Spray stinging insects with enzymes or dish detergent mixed with water (3 tablespoons dish detergent per gallon of water). Commercially available wasp and hornet sprays of mint oil or clove oil
Improved pasture	N/A	N/A	N/A
Native range/ brush	N/A	N/A	N/A
Forestland	N/A	N/A	N/A
Orchards/ gardens	Burn the nests.	N/A	N/A

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Africanized Honey Bees

Africanized honey bees – melodramatically labeled "killer bees" by Hollywood hype – are the result of honey bees brought from Africa to Brazil in the 1950s in hopes of breeding a bee better adapted to the South American tropical climate. These honey bees reached the Brazilian wild in 1957 and then spread south and north until they officially reached the United States on October 19, 1990.

Actually, all honey bees are imports to the New World. Those that flourished here before the arrival of Africanized honey bees (AHBs) are considered European honey bees (EHBs) because they were introduced by European colonists in the 1600s and 1700s. EHBs that escaped from domestication are considered feral rather than wild.

Africanized honey bees are so called because it was assumed that the African honey bees spreading out from Brazil would interbreed with existing feral EHBs and create a hybridized, or Africanized, honey bee. While substantial hybridization does occur when AHBs first move into areas with strong resident EHB populations, over time European traits tend to be lost.

When an Africanized colony replaces its queen, she can have either African or European paternity. Virgin queens fathered by African drones emerge as much as a day earlier than European-patriline queens. This enables them to destroy rival queens that are still developing. African virgin queens are more successful fighters, too, which gives them a significant advantage if they encounter other virgin queens in the colony.

While AHBs do make honey and pollinate plants, two traits make them undesirable for beekeepers: First, colonies regularly abscond from hives, and second, they are often too defensive to be easily tended. Because of AHBs' genetic dominance there has been little dilution of their strong defensive reaction to threats to their nests. This defensiveness is probably the bees' best-known trait. All honey bee behavior runs the gamut from very defensive to very docile and can change depending on temperature, humidity, cloud cover, and food supply. But when provoked, AHBs do tend to sting in greater numbers than EHBs, although their sting is no more toxic than that of the EHB.

Excerpted from "Agricultural Research: What's Buzzing with Africanized Honey Bees?". March 2004, USDA, Agricultural Research Service, by J. Kim Kaplan

See http://honeybee.tamu.edu/ for additional honeybee information.

AFRICANIZED HONEY BEE MANAGEMENT

Land Use	Cultural Control	Biological Control	Chemical Control*
Residential/ commercial	Remove or cover all garbage, dropped fruit, soft drinks, pet food and other protein and sugar food sources. Routinely clean all dumpsters, garbage cans and spills.	N/A	Spray stinging insects with enzymes or dish detergent mixed with water (3 tablespoons dish detergent per gallon of water).
Improved pasture	N/A	N/A	N/A
Native range/ brush	N/A	N/A	N/A
Forestland	N/A	N/A	N/A
Orchards/ gardens	N/A	N/A	Spray stinging insects with enzymes or dish detergent mixed with water (3 tablespoons dish detergent per gallon of water).

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Honey Bees

Honey bees are somewhat variable in color but are some shade of black, brown or brown intermixed with yellow. They have dense hairs on the pronotum (the first segment of the thorax) and sparser hair on the abdomen. Microscopically, at least some of the body hairs of bees are branched. The abdomen often appears banded. Larvae are legless grubs, white in color.

Honey bees are the only bee in the genus *Apis* in Texas. Honey bees have several varieties or races and have been bred for honey production, temperament and resistance to disease. These varieties may be recognized to some extent by color and size. However, cross breeding may take place in the wild, so queens from commercial breeders should always be purchased to re-queen colonies.

Honey bees are social insects. There are three castes of bees: queens, which produce eggs; drones or males, which mate with the queen; and, workers, which are all non-reproducing females. The queen lays eggs singly in hexagonal cells of the comb. Larvae hatch from eggs in 3 to 4 days and are fed by worker bees and develop through several stages (instars) in the cells. Cells are capped by worker bees when the larvae pupates. Queen and drones (that develop from unfertilized eggs) are larger than workers and require enlarged cells to develop. Queens complete development in 15 1/2 days, drones in 24 days and workers in 21 days for larvae and pupae stages. Only one queen is usually present in a hive. New queens develop in enlarged cells by differential feeding by workers when the existing queen ages or dies or the colony becomes very large. Virgin queens fly on a nuptial flight and are mated by drones from their own colony or other colonies. Queens mate with several drones during the nuptial flight. New colonies are formed when newly mated queens leave the colony with worker bees, a process called "swarming." Swarms of bees are often noticed and sometimes cause concern until they find a suitable nesting location. A queen may live three to five years; drones usually die before winter; and, workers may live for a few months. A colony may typically consists of 20,000 to 90,000 individuals.

Complex mouthparts of adults can be used for chewing and sucking. Larvae ingest liquids and have mouthparts reduced. Honey bee workers visit flowers to collect pollen and nectar. During transport to the hive, pollen is held in a structure on each hind leg called the "pollen basket" and nectar is carried in a structure in the front part of the digestive system, called the "honey sac." They return to the hive, which may be provided by humans or located in a hollow tree, wall void, or some other sheltered habitat. Pollen is stored in the cells of the comb within the hive. In other cells ("honeycombs"), nectar is converted into honey when the bee regurgitates the nectar, adding an enzyme that facilitates the conversion. Nectar must also be concentrated by evaporation. Worker bees feed the larvae, drones, and queen. Wax is produced between the segments of the worker bee's body wall in small flakes. It is chewed and reshaped to form honey combs.

Worker bees communicate with other worker bees, conveying information about the type of nearby nectar source, distance and direction from the hive using “dances.” They also regulate the temperature in the colony and collect water to use as an evaporative coolant during hot times of the year. Worker bees are generally not aggressive (defensive) during foraging or swarming activities. However, when the hive contains developing larvae and pupae, they will aggressively attack intruders to defend their colony. They also communicate with sound, queen pheromone and alarm pheromone.

Bees are mostly considered beneficial because they pollinate many fruits, vegetables and ornamental flowers, and they produce honey, beeswax, pollen and royal jelly. Adult bees can sting, making them a nuisance to humans and animals. They are a hazard only to sensitive individuals. Historically in Texas, an average of one human per year dies from insect stings.

When worker honey bees sting they leave the barbed stinger in the skin with the poison sac still attached. Each bee can only sting once, and this is fatal for the bee. Stings should be removed promptly to prevent injection of additional venom. Scrape the sting and poison sac away with a knife or fingernail in such a way as to avoid slapping or pinching the poison sac because this will inject additional poison into the skin (http://insects.tamu.edu/fieldguide/cimg341.html).

See http://honeybee.tamu.edu/ for additional honeybee information.

HONEY BEE MANAGEMENT

Land Use	Cultural Control	Biological Control	Chemical Control*
Residential/ commercial	Remove or cover all garbage, dropped fruit, soft drinks, pet food and other protein and sugar food sources. Routinely clean all dumpsters, garbage cans and spills.	N/A	Spray stinging insects with enzymes or dish detergent mixed with water (3 tablespoons water per gallon of water).
Improved pasture	N/A	N/A	N/A
Native range/ brush	N/A	N/A	N/A
Forestland	N/A	N/A	N/A
Orchards/ gardens	N/A	N/A	Orchards: N/A Gardens: Spray stinging insects with enzymes or dish detergent mixed with water (3 tablespoons dish detergent per gallon of water).

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Scorpions

Striped bark scorpions, the only scorpion species found in the Bastrop area, are non-insect arthropods. Adults average about 2 3/8 inches in length, with the tail being longer in the males than in the females. Body color of adults varies from yellowish to tan, marked with two broad, blackish stripes on the upper surface of the abdomen. There is a dark triangular mark on the front portion of the head region in the area over the eyes. Younger specimens may be overall lighter in color, and basis of the pedipalps (second pair of appendages corresponding to the mandibles of insects) and the last segment of the body is dark brown to black. The key recognition characters for this species are the slender pedipalps and the long slender tail.

Scorpions are capable of reducing their metabolic rates to very low levels. Mating apparently takes place in the fall, spring and early summer. All scorpions are born live, and embryos are nourished in the female's body. Development is estimated to take about 8 months, but varies depending on the species. Young are born in litter sizes from 13 to 47, averaging about 31. The young climb to the mother's back after birth and soon molt. After the first molt they disperse to lead independent lives. Immature scorpions molt an average of six times before maturity. Some species may live for 20 to 25 years but the typical scorpion probably lives between three and eight years. Adults may produce several broods.

Scorpions use the pincers to capture and hold prey. They occur under rocks, under boards, and in debris. They can be found indoors or outdoors in a wide variety of habitats (pine forests in East Texas, rocky slopes, grasslands, juniper breaks in other parts of the state).

Scorpions are active foragers and do not burrow. They are distinctly associated with dead vegetation, fallen logs, and human dwellings. It is common for them to climb, and many reports in homes are associated with attics. Scorpions remain sheltered in the daytime and become active at night. This behavior helps with regulating temperature (thermoregulation) and water balance. Their bodies are covered with a waxy cuticle which also helps reduce water loss. For reasons yet unknown, the scorpion fluoresces under ultraviolet light i.e., a blacklight.

