

**SSC Facilities Services at Texas A&M University**

*Integrated Pest Management  
Procedure Manual*



# **INTEGRATED PEST MANAGEMENT**

## **PROCEDURE MANUAL**

SSC Services for Education  
600 Agronomy Road  
College Station, Texas 77843



Written by: Amanda J. Bakken  
Under the direction of: Bryan McGee  
Layout and Design by: Barbara Musgrove

## PURPOSE OF BOOK

The purpose of this Integrated Pest Management (IPM) book is to educate pest management technicians and the Texas A&M University (TAMU) campus on the newly adopted IPM plans and policies. This book includes the IPM policies, objectives, recordkeeping, and requirements that will be used by technicians. This book is not comprehensive, but an ongoing work in progress that is meant to be updated as more effective techniques, technologies, and methods become available to properly maintain and prevent pests. Pest-specific examples, including visual references, are given and should be referenced as needed. SSC Services for Education and TAMU take the safety and well-being of students, faculty, staff, and visitors seriously. Dangers associated with pesticides exist to humans, animals, and the environment, but by following this plan many of these risks can be mitigated and effective management of pests and diseases can be exacted.

## DEFINITION OF IPM AND PROCEEDING POLICIES

Integrated Pest Management, or IPM, is an ecosystem-based strategy that focuses on long-term prevention of pests or their damage through a combination of techniques. Techniques include mechanical control, genetic manipulation and control, regulatory practices, biological control, habitat manipulation, modification of cultural practices, and use of resistant varieties of plants. Pesticides are used only after surveillance and/or monitoring indicates they are needed. Pesticides will be used according to established guidelines, and applications will be made with the goal of removing only the target organism. Pest control materials are selected and applied in a manner that minimizes risks to human health, beneficial and non-target organisms, and the environment. It is the policy of SSC and TAMU to practice IPM for the buildings, and with time, the grounds, that they care for. Long-term monitoring, surveillance, and IPM practices can be cost-effective, and minimize risks associated with corrective maintenance measures.

## INTRODUCTION

Pests are any living organism which is invasive or prolific, detrimental, troublesome, noxious, destructive, a nuisance to either plants or animals, and harmful to human or human concerns, livestock, human structures, and wild ecosystems. Pests can be detrimental in one setting (i.e. bees in an office), but beneficial in another (bees pollinating crops). Integrated pest management attempts to strike a balance between recognizing an organism as a necessary component in an ecological niche, while managing their presence when it interferes with humans, plants, or animals.

This book will focus its attention on structural pests, and work towards eventually encompassing ground management pests. TAMU/ SSC is moving progressively towards an IPM plan for grounds management and structural pest control and has adopted this IPM plan for the buildings and grounds that SSC manages. The plan is designed to voluntarily comply with policies and regulations promulgated by the TAMU AgriLife Extension Service for public buildings and educational facilities.

## OBJECTIVES

SSC/TAMU has the following objectives for this IPM plan:

- Provide a safe environment through managing buildings by monitoring, identifying causal agents/ symptoms or structural flaws creating portals of entry, and identifying environments conducive to pest population build up.
- Eliminate significant threats caused by pests to the health and safety of students, faculty, staff, and visitors.
- Prevent loss or damage to structures or property by pests.
- Protect environmental quality inside and outside buildings.
- Identify different components of IPM that can be combined for more complete pest control.
- Reduce potential pesticide exposure for students, faculty, staff, and visitors.
- Reduce overuse of pesticides utilizing target specific applications.
- Prioritize pests by potential to harm: bed bugs, fire ants, biting and stinging insects, bats or other animal pests have priority, whereas less harmful pests, i.e. sugar ants, have less priority.

This IPM plan document will be stored in the Grounds Management office of the IPM Coordinators and is available to the public upon request.