Stings are painful and produce local swelling and itching. Reaction to the bite may vary based on sensitivity of the individual. Non-lethal stings may be mild to strong and produce swelling, discoloration, numbness, and pain which may last for several minutes to several days. Deaths attributed to this species are not well substantiated.
(http://insects.tamu.edu/fieldguide/cimg364.html)

SCORPION MANAGEMENT

Land Use	Cultural Control	Biological Control	Chemical Control*
Residential/ commercial	Remove all trash, logs, boards, stones, bricks and other objects from around the home. Keep grass closely mowed near the home. Prune bushes and overhanging tree branches away from the house. Tree branches can provide a path to the roof for scorpions. Store garbage containers in a frame that allows them to rest above ground level. Never bring firewood inside the house unless it is placed directly on the fire. Install weather-stripping around loose fitting doors and windows. Plug weep holes in brick veneer homes with steel wool, pieces of nylon scouring pad or small squares of screen wire. Caulk around roof eaves, pipes and any other cracks into the home. Keep window screens in good repair. Make sure they fit tightly in the window frame.	N/A	Commercially available lambda-cyhalothrin or deltamethrin products applied per label instructions
Improved pasture	N/A	N/A	N/A
Native range/ brush	N/A	N/A	N/A
Forestland	N/A	N/A	N/A

Land Use	Cultural Control	Biological Control	Chemical Control*
Orchards/ gardens	N/A	N/A	N/A

* Pesticides are not always effective against scorpions because they hide in cracks and crevices during daylight hours. Adult scorpions are more difficult to kill with pesticides because of their larger body size and thicker cuticle. Read and follow label directions and use pesticides only in combination with other control measures outlined above. If you choose to use pesticides, apply them to exterior walls around the foundation of the house from the ground up to 1 foot; also make applications around doors, window eaves, and other potential points of entry. Follow directions on the package for dosage, mixing, and application methods.

Plants

Mesquite

Mesquite (genus *Prosopis*) is a thorny shrub or tree of the legume family that occurs naturally in arid and semiarid areas of North and South America, northern Africa, and eastern Asia. The species of concern in Texas is honey mesquite (*Prosopis glandulosa*).

Mesquite reproduce only by seed and not vegetatively. Honey mesquite seed are borne in pods (i.e., legumes) which are about 8 to 12 inches long and contain 10 to 30 seeds per pod. Most pods that fall to the ground are destroyed by insects or fungi or are consumed by animals. Unlike many legumes, mesquite pods do not split open at maturity. This feature allows foraging animals that ingest seed in the process of consuming the pod, which is high in sugars, to disperse seed away from the parent tree. Cattle and many wildlife species, including deer, coyotes, javelina, feral hogs, rodents, and rabbits consume and fecally distribute mesquite seed.

Germination of mesquite seeds occurs principally during early spring and late fall when soil moisture is favorable. Maximum emergence of honey mesquite occurs when seeds are planted at 0.25 inch depth and soil temperature is near 80 °F. A substantial proportion of the carbohydrate in the embryo is devoted to root system development, and many young mesquite plants, which appear to be seedlings, may actually be 3 to 4 years old. The amount of standing herbaceous biomass affects germination and establishment of honey mesquite. Germination is enhanced when seed are scarified by passage through animal digestive tracts. Fecal-deposited seed have an immediate source of nutrients in the dung, which may enhance seedling survival. However, large-sized fecal deposits, especially those from cattle may dry more rapidly than the surrounding soil and actually inhibit seedling survival.

Emerging seedlings are killed if clipped (or grazed) below the seed leaf within the embryo of a seed (cotyledon). It is hypothesized that stem tissue near or just above the cotyledonary node eventually forms the underground “bud zone,” which produces resprouts when above-ground parts are removed or damaged. The rate at which the cotyledonary node (and future bud zone) becomes buried determines how long mesquite seedlings are susceptible to above-ground disturbance. The cotyledonary node may extend to 1 1/2 inches above ground on seeds that germinate on the soil surface and extend the root radicle (the embryonic root of the plant that grows downward) into the soil. The node is closer to the ground on seedlings emerging from buried seed.

Depending on the site and climate, honey mesquite can grow to approximately 25 feet in height with main support stems as much as 2 feet in diameter. Seedlings develop as single to few-stemmed plants unless the top is removed and resprouting occurs.

The annual growth cycle of mesquite begins during April and May with a period of leaf emergence and twig elongation. This process is completed within six weeks, followed by a

period of radial stem growth. Vegetative growth subsides by mid-June with the onset of summer drought, but new leaves may be produced later in the growing season if moisture is abundant. Mesquite are deciduous (lose their leaves). Flowering begins shortly after leaf development. During flowering, trees are covered with thousands of blooms. However, few of these actually produce pods.

Mesquite has been defined as a deep-rooted, water-using "phreatophyte" that avoids drought. In north and central Texas, mesquite rely on shallow lateral roots that extend as much as 50 feet from the plant. Mesquite that rely mainly on lateral roots grow deeper roots during drought and compete successfully with grasses by using soil moisture in subsoil layers.

The mesquite canopy exerts a profound influence on neighboring vegetation, soils, subcanopy microclimate, wildlife, and insect populations. High densities of mesquite (>25% canopy cover) suppress grass growth and may reduce understory species diversity. Many studies have shown that grass production increases following control of mesquite. However, response is highly variable and dependent on many factors, such as density of mesquite prior to treatment, effectiveness of treatment, soil type, and precipitation.

Mesquite is a nitrogen fixer and may modify soil fertility. The capacity of mesquite or related woody legumes to fix nitrogen and enrich soil fertility beneath their canopies may significantly alter responses of individual and/or assemblages of herbaceous species beneath canopies. Control of mesquite provides regions of enhanced soil nitrogen and carbon that are temporarily exploited by associated grasses. However, in the long-term, mesquite in light densities may enhance recruitment of grasses into the landscape at a greater rate than mesquite-free areas.

While adult mesquite plants are not palatable and are not browsed by mammals (with the possible exception of new regrowth sprouts), they provide cover for many wildlife species, including deer, javelina, turkey, quail and numerous small mammals. In addition, many species of insects are dependent on mesquite, including the cutworm (*Melipotis* spp.), the twig girdler (*Oncideris* spp.), and Bruchid beetles.

Although regarded as a noxious plant because of its interference with livestock production, mesquite has an emerging image as a *resource* that should be managed. Unfortunately, decades of attempts to control mesquite with nonlethal, topkilling treatments (herbicides, mechanical and fire) have altered the structure of many mature stands of few-stemmed trees to multi-stemmed resprout thickets. While these thickets may offer some benefits to wildlife habitat, they generally reduce management options because they negatively impact understory herbaceous species diversity, visibility, and watershed yield.

Mesquite has many benefits to the ecosystem when maintained at moderate densities (i.e., as a savanna) or as a mosaic of thickets, grasslands and savannas. Such benefits include enhanced soil fertility, shade for livestock, wildlife habitat, protection for some plant species, modified

microclimate for cool-season plant species, and the potential for wood products. (http://www.dirtdoctor.com/organic/garden/view_question/id/896/)

MESQUITE MANAGEMENT

Land Use	Cultural Control*	Biological Control	Chemical Control** *** ****
Residential/ commercial	Pulling Mowing	N/A	Commercially available triclopyr products applied per label instructions
Improved pasture	Chain pulling for high density brush	N/A	Commercially available triclopyr products applied per label instructions
Native range/ brush	Chain pulling for high density brush	N/A	Commercially available triclopyr products applied per label instructions
Forestland	Chain pulling for high density brush	N/A	Commercially available triclopyr products applied per label instructions
Orchards/ gardens	Pulling Mowing	N/A	Commercially available triclopyr products applied per label instructions

* Cultural controls are of limited effectiveness and may result in greater plant density due to the plant's extensive lateral root system.
** Chemicals should not be used within 150' of water features or drainages that feed ponds/stock tanks.
*** Contact the LPHCP Administrator for commercially available products containing the chemical(s) listed. Pesticides used improperly can be injurious to humans, animals and plants. Follow the directions and heed all precautions on labels. Apply pesticides so that they do not endanger humans, livestock, crops, beneficial insects, fish and wildlife. Do not apply pesticides when there is danger of drift, when honeybees or other pollinating insects are visiting plants, or in ways that may contaminate or leave illegal residues.
**** Applications of triclopyr vary depending on the growth stage of the mesquite. Consult AgriLife Extension Publication No. B-1466, "Chemical Weed and Brush Control Suggestions for Rangeland" for growth-specific instructions.

Greenbrier

Saw greenbrier, also known as Cat-brier, is a prickly evergreen to semi-evergreen vine forming dense tangles in shrubby and wooded areas. It is common in dry to wet habitats, old fields and fencerows. Stems are smooth, green, with stout, sharp prickles on the lower sections. The leaves are up to 4 1/2 inches long and 4 inches wide, varying from triangular to heart shaped, often with a broad lobe on each side. They are firm-textured, occasionally mottled on the upper surface and persist into winter. Greenbrier flowers are small, rather inconspicuous, develop in clusters arising from the point where the leaf meets the vine's stem, and appear from March through May. The fruit of greenbrier is spherical, l/4 inch in diameter, fleshy, and black.

The fruits of saw greenbrier are eaten by wood ducks, ruffed grouse, wild turkeys, fish crows, black bears, opossums, raccoons, squirrels, and many species of songbirds. White-tailed deer browse the foliage. Greenbrier also provides cover for small animals and birds. (http://www.wildflower.org/plants/result.php?id_plant=SMBO2)

GREENBRIER MANAGEMENT

Land Use	Cultural Control*	Biological Control	Chemical Control** ***
Residential/ commercial	Cut the vines Digging up the plant	None	Triclopyr (25%) in diesel fuel oil, stem application any time of year
Improved pasture	N/A	None	N/A
Native range/ brush	Cut the vines Digging up the plant Shredding to stimulate new stalks with leaves palatable to wildlife	None	Triclopyr (25%) in diesel fuel oil, stem application any time of year
Forestland	Cut the vines Digging up the plant Shredding to stimulate new stalks with leaves palatable to wildlife	None	Triclopyr (25%) in diesel fuel oil, stem application any time of year
Orchards/ gardens	Cut the vines Digging up the plant Shredding to stimulate new stalks with leaves palatable to wildlife	None	Triclopyr (25%) in diesel fuel oil, stem application any time of year

* Cutting the stems at the soil line does not control greenbrier due to re-growth from rootstocks.
** Chemicals should not be used within 150' of water features or drainages that feed ponds/stock tanks.
*** Contact the LPHCP Administrator for commercially available products containing the chemical(s) listed. Pesticides used improperly can be injurious to humans, animals and plants. Follow the directions and heed all precautions on labels. Apply pesticides so that they do not endanger humans, livestock, crops, beneficial insects, fish and wildlife. Do not apply pesticides when there is danger of drift, when honeybees or other pollinating insects are visiting plants, or in ways that may contaminate or leave illegal residues.

Chinese Tallowtree

Chinese tallowtree (*Triadica sebifera* (L.) Small) is a deciduous to evergreen tree introduced around 1850 as a seed oil crop. It is native to China, Japan, and Korea, but commonly grown in the United States as an ornamental for its yellow flowers, red fall foliage, and unusual white fruit, which gave it the name "popcorn tree." Currently, it has escaped from cultivation in at least nine southern states. This invasive plant can tolerate a wide range of environmental conditions from saline to freshwater flooding, shade to full sun, acid to alkaline soils, and from wet to droughty soils. It can establish dense, solid stands, crowding out native plant species and producing little food value for animals. Characterized by rapid growth and prolific seed production, it is an extremely competitive invasive plant.

It is a fast-growing, weedy tree with milky sap. It often spreads by root sprouts. Its slender limbs and branches droop and are easily broken. It generally grows to between 30 and 40 feet tall, but can reach over 50 feet. In the southeastern United States it is deciduous (loses its leaves in the fall). Leaves are alternate, heart-shaped, 2 to 3 inches long with a long, pointed tip. They turn bright yellow, orange or red in the fall. The flowers are yellowish, have no petals and grow in 2-inch to 6-inch drooping spikes at the end of each branch. Flowering occurs from April to June. The walls of the three-lobed, greenish fruit fall readily at maturity, leaving three chalky white seeds, which may remain attached through the winter. These nutlike seeds have a hard coat covered by tallow that becomes black with weathering. The white fruit can persist throughout the winter and are thought to be poisonous. Seed production can be heavy, averaging around 100,000 per tree. Seedlings have tremendous vigor. Despite being poisonous, fruit can be spread by birds and other wildlife. Water also disseminates fruit as evidenced by seedlings germinating on floodplains.

Chinese tallowtree is listed as a state noxious weed in Texas, Florida, Louisiana, and Mississippi, but is not considered a federal noxious weed. It is possibly still planted in certain states as an ornamental or for honeybee pollen. Tallowtree invades wet areas such as stream banks and ditches but can also invade drier upland sites. Chinese tallowtree is a serious threat because of its ability to invade high quality, undisturbed forests. It can displace native vegetation as well as alter soil conditions due to the high amount of tannins present in the leaf litter. Once introduced into a landscape and mature enough to produce seeds, it quickly spreads into surrounding landscapes. If allowed to perpetuate, control can be difficult and expensive.

Hand removal may be possible for smaller infestations, although treating cut stumps with herbicides will assist with preventing regrowth. Seedlings can often be pulled up in wet soil. Early detection and eradication is important.
(http://www.gri.msstate.edu/ipams/Species.php?SName=&CName=Tallowtree)

CHINESE TALLOWTREE MANAGEMENT

Land Use	Cultural Control*	Biological Control	Chemical Control** ***
Residential/ commercial	Tree pulling	None	Triclopyr (15%) in diesel fuel oil, cut stump application any time of year
Improved pasture	Tree pulling	None	Triclopyr (15%) in diesel fuel oil, cut stump application any time of year
Native range/ brush	Tree pulling Prescribed burning	None	Triclopyr (15%) in diesel fuel oil, cut stump application any time of year
Forestland	Tree pulling Prescribed burning	None	Triclopyr (15%) in diesel fuel oil, cut stump application any time of year
Orchards/ gardens	Tree pulling	None	Triclopyr (15%) in diesel fuel oil, cut stump application any time of year

* Because Chinese tallowtree forms colonies from root sprouts or sprouts from root collars, cultural controls will likely be ineffective in controlling its spread and extent.

** Chemicals should not be used within 150' of water features or drainages that feed ponds/stock tanks.

*** Contact the LPHCP Administrator for commercially available products containing the chemical(s) listed. Pesticides used improperly can be injurious to humans, animals and plants. Follow the directions and heed all precautions on labels. Apply pesticides so that they do not endanger humans, livestock, crops, beneficial insects, fish and wildlife. Do not apply pesticides when there is danger of drift, when honeybees or other pollinating insects are visiting plants, or in ways that may contaminate or leave illegal residues.

Retama

Retama is a spiny shrub or small tree, as high as 30 feet but normally half that, with long, graceful, slightly drooping branches bearing many long, delicate leaves and sprays of yellow flowers. The 5 yellow petals of the flower, 1/3 to 2/3 inch long, are almost equal, but one has a honey gland at its base and soon becomes red; this petal remains on the stalk longer than the others.

The Retama has a profusion of blossoms through the warm months, especially after rains. The seedpods are 3 to 5 inches long, narrow, and constricted between the seeds. The leaves are unusual. The leaf stem produces 2 stalks, almost parallel and 15 to 18 inches long, with 10 to 25 pairs of leaflets on each. The leaflets usually fall off during the summer, and the stems then carry on the function of leaves. Retama can be single-stemmed or multi-trunked, and because it has long thin leaves it casts only dappled shade.

Retama's native habitat is in flood plains, bottomland, hillside chaparral, and disturbed grasslands. It is usually found on limestone soils in areas with good moisture, but it is nevertheless strongly drought-tolerant, and can also withstand saline conditions. In cold and drought it drops its leaves and the trunk and stems act as the photosynthetic organ. It is fast-growing, tough and durable. Needle-like thorns at the nodes on twigs and old trunks can be maintenance and pedestrian hazards.

The foliage and pods have been used as emergency forage for livestock, as well as by wildlife. Bees produce fragrant honey from the flowers. It is a nectar source for insects, a seed source for small mammals and provides nesting sites and cover for birds.
(http://www.wildflower.org/plants/result.php?id_plant=paac3)

RETAMA MANAGEMENT

Land Use	Cultural Control	Biological Control	Chemical Control* ** ***
Residential/ commercial	Cutting Digging up the plant	None	Individual plant treatment using commercially available triclopyr (1/2%) plus picloram (1/2%) in a 1 to 5 diesel fuel oil to water mixture
Improved pasture	Cutting Digging up the plant	None	Individual plant treatment using commercially available triclopyr (1/2%) plus picloram (1/2%) in a 1 to 5 diesel fuel oil to water mixture
Native range/ brush	Cutting Digging up the plant	None	Individual plant treatment using commercially available triclopyr (1/2%) plus picloram (1/2%) in a 1 to 5 diesel fuel oil to water mixture
Forestland	Cutting Digging up the plant	None	Individual plant treatment using commercially available triclopyr (1/2%) plus picloram (1/2%) in a 1 to 5 diesel fuel oil to water mixture
Orchards/ gardens	Cutting Digging up the plant	None	Individual plant treatment using commercially available triclopyr (1/2%) plus picloram (1/2%) in a 1 to 5 diesel fuel oil to water mixture

* Chemicals should not be used within 150' of water features or drainages that feed ponds/stock tanks.
** Refer to AgriLife Extension Publication No. B-1466, "Chemical Weed and Brush Control Suggestions for Rangeland" for more detailed information.
*** Contact the LPHCP Administrator for commercially available products containing the chemical(s) listed. Pesticides used improperly can be injurious to humans, animals and plants. Follow the directions and heed all precautions on labels. Apply pesticides so that they do not endanger humans, livestock, crops, beneficial insects, fish and wildlife. Do not apply pesticides when there is danger of drift, when honeybees or other pollinating insects are visiting plants, or in ways that may contaminate or leave illegal residues.

Sennabean

Sennabean (*Sesbania drummondii*), grows in East and South Texas along the coast, extending inland along waterways. It is found in wet areas, usually in tight soil, and often grows in shallow water.

Also known as poisonbean, rattlebush, and rattlebox, sennabean is a rank-growing, perennial woody plant that grows 2 to 10 feet tall. It has many, well-separated branches in the upper part, and few leaves, giving it a rather spare appearance. The bark is green to light brown and smooth. Its leaves are alternate, 4 to 8 inches long on a short stem. They are divided into 20 to 50 leaflets, 1/2 to l 1/2 inches long and about 1/4 inch wide with no terminal leaflet. Flowers bloom from June through September, are about 1/2 inch long, yellow, and often streaked with red. The flowers hang in clusters about 2 inches long on a threadlike stem of about the same length. Each flower has 5 petals, the top petal being longer than the others and standing erect. When the seeds mature they are loose in the pod and rattle when shaken, suggesting the name “rattlebush.”

Sennabean plants contain sesbaimide, which is concentrated in the seed. The green and flowering plants are unpalatable; only the mature, dry legumes and seed are consumed. Animals raised in pastures with the plant learn to avoid it and are seldom poisoned. However, naïve cattle, goats or sheep placed on pastures containing dried plants in late fall and winter are often poisoned. Observations of field cases indicate that seeds are much more toxic when they first mature than they are 2 or 3 months later.

In general, good range management practices can reduce poisoning instances. Avoid placing hungry, naïve ruminants in pastures containing mature Sesbania seedpods. Fill newly introduced animals with hay before releasing them; do not place them in heavily infested pastures without supplemental feed. (http://essmextension.tamu.edu/plants/toxics/detail.aspx?plantID=107)

SENNA BEANS MANAGEMENT

Land Use	Cultural Control	Biological Control	Chemical Control* **
Residential/ commercial	N/A	None	None recommended
Improved pasture	Avoid placing hungry, naive ruminants in pastures containing mature Sesbania seedpods. Do not place ruminants in heavily infested pastures without supplemental feed.	None	Spot application of commercially available glyphosate applied per label directions
Native range/ brush	Avoid placing hungry, naive ruminants in pastures containing mature Sesbania seedpods. Do not place ruminants in heavily infested pastures without supplemental feed.	None	None recommended
Forestland	N/A	None	None recommended
Orchards/ gardens	N/A	None	None recommended

* Chemicals should not be used within 150' of water features or drainages that feed ponds/stock tanks.

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Willow Trees

There are several varieties of willow (Salix) that are suitable for planting in the landscape, such as the weeping willow. Willow trees prefer to grow in damp moist soils, so the area around a pond is ideal for most willow trees. But willow trees planted near a pond can be a source of numerous problems.

A willow tree usually grows very well near a pond or other area where there is lots of moisture, including standing water. Willow trees also absorb more water than most trees. This causes a decline in pond water levels that is more commonly noticed during dry periods if the pond is not kept full with an outside water source.

The roots of willow trees are known for their aggressiveness when seeking water. They are known to grow completely through pond dams and liners. The roots also grow large very quickly. Because the average life span of a willow tree is less than 50 years, when the tree dies it leaves large rotting roots that leave channels in the dam for water to escape, thus destabilizing the dam.

All willows are deciduous, meaning they lose their leaves in the fall. When this happens, large amounts of leaves fall into the pond water and sink to the bottom. Over the years, as the leaves begin to rot, they give off a variety of gases. Some, such as methane gas and ammonia, are toxic to fish.

Willow bark contains salicylic acid, the ingredient in common aspirin. In low amounts, it does not harm fish populations in the pond. But if large areas of the woody sections of the willow trees are submerged in the water, and leaves and branches are soaking in the water, salicylic acid levels can build up to toxic levels in the pond water. (http://www.gardenguides.com/101556-problems-willow-trees-growing-pond.html)

WILLOW TREE MANAGEMENT

Land Use	Cultural Control	Biological Control	Chemical Control* **
Residential/ commercial	N/A	None	None recommended
Improved pasture	Cutting	None	None recommended
Native range/ brush	Cutting	None	None recommended
Forestland	N/A	None	None recommended
Orchards/ gardens	N/A	None	None recommended

* Chemicals should not be used within 150' of water features or drainages that feed ponds/stock tanks.

** Pesticides used improperly can be injurious to humans, animals and plants. If pesticides are used, follow the directions and heed all precautions on labels. Apply pesticides so that they do not endanger humans, livestock, crops, beneficial insects, fish and wildlife. Do not apply pesticides when there is danger of drift, when honeybees or other pollinating insects are visiting plants, or in ways that may contaminate or leave illegal residues.

Aquatic Plants

Aquatic plants are generally divided into four groups for management purposes. These groups are “algae,” “floating plants,” “submerged plants,” and “emergent plants.”

Algae are very primitive plants. Some algae are microscopic (planktonic algae), others are thin and stringy or hair-like (filamentous algae), while still others are large and resemble higher plants but without true roots (chara).

True floating plants are not attached to the bottom. Floating plants come in sizes from very small (duckweed) to over a foot in diameter (water hyacinth). Most have roots that hang in the water from the floating green portions.

Submerged plants are rooted plants with most of their vegetative mass below the water surface, although some portions may stick above the water. One discerning characteristic of submerged plants is their flaccid or soft stems, which is why they do not usually rise above the water’s surface.

Emergent plants are rooted plants often along the shoreline that stand above the surface of the water (cattails). The stems of emergent plants are somewhat stiff or firm.

Many ponds have more than one type of aquatic plant, and care must be taken to identify all the aquatic plants inhabiting the pond. Some pond plants may be beneficial to local or migratory wildlife, and therefore, may want to be encouraged or at least not eliminated. (http://aquaplant.tamu.edu/database/index.htm)

For a complete list of aquatic plants and management alternatives, visit http://aquaplant.tamu.edu/index.htm.

AQUATIC WEED MANAGEMENT

Land Use	Cultural Control	Biological Control	Chemical Control*
Residential/ commercial	Raking or seining	Species dependent	None recommended
Improved pasture	N/A	Species dependent	None recommended
Native range/ brush	Raking or seining	Species dependent	None recommended
Forestland	Raking or seining	Species dependent	None recommended
Orchards/ gardens	N/A	Species dependent	None recommended

*Chemicals should not be used within 150' of water features, nor should aquatic herbicides be applied directly to water bodies in the Lost Pines Habitat Conservation Plan area.

Grassbur

Field sandbur (grassbur) is a summer annual grassy weed that can be found in home lawns, sports fields, parks and along roadsides. This weed is especially adapted to dry, sandy soils but can be found growing in other types of soils as well. The big problem with this weed is the sharp, spiny burs that are part of the inflorescence. These burs can be painful and are difficult to remove from clothing material. Field sandburs generally start germinating in late spring and will continue to germinate until late summer or early fall months. This weed will continue to grow until the first hard frost or freeze occurs in the fall.

Field sandburs are generally not a problem in well-maintained turfgrass areas. With proper fertilization, mowing and irrigation, you can produce a turf that is dense enough to prevent sandburs from becoming a problem.

In pastures, sandburs compete poorly with dense vegetation and rarely become established in pastures that are well-managed. Disturbances that bury burs and remove existing vegetation stimulate germination and enhance seedling establishment. However, repeated cultivation before burs develop reduces the seed bank and can eventually eliminate an infestation. Under mowing regimes, plants grow low to the ground and can still produce burs.

A dense stand of healthy grass provides the best weed control. Because most weeds are "opportunists" that invade weakened lawns, the fight against weeds starts with good management. All cultural practices such as mowing, fertilizing and watering should be done in a manner and time that will favor the grass rather than the weeds. Height of mowing influences competition against weeds such as crabgrass – the higher the cut, the lower the infestation. Frequent, light sprinkling encourages shallow-rooted weeds and seed germination. Less frequent "deep-soak" watering that maintains a dry surface layer provides the grass with a competitive advantage.

Temperature, light, soil moisture and other factors determine the time and extent of weed germination and development. Some weeds germinate in early spring while others sprout in summer or fall. If conditions are favorable, a weed may be particularly abundant in a given year, but under different conditions the next year, it may be little in evidence. (http://aggie-horticulture.tamu.edu/archives/parsons/turf/grassbur.html)

GRASSBUR MANAGEMENT

Land Use	Cultural Control	Biological Control	Chemical Control* **
Residential/ commercial	Maintain a dense, healthy lawn through implementation of a good fertilizing regimen (test soil first and amend for soil deficiencies). Corn gluten meal spread before germination	None	Commercially available pendimethalin applied per label instructions as a pre-emergent; commercially available MSMA applied per label instructions as a post-emergent
Improved pasture	Maintain a dense, healthy pasture through implementation of a good fertilizing regimen (test soil first and amend for soil deficiencies).	None	Commercially available pendimethalin applied per label instructions
Native range/ brush	N/A	None	N/A
Forestland	N/A	None	N/A
Orchards/ gardens	N/A	None	N/A

* Chemicals should not be used within 150' of water features or drainages that feed ponds/stock tanks.

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Chinaberry

Chinaberry is a native of Southeast Asia and Northern Australia that was introduced to the U.S. in the mid-1800s as an ornamental. Chinaberry is a deciduous (loses its leaves in the fall), small to medium-sized tree in the mahogany family (*Meliaceae*), growing to a height of 50 feet and diameter of 2 feet, with a spreading crown and branched trunk with multiple boles. Its stems are stout and glossy olive green to brown with numerous lighter dots and three-lobed leaf scar. The buds are small, round and fuzzy light brown. Chinaberry bark is dark chocolate brown becoming increasingly fissured with age. The wood is soft and white.

The leaves are lacy, a glossy dark-green, alternately whorled, bi-pinnately compound, 1 to 2 feet long and 9 to 16 inches wide with a musky odor. Each leaflet is lance-shaped with tapering tips, 1 to 3 inches long and 0.5 to 1.2 inches wide. The leaves become golden yellow in the fall.

Long loose clusters of pinkish-lavender to whitish flowers are produced in spring, from March to May. The fragrant clusters of flowers yield yellow-brown berries July to January. Berrylike spherical drupes contain a stone with one to six seeds.

Chinaberry is commonly found on roadsides, forest margins, open areas, clearings, and near dwellings. It invades disturbed areas and is tolerant of dry soils and semi-shade. Chinaberry has the potential to grow in dense thickets, which restricts the growth of native vegetation. Chinaberry forms colonies from root sprouts or sprouts from root collars. Seeds are dispersed by birds, although they are toxic to humans and livestock.
(http://www.invasive.org/weedcd/pdfs/wow/chinaberry-tree.pdf)

CHINABERRY TREE MANAGEMENT

Land Use	Cultural Control*	Biological Control	Chemical Control** ***
Residential/ commercial	Tree pulling	None	Commercially available glyphosate applied per label instructions or 25% triclopyr in diesel fuel oil, stem application any time of year
Improved pasture	Tree pulling	None	Commercially available glyphosate applied per label instructions or 25% triclopyr in diesel fuel oil, stem application any time of year
Native range/ brush	Tree pulling Prescribed burning	None	Commercially available glyphosate applied per label instructions or 25% triclopyr in diesel fuel oil, stem application any time of year
Forestland	Tree pulling Prescribed burning	None	Commercially available glyphosate applied per label instructions or 25% triclopyr in diesel fuel oil, stem application any time of year
Orchards/ gardens	Tree pulling	None	Commercially available glyphosate applied per label instructions or 25% triclopyr in diesel fuel oil, stem application any time of year

* Because Chinaberry forms colonies from root sprouts or sprouts from root collars, cultural controls will likely be ineffective in controlling its spread and extent.

** Chemicals should not be used within 150' of water features or drainages that feed ponds/stock tanks.

*** Contact the LPHCP Administrator for commercially available products containing the chemical(s) listed. Pesticides used improperly can be injurious to humans, animals and plants. Follow the directions and heed all precautions on labels. Apply pesticides so that they do not endanger humans, livestock, crops, beneficial insects, fish and wildlife. Do not apply pesticides when there is danger of drift, when honeybees or other pollinating insects are visiting plants, or in ways that may contaminate or leave illegal residues.

Gum Bumelia

Also called Chitamwood, Gum elastic, and Buckthorn, this native North American deciduous tree grows 40 to 50 feet in height and has an open canopy. Bumelia can grow as an individual tree or in dense thickets or mottes. It is common in valleys and rocky slopes of uplands.

The bark varies considerably from tree to tree. Thorns are present along stem tips and the zigzag shaped branches. Leaves are alternate or clustered on short lateral spurs and are 1 to 3 inches long. They are elliptical and oblong shaped with smooth margins, shiny dark green above with densely covered gray or rust colored hairs beneath. The leaves drop in late fall without a show.

Small, fragrant white flowers appear from June to July and are followed in fall by large, shiny, blue/black, fleshy fruits (about 1/2 inch) that are eaten by a variety of wildlife, including turkey and deer. Bumelia is a moderately-preferred browse species and provides good cover for wildlife. While the fruits are edible to humans, they have been known to produce unpleasant side-effects if eaten in quantity. (http://hort.ufl.edu/trees/BUMLANA.pdf)

GUM BUMELIA MANAGEMENT

Land Use	Cultural Control	Biological Control	Chemical Control* **
Residential/ commercial	Cutting	N/A	25% triclopyr in diesel fuel oil, stem application any time of year
Improved pasture	Cutting Chaining Shredding Tree pulling	N/A	25% triclopyr in diesel fuel oil, stem application any time of year
Native range/ brush	Cutting Chaining Shredding Tree pulling Prescribed burning	N/A	25% triclopyr in diesel fuel oil, stem application any time of year
Forestland	Cutting Chaining Shredding Tree pulling Prescribed burning	N/A	25% triclopyr in diesel fuel oil, stem application any time of year
Orchards/ gardens	Cutting Shredding	N/A	25% triclopyr in diesel fuel oil, stem application any time of year

* Chemicals should not be used within 150' of water features or drainages that feed ponds/stock tanks.

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Eastern Red Cedar

Juniperus virginiana L., eastern red cedar, is a small evergreen tree, commonly 10 to 40 feet, of pyramidal shape becoming rounder in age. Fruits are pale-blue with a whitish bloom, 1/4 inch in diameter and ripen during the first season. Each bony-coated cone (fruit) contains 1 to 2 seeds. The flowers are small, cone-like and develop on the end of short twigs; male and female are borne on separate plants. Eastern red cedar leaves are opposite and scalelike, covering older twigs closely in alternating pairs to 1/8 inch long. New shoots are awl-shaped, sharp-pointed and spreading, 1/4 inch long and dark green. Stems are single with upright or spreading branches. The bark is reddish-brown, thin and shreddy. Branchlets are very slender. Its roots are deep and widely spreading.

Eastern red cedar is native to eastern North America, where it occurs strongly on limestone-derived soils. This species has a wide distribution and is found on many types of soil ranging from acid sands to those derived from limestone. It does best on dry soils in full sunlight, is winter hardy, and is tolerant of droughty and salty soils. Like most junipers, it is very slow growing and is moderately long lived.

This plant is invasive in poorly managed or extensively grazed pastures and rangelands, especially those with neutral pH soils. It is relatively free of serious insect and disease problems. (USDA NRCS Plant Materials Program)

EASTERN RED CEDAR MANAGEMENT

Land Use	Cultural Control*	Biological Control	Chemical Control
Residential/ commercial	Cutting below last live branch	None	None needed
Improved pasture	Cutting below last live branch Shredding	None	None needed
Native range/ brush	Cutting below last live branch Shredding Prescribed burning	None	None needed
Forestland	Cutting below last live branch Shredding Prescribed burning	None	None needed
Orchards/ gardens	Cutting below last live branch	None	None needed

* Cutting below the last live branch is the recommended control practice.

Hackberry

Hackberry is a widespread small to medium-sized tree, known also as common hackberry, sugarberry, nettletree, beaverwood, northern hackberry, and American hackberry. On good bottomland soils it grows fast and may live to 20 years. The wood, heavy but soft, is of limited commercial importance. It is used in inexpensive furniture where a light-colored wood is desired. The bark is grayish and warty, and stems have a zigzag appearance. The branches tend to droop, giving mature trees a cylindrical shape and the appearance of even and equal spread of branches. Leaves are alternately arranged, simple, 2.8 to 4.7 inches long, and sharply toothed. They are dark green above, paler beneath, have asymmetrical leaf bases (oblique), and sometimes have a rough texture. Flowers are small, greenish-yellow, and emerge in April and May with the leaves. Fruit are small greenish drupes that change to dark red or black upon maturity in September and October.

Hackberry grows in many soils, and although principally a bottomland tree, it is frequently found on limestone outcrops or limestone soils. Sites with a permanently high water table are unfavorable for hackberry, although periodic flooding apparently is not detrimental. Hackberry trees often survive the first season of permanent flooding but usually die during or after the second season. Occasional trees have lived 3 years under flooded conditions.

The small greenish flowers appear with, or shortly after, the leaves in early April in the southern part of the range. The seed ripens in September and October, sometimes remaining on the tree until the following spring. The fruit (a spherical drupe) is usually from 0.25 to 0.33 inch in diameter and dark red to purple when ripe. A thin pulp encloses a single bony nutlet. Hackberry bears good seed crops in most years and light seed crops on intervening years. The seed is disseminated principally by birds and small mammals, but some may be dispersed by water.

Hackberry is a deep rooting species, ultimately reaching depths between 10 and 20 feet on most sites. Strong taproots develop only occasionally. Hackberry is intermediate to tolerant in its ability to withstand shade. Trees suppressed for an extended period are often poorly formed.

Wild turkey, ring-necked pheasant, quail, grouse, lesser prairie chicken, cedar waxwing, robins, and other bird species consume common hackberry fruit, which persist throughout the winter. Small mammals also consume the fruit. Deer will browse common hackberry leaves in the absence of preferred browse species. Common hackberry provides good cover for species such as white-tailed deer, upland game birds, small non-game birds, and small mammals. (http://forestry.about.com/library/silvics/blsilcelocc.htm; plants.usda.gov/plantguide/doc/pg_ceoc.doc)

HACKBERRY MANAGEMENT

Land Use	Cultural Control	Biological Control	Chemical Control* **
Residential/ commercial	Cutting	N/A	25% triclopyr in diesel fuel oil, stem application any time of year
Improved pasture	Cutting Chaining Shredding Tree pulling	N/A	25% triclopyr in diesel fuel oil, stem application any time of year
Native range/ brush	Cutting Shredding	N/A	25% triclopyr in diesel fuel oil, stem application any time of year
Forestland	Cutting Shredding	N/A	25% triclopyr in diesel fuel oil, stem application any time of year
Orchards/ gardens	Cutting Shredding	N/A	25% triclopyr in diesel fuel oil, stem application any time of year

* Chemicals should not be used within 150' of water features or drainages that feed ponds/stock tanks.

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Yaupon

Yaupon is a native, slow-growing, erect evergreen tree or shrub that is adapted to open areas, but also grows well beneath trees. It can form dense thickets about 26 feet in height. This species grows best in climates with mild winters and long, hot, humid summers and on moist, sandy soils with permeable subsoils. Plant growth begins in mid- to late-March and will continue until mid-October when sufficient soil water is available. Twig growth essentially stops during dry weather, but the plant will produce new growth again when soil water becomes adequate. When growth begins, many new shoots form and elongate rapidly (forming long-shoots), which form divergent stems creating a low, dense, rounded crown. Yaupon has thin, gray, smooth bark and simple, alternate, and leathery leaves which range in length from 1/2 to 2 inches.

Yaupon flowers are inconspicuous at the base of the leaves. The fruit produced is small, shiny, and red with a diameter of about 1/4 inch. Yaupon flowers April through May, and its fruit ripens in September and October. Plants that grow in open areas tend to produce high fruit yields during alternate years and this species can reproduce sexually and asexually (by root or basal crown sprouting).

Yaupon provides fruit for deer, turkey, quail, squirrel, raccoon, and many songbirds, and deer browse on the leaves during the winter. Many species of birds eat the fruit but usually only in late winter after several freezes and thaws. Mammals eat the fruit as well, and the flowers attract insects. Birds employ the dense branches for nesting sites.

Production of yaupon has been reported up to 150 pounds/acre underneath pine stands in east Texas, but in the open they have produced 5 to 57 times more than plants of the same age beneath trees. In dense stands, however, it out-competes forage grasses, forbs, and more desirable shrubs, causing a decrease in forage diversity and cover for many wildlife species. (http://etd.lib.ttu.edu/theses/available/etd-07012008-31295019526226/unrestricted/31295019526226.pdf)

YAUPON MANAGEMENT

Land Use	Cultural Control	Biological Control	Chemical Control* **
Residential/ commercial	Cutting (will encourage new growth for wildlife use) Digging/pulling up the plant	N/A	25% triclopyr in diesel fuel oil, stem application any time of year
Improved pasture	Cutting (will encourage new growth for wildlife use) Digging/pulling up the plant	N/A	25% triclopyr in diesel fuel oil, stem application any time of year
Native range/ brush	Cutting (will encourage new growth for wildlife use) Shredding (will encourage new growth for wildlife use) Digging/pulling up the plant	N/A	25% triclopyr in diesel fuel oil, stem application any time of year
Forestland	Cutting (will encourage new growth for wildlife use) Shredding (will encourage new growth for wildlife use) Digging/pulling up the plant	N/A	25% triclopyr in diesel fuel oil, stem application any time of year
Orchards/ gardens	Cutting (will encourage new growth for wildlife use) Shredding (will encourage new growth for wildlife use) Digging/pulling up the plant	N/A	25% triclopyr in diesel fuel oil, stem application any time of year

* Chemicals should not be used within 150' of water features or drainages that feed ponds/stock tanks.

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Mammals

Plains Pocket Gopher

Plains pocket gophers are small to medium-sized, dark brown gophers with large, fur-lined cheek pouches. The body is thick-set and appears heaviest near the head, from which it gradually tapers to the tail, widening a little at the thighs. The eyes are tiny and bead-like, and the ears are very rudimentary, represented only by a thickened ridge of skin at the base. Long curved claws are present on the front feet for digging; the claws on the hind feet are much smaller.

This pocket gopher typically inhabits sandy soils where the topsoil is 4 inches or more in depth. Clayey soils are usually avoided. They live most of their solitary lives in underground burrows, coming to the surface only to throw out earth removed in their tunneling and to forage for some items of food. They seldom travel far over land. The average diameter of 40 burrows examined in Texas was nearly 2 1/4 inches; the average depth below the surface 5 1/2 inches, with extremes of 4 inches and 16 1/2 inches. Much of their burrowing is done in search of food. The underground galleries attain labyrinthine proportions in many instances because the tunnels meander aimlessly through the feeding areas. This is particularly noticeable under oak trees that have dropped a good crop of acorns. Burrows have been examined that extend well over 1/2 mile, excluding the numerous short side branches. Only one adult gopher normally occupies a single burrow system.

The average mound thrown up by these gophers is about 12 by 18 inches, about 3 inches in height, and crescentic in outline. The opening through which the earth is pushed is usually plugged from within. The gopher digs with its front claws and protruding teeth, shoves the loose earth ahead of it with its chin and forefeet, and uses the hind feet for propulsion. The ceaseless energy of these subterranean miners is suggested by the size of the huge winter mounds they make in sites that have poor underground drainage. One of these was 6 1/2 feet long, 5 feet wide, 23 1/2 inches high, and weighed an estimated 790 pounds. The female that occupied this mound weighed 1/3 pound. A typical winter mound contains numerous galleries, a nest chamber, a toilet, and food storage chambers.

These rodents feed on a variety of plant items, chiefly roots and stems of weeds and grasses. Most plant food is encountered and ingested while the gopher digs, but some “grazing” of food present along burrow walls probably also occurs. The fur-lined cheek pouches are used to carry food and nesting material but never dirt.

Breeding begins in late January or early February in eastern Texas and continues for a period of 3 or 4 months. One litter a year, or two in quick succession, appears to be the rule. The young, usually two or three in number, are born from March to July. The young are nearly naked, blind, and helpless at birth. They remain with their mother until nearly full-grown and then are evicted to lead an independent life.

As long as they remain in their burrows, pocket gophers are relatively safe from predators other than those that are specialized for digging, such as badgers and long-tailed weasels. However, when a gopher leaves its burrow it is highly vulnerable, and most predation losses probably occur on the surface. Known predators, other than those mentioned above, include coyotes, skunks, domestic cats, hawks, owls, and several kinds of snakes. As a result of the protection offered by the burrow, pocket gophers are long-lived relative to many other rodents, insectivores, and lagomorphs, living an average of 1 to 2 years in the wild.

In farming regions these rodents can be destructive to crops and orchards. The amount of damage is closely associated with the number of animals. The average population density in eastern Texas is about 7.9 gophers per acre. The highest population density of record is 43.5 per acre. These gophers can be controlled on small areas by trapping and on large ones by placing poisoned grain in their burrows. (http://icwdm.org/handbook/rodents/pocketgophers.asp)

POCKET GOPHER MANAGEMENT

Land Use	Cultural Control	Biological Control	Chemical Control*
Residential/ commercial	Buried cables may be protected from gopher damage by surrounding the cable with 6 to 8 inches of coarse gravel. Pocket gophers usually burrow around gravel 1 inch in diameter, whereas smaller pebbles may be pushed to the surface. Fencing of highly valued ornamental shrubs or landscape trees may be justified. The fence should be buried at least 18 inches. The mesh should be small enough to exclude gophers - 1/4-inch or 1/2-inch; hardware cloth will suffice. Trapping	N/A	Carbon monoxide from automobile exhaust: Connect a piece of hose or pipe to the engine exhaust, and place it in a tunnel near a fresh soil mound. Pack soil around the hose or pipe and allow the engine to run for about 3 minutes. The method is usually 90% effective but can be dangerous or fatal to people and should only be undertaken with due caution.
Improved pasture	Planting 50 foot buffer strips of grain around hay fields provides unsuitable habitat around the fields and can minimize immigration of gophers. Trapping Mechanical Burrow Builder	N/A	Strychnine alkaloid bait
Native range/ brush	Trapping	N/A	Strychnine alkaloid bait
Forestland	For seedlings, cylindrical plastic netting placed over the entire seedling, including the bare root, significantly reduces damage to newly planted seedlings. Trapping	N/A	Strychnine alkaloid bait

Land Use	Cultural Control	Biological Control	Chemical Control*
Orchards/ gardens	Trapping	N/A	Strychnine alkaloid bait

* Contact a professional before using this bait. Strychnine alkaloid bait is toxic to fish, birds and other wildlife. Baits exposed on soil surface may be hazardous to birds and other wildlife. Do not contaminate water in lakes, streams or ponds. Do not contaminate water by cleaning of equipment or disposal of wastes.

Nutria

The nutria is a large, dark-colored, semi-aquatic rodent that is native to southern South America. At first glance, a casual observer may misidentify a nutria as either a beaver or a muskrat, especially when it is swimming. This superficial resemblance ends when a more detailed study of the animal is made. Other names used for the nutria include coypu, nutria-rat, South American beaver, Argentine beaver, and swamp beaver.

Nutria have short legs and a robust, highly arched body that is approximately 24 inches long. Their round tail is from 13 to16 inches long and scantily haired. Males are slightly larger than females; the average weight for each is about 12 pounds. Males and females may grow to 20 pounds and 18 pounds, respectively.

The dense, grayish underfur is overlaid by long, glossy guard hairs that vary in color from dark brown to yellowish brown. The forepaws have four well-developed and clawed toes and one vestigial toe. Four of the five clawed toes on the hind foot are interconnected by webbing; the fifth outer toe is free. The hind legs are much larger than the forelegs. When moving on land, a nutria may drag its chest and appear to hunch its back. Like beavers, nutria have large incisors that are yellow-orange to orange-red on their outer surfaces.

In addition to having webbed hind feet, nutria have several other adaptations to a semi-aquatic life. The eyes, ears, and nostrils of nutria are set high on their heads. Additionally, the nostrils and mouth have valves that seal out water while swimming, diving, or feeding underwater. The teats of the female are located high on the sides, which allows the young to suckle while in the water. When pursued, nutria can swim long distances under water and see well enough to evade capture.

In the wild, most nutria probably live less than 3 years; captive animals, however, may live 15 to 20 years. Predation, disease and parasitism, water level fluctuations, habitat quality, highway traffic, and weather extremes affect mortality. Annual mortality of nutria is between 60% and 80%.

Predators of nutria include humans (through regulated harvest), alligators, garfish, bald eagles, and other birds of prey, turtles, snakes such as the cottonmouth, and several carnivorous mammals.

In summer, nutria live on the ground in dense vegetation, but at other times of the year they use burrows. Burrows may be those abandoned by other animals such as armadillos, beavers, and muskrats, or they may be dug by nutria. Underground burrows are used by individuals or multigenerational family groups. Burrow entrances are usually located in the vegetated banks of natural and human-made waterways, especially those having a slope greater than 45 degrees. Burrows range from a simple, short tunnel with one entrance to complex systems with several tunnels and entrances at different levels. Tunnels are usually 4 to 6 feet long; however, lengths of

up to 150 feet have been recorded. Compartments within the tunnel system are used for resting, feeding, escape from predators and the weather, and other activities.

In addition to using land nests and burrows, nutria often build flattened circular platforms of vegetation in shallow water. Constructed of coarse emergent vegetation, these platforms are used for feeding, loafing, grooming, birthing, and escape, and are often misidentified as muskrat houses. Initially, platforms may be relatively low and inconspicuous; however, as vegetation accumulates, some may attain a height of 3 feet.

Nutria breed in all seasons throughout most of their range, and sexually active individuals are present every month of the year. Reproductive peaks occur in late winter, early summer, and mid-autumn, and may be regulated by prevailing weather conditions. Under optimal conditions, nutria reach sexual maturity at 4 months of age. Female nutria are polyestrous (having several estrous or "heat" cycles during a single breeding season), and non-pregnant females cycle into estrous every 2 to 4 weeks. Estrous is maintained for 1 to 4 days in most females.

The gestation period for nutria ranges from 130 to 132 days. A postpartum estrus occurs within 48 hours after birth and most females probably breed again during that time. Litters average 4 to 5 young, with a range of 1 to 13. Litter sizes are generally smaller during winter, in suboptimal habitats, and for young females. Females often abort or assimilate embryos in response to adverse environmental conditions. Young are born fully furred and active. They weigh approximately 8 ounces at birth and can swim and eat vegetation shortly thereafter. Young normally suckle for 7 to 8 weeks until they are weaned.

The start and end of activity periods for nutria coincides with sunset and sunrise, respectively. Peak activity occurs near midnight. When food is abundant, nutria rest and groom during the day and feed at night. When food is limited, daytime feeding increases, especially in wetlands free from frequent disturbance.

Nutria generally occupy a small area throughout their lives. Daily cruising distances for most nutria are less than 600 feet, although some individuals may travel much farther. Nutria move most in winter due to an increased demand for food. Adults usually move farther than young. Seasonal migrations of nutria may also occur. Nutria living in some agricultural areas move in from marshes and swamps when crops are planted and leave after the crops are harvested.

Nutria have relatively poor eyesight and sense danger primarily by hearing. They occasionally test the air for scent. Although they appear to be clumsy on land, they can move with surprising speed when disturbed. When frightened, nutria head for the nearest water, dive in with a splash, and either swim underwater to protective cover or stay submerged near the bottom for several minutes. When cornered or captured, nutria are aggressive and can inflict serious injury to pets and humans by biting and scratching.

Nutria adapt to a wide variety of environmental conditions and persist in areas previously claimed to be unsuitable. In the United States, farm ponds and other freshwater impoundments, drainage canals with spoil banks, rivers and bayous, freshwater and brackish marshes, swamps, and combinations of various wetland types can provide a home to nutria. Nutria habitat, in general, is the semi-aquatic environment that occurs at the boundary between land and permanent water. This zone usually has an abundance of emergent aquatic vegetation, small trees, and/or shrubs and may be interspersed with small clumps and hillocks of high ground.

Nutria are almost entirely herbivorous and eat animal material (mostly insects) incidentally, when they feed on plants. Freshwater mussels and crustaceans are occasionally eaten in some parts of their range. Nutria are opportunistic feeders and eat approximately 25% of their body weight daily. They prefer several small meals to one large meal. The succulent, basal portions of plants are preferred as food, but nutria also eat entire plants or several different parts of a plant. Roots, rhizomes, and tubers are especially important during winter. (http://www.extension.org/pages/Nutria_Overview)

NUTRIA MANAGEMENT

Land Use	Cultural Control	Biological Control	Chemical Control
Residential/ commercial	Trapping Shooting	N/A	N/A
Improved pasture	Contour bank slopes at less than 45 degrees to discourage new burrowing. Sheet piling, bulkheads, and riprap can effectively protect stream banks from burrowing nutria. Trapping Shooting	N/A	N/A
Native range/ brush	Contour bank slopes at less than 45 degrees to discourage new burrowing. Sheet piling, bulkheads, and riprap can effectively protect stream banks from burrowing nutria. Trapping Shooting	N/A	N/A
Forestland	Contour bank slopes at less than 45 degrees to discourage new burrowing. Sheet piling, bulkheads, and riprap can effectively protect stream banks from burrowing nutria. Trapping Shooting	N/A	N/A

Land Use	Cultural Control	Biological Control	Chemical Control
Orchards/ gardens	Low fences (about 4 feet) with an apron buried at least 6 inches Trapping Shooting	N/A	N/A

Bats

Bats are essential to the health of our natural world. They help control pests and are vital pollinators and seed-dispersers for countless plants. Yet these wonderfully diverse and beneficial creatures are among the least studied and most misunderstood of animals. Centuries of myths and misinformation still generate needless fears and threaten bats and their habitats around the world. Bat populations are declining almost everywhere. Losing bats would have devastating consequences for natural ecosystems and human economies.

Bats are hard at work around the world, fulfilling tasks that are vital to healthy ecosystems and human economies. Many of the more than 1,100 bat species consume vast amounts of insects, including some of the most damaging agricultural pests. Others pollinate countless plants, ensuring the production of fruits that support local economies, as well as diverse animal populations. Even bat droppings (guano) are valuable as a rich natural fertilizer. Guano was a major natural resource in the United States a century ago, and it's still mined commercially in many countries.

Insectivorous bats are primary predators of night-flying insects, and many very damaging pests are on their menu. Pregnant or nursing mothers of some species will consume their body weight in insects each night. A single little brown bat can eat more than 1,000 mosquito-sized insects in just one hour. The 20 million Mexican free-tailed bats at Bracken Cave in Central Texas eat up to 200 tons of insects each summer night. And a favorite target of Mexican free-tails in the United States and Mexico is an especially damaging moth called the corn earworm moth (also known as cotton bollworm, tomato fruitworm, etc.) that attacks a host of commercial plants from artichokes to watermelons. Worldwide crop damage from this moth is estimated at more than $1 billion a year, and recent research concluded that free-tails are so effective that they save farmers in south-central Texas up to $1.7 million a year in pesticide costs.

Bats can be found living in almost any conceivable shelter, though they are best known for living in caves. Many species that now live mostly in buildings do so, at least in part, because of shrinking natural habitat. A landowner can attract bats by installing bat houses. (See Bat Conservation International's website, http://www.batcon.org/, for bat house construction and placement information.)

Most bats that live in temperate regions, such as the United States and Canada, mate in the fall just before entering hibernation. Some sing, do wing displays or other actions to attract mates, but few details are known. Ovulation and fertilization (through sperm that have been dormant in the female reproductive tract since the previous fall) occur in the spring as females emerge from hibernation. Pregnant females then move from hibernating sites (hibernacula) to warmer roosts, where they form nursery colonies. Birth occurs approximately 1 1/2 to 2 months later. The young grow rapidly, often learning to fly within three weeks. While the pups are being reared, males and non-reproductive females often segregate into separate groups called bachelor colonies.

Exceptionally long-lived, there is a record of a bat that survived in the wild for 41 years, and bats of a number of species live 15 to 20 years or more. Field mice, by contrast, rarely live beyond 3 to 4 years.

Like dolphins, most bats communicate and navigate with high-frequency sounds. They hunt insects and avoid collisions at night by sending out “echolocation” beeps and analyzing the echoes that come bouncing back. Using sound alone, bats can see everything but color, and in total darkness they can detect obstacles as fine as a human hair. This unique biological sonar system is considered far more efficient than any similar system developed by humans. In addition, bats are not blind and many have excellent vision.

In temperate regions, cold winters force bats to migrate or hibernate. Most travel less than 300 miles to find a suitable cave or abandoned mine, where they remain for up to six months or more, surviving solely on stored fat reserves. However, several species are long-distance migrators, traveling from as far north as Canada to the Gulf Coast states or Mexico for the winter. A few species can survive short-term exposure to sub-freezing temperatures, enabling them to overwinter in cliff faces or in the outer walls of buildings. Bats usually are very loyal to their birthplaces and hibernation sites, but how they find their way over the long distances that often exist between their hibernating and summer caves remains largely a mystery. It appears that some orient visually, using mountain ranges and other landmarks to guide them, but a few are known to have found their way even when blinded. Information about how to find obscure sites, such as small cave entrances, apparently is passed on from generation to generation.

Management of bats should be restricted to safe and humane removal and exclusions to prevent bats from taking up residence in your home, barn, or other structures. (http://batcon.org/)

BAT MANAGEMENT

Land Use	Cultural Control	Biological Control	Chemical Control
Residential/ commercial	Bats can enter buildings through openings as small as 1/2 inch in diameter. Seal common entry points, which include broken or poorly fitted screens, open soffits, loose or missing roof shingles or tiles, places where flashing or boards have come loose and where pipes or wiring enter buildings. Solitary bats that have entered a home can be removed by placing a small box over the bat, then sliding a piece of cardboard between the wall and container. Once the bat is contained, wait until dark and release it outside. For colonies of bats that have already taken up residence, install bat-exclusion devices, leave them in place at least 7 days to ensure all the bats have left, and then seal the entrance holes permanently. Contact a bat control specialist.	N/A	N/A
Improved pasture	None needed	N/A	N/A
Native range/ brush	None needed	N/A	N/A
Forestland	None needed	N/A	N/A
Orchards/ gardens	None needed	N/A	N/A

Feral Hogs

Feral hogs are an old world species belonging to the family *Suidae,* and in Texas include European wild hogs, feral hogs, and European-feral crossbreeds. Feral hogs are domestic hogs that either escaped or were released for hunting purposes. With each generation, the hog's domestic characteristics diminish and they develop the traits needed for survival in the wild.

Feral hogs may appear basically the same as domestic hogs and will vary in color and coat pattern. A mature feral hog may reach a shoulder height of 36 inches and weigh from 100 to over 400 pounds. The extreme larger hogs are generally not far removed from domestication. Males are generally larger than females. European wild hogs are about the same size; however, their legs and snouts are usually longer and they have a larger head in proportion to the body. Their body is covered with long, stiff, grizzled colored hairs, long side whiskers, a longer and straighter tail, and a nape on the neck giving the European hog a razorback, sloped appearance. The crossing of European and feral hogs often produces an offspring with some European characteristics. Feral hogs are more muscular than domestic hogs, and have very little fat. Additionally, the hairs of European appearing hogs and their hybrids frequently have multiple split ends. The young are born a reddish color with black longitudinal stripes. As they mature, the coat color becomes predominantly dark brown or black. Hogs have four continuously growing tusks (two on top, two on bottom) and their contact causes a continuous sharpening of the lower tusks. They have relatively poor eyesight but have keen senses of hearing and smell.

Feral hogs are capable of breeding at six months of age but eight to ten months is normal, provided there is good nutrition. Under poor habitat conditions, sows have been known to eat their young. Gestation is around 115 days with an average litter size of 4 to 6, but under good conditions sows may have 10 to 12 young. While capable of producing two litters per year, research has shown that the majority of sows have only one litter per year. Young may be born throughout the year with peak production in the early spring. The young are born with a 1:1 male to female sex ratio. Feral hogs generally travel in family groups called "sounders," comprised normally of two sows and their young. Mature boars are usually solitary, only joining a herd to breed.

Feral hogs are omnivorous, meaning they eat both plant and animal matter. They are very opportunistic feeders and much of their diet is based on seasonal availability. Foods include grasses, forbs, roots and tubers, browse, mast (acorns), fruits, bulbs and mushrooms. Animal matter includes invertebrates (insects, snails, earthworms, etc.), reptiles, amphibians, and carrion (dead animals), as well as live mammals and birds if given the opportunity. Feral hogs are especially fond of acorns and domestic agricultural crops such as corn, milo, rice, wheat, soybeans, peanuts, potatoes, watermelons and cantaloupe. Feral hogs feed primarily at night and during twilight hours, but will also feed during daylight in cold or wet weather.

Feral hogs are found in a variety of habitats from moist pine forests in East Texas to the brush country of South Texas. They prefer bottomlands such as rivers, creeks, and drainages when available. Hogs are generally found in dense vegetation cover often associated with water, but also do well in drought-prone environments. During hot weather, feral hogs enjoy wallowing in wet, muddy areas and are never far from dense protective cover. They will concentrate in areas of food availability, especially where there are nut-producing trees or agricultural crops. Their home range is based mainly on food availability and cover. It is usually less than 5,000 acres, but can range up to 70,000 acres. In general, boars have a larger home range and will also travel greater distances.

Feral hogs compete directly with livestock as well as game and nongame wildlife species for food. However, the main damage caused to livestock and wildlife is indirect destruction of habitat and agriculture commodities. Rooting and trampling activity for food can damage agricultural crops, fields, and livestock feeding and watering facilities. Often wildlife feeders are damaged or destroyed. They also destabilize wetland areas, springs, creeks and tanks by excessive rooting and wallowing. In addition to habitat destruction and alteration, hogs can destroy forestry plantings and damage trees. While not active predators, wild hogs may prey on fawns, young lambs, and kid goats. If the opportunity arises, they may also destroy and consume eggs of ground nesting birds, such as turkey and quail. (http://www.tpwd.state.tx.us/publications/pwdpubs/media/pwd_bk_w7000_0195.pdf)

FERAL HOG MANAGEMENT

Land Use	Cultural Control	Biological Control	Chemical Control
Residential/ commercial	Exclusion fencing Snares Live trapping	N/A	N/A
Improved pasture	Exclusion fencing Snares Live trapping Shooting	N/A	N/A
Native range/ brush	Exclusion fencing Snares Live trapping Shooting	N/A	N/A
Forestland	Exclusion fencing Snares Live trapping Shooting	N/A	N/A
Orchards/ gardens	Exclusion fencing Snares Live trapping	N/A	N/A

Appendix A – Insect Identification

Red Imported Fire Ant

Copyright: Matt Yoder, Texas A&M

Red imported fire ant mounds

Armyworms

Fall armyworm

Common armyworm

Yellowstriped armyworm

Beet armyworm

Grasshoppers

Differential grasshopper

Red-legged grasshopper

Migratory grasshopper

Two-striped grasshopper

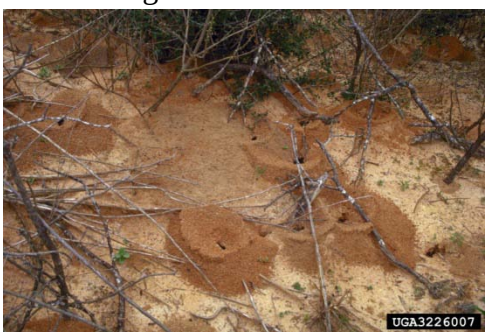
Packard grasshopper

Leaf cutting ants

Leaf cutting ant

Photo by Alex Wild

Leaf cutting ant mounds



Wasps, Hornets and Yellowjackets (For a complete listing: http://insects.tamu.edu/fieldguide/)

Paper wasps with nest

Yellowjacket

Mud dauber wasp

Mud dauber nest

Bald faced hornet

Bald faced hornet nest

Honey Bees & Africanized Honey Bees

Honey bee

Honey bee hive

Note: The Africanized honey bee is virtually indistinguishable in the field from the common honey bee.

Striped Bark Scorpion

Appendix B – Plant Identification

Mesquite

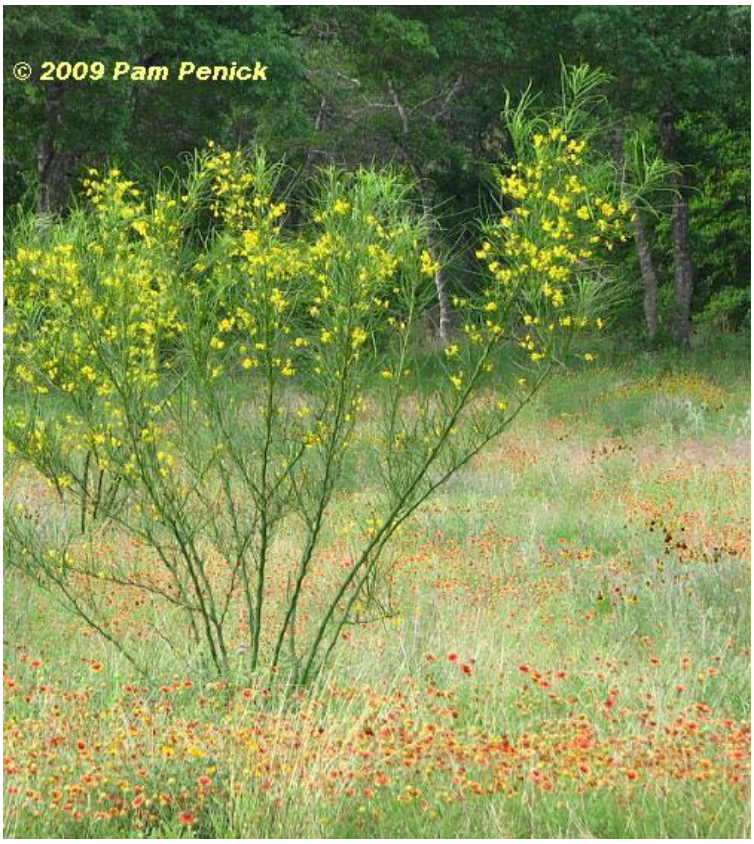
Mesquite trees

Mesquite seed pods

Greenbrier

Chinese Tallowtree

Retama



Sennabean

Sennabean plant

Sennabean fruit

Willow Tree

Photos by Dr. Charlie Hart

Aquatic Plants

See http://aquaplant.tamu.edu for a complete listing of aquatic plants.

Grassbur

Chinaberry

Gum Bumelia

Eastern red cedar

Hackberry

Yaupon

Appendix C – Mammal Identification

Plains pocket gopher

Pocket gopher mounds

Nutria

Bats

Mexican free-tailed bat

For a complete listing of bats native to Central Texas, see http://www.batcon.org/index.php/all-about-bats/species-profiles.html.

Feral Hogs