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## IPM COORDINATOR

SSCs IPM Coordinators shall be our Structural Pest Control Supervisor/Manager and Turf and Ornamental Pest Control Supervisor/Manager for TAMU's campus. Structural Pest Control Technicians and IPM Technicians will be responsible for implementing the IPM plan, and coordinating pest management-related communications on campus. Responsibilities of the coordinators and technicians include:

- Utilizing the AggieWorks system to track records of work orders being placed for corrective pest management measures placed by students and staff.
- Maintaining a filing system to track service invoices for pest management's actions taken in reaction to work orders. Invoices will include information concerning what actions were taken, where actions were performed, what chemicals or measures were used to solve the pest problem, and any follow-up/additional information.
- These records will be kept on file for a minimum of two years, and can be accessed upon request by TDA inspectors or, when necessary, students/staff have questions concerning actions taken.
- Keep up-to-date records of Safety Data Sheets (SDS) for all tools, both chemical and non-chemical, used by technicians.
- Collaborate with staff in Building Maintenance, HVAC, Sanitation, Grounds Management, etc. to address components that can lead to pest issues.
- Work to improve the effectiveness of this IPM program by evaluating the program annually and making updates to this manual as needed.
- Keep up technicians licenses and certifications by enrolling staff in continuing education classes.
- Work to maintain and expand a network of professionals, professors, and technicians for consultation.

# LICENSING AND TRAINING

SSC will maintain a Structural Pest Control Service (SPCS) Business License issued by the Texas Department of Agriculture (TDA) and all Structural Pest Control Technicians who perform work on campus will be properly licensed under this business license. IPM technicians can either be licensed under the SPCS business license in the categories appropriate to their work, or listed under a TDA license appropriate to their work.

## SPCS Licenses

1. Apprentice License- An individual without any pesticide application experience will be registered with the TDA as an apprentice during his/her training period. During this time, the Responsible Certified Applicator of Record for the SPCS Business License is responsible for providing training and supervision of any work performed by the individual. This individual must obtain 20 hours of classroom training in 12 different areas of study, and an additional 8 hours of training for each category they wish to test in, along with 40 hours of on-the-job training with a Certified Applicator. They also must complete a state-approved and mandated 8 hour Technician Training Course before taking a licensure exam.
2. Certified Pest Control Technician- A Certified Pest Control Technician has completed all apprentice training requirements and has passed an exam for General Pest Control Operations/Laws and Regulations and at least 1 category. A Certified Pest Control Technician must always work under the license of a Certified Pest Control Applicator. A Certified Pest Control Technician can, after 6 months as a Technician, take exams to receive a Certified Pest Applicator license.
3. Certified Pest Control Applicator- This is the highest license issued by the SPCS and these license holders have completed requirements of both Apprentice and Technicians, and are able to work independently and can own and operate their own commercial pest control business.

## SPCS License Categories

- Pest
- Termite
- Lawn & Ornamental
- Weed
- Structural Fumigation (not applicable)
- Commodity Fumigation (not applicable)
- Wood Preservation (not applicable)

## TDA Pest Licenses

These licenses require no formal training but individuals must pass exams in the categories relevant to the work they perform. This license does not allow individuals to make indoor applications.

## **TDA License Categories**

1. Agricultural Pest Control
  - a. Field Crop Pest Control
  - b. Fruit, Nut and Vegetable Pest Control
  - c. Pasture and Rangeland
  - d. Vertebrate Pest Control
  - e. Farm Commodity Pest Control
  - f. Animal Health
  - g. Citrus Pest Control
  - h. Livestock Protection Collar
  - i. M-44
2. Forest Pest Control
3. Lawn and Ornamental Pest Control
  - a. Landscape Maintenance
  - b. Nursery Plant Production
4. Seed Treatments
5. Vegetation Management
6. Aquatic Pest Control
7. Demonstration and Research
8. Regulatory Pest Control
9. Aerial Application
10. Soil Fumigation
11. Public Health Pest Control

*All licenses require Continuing Education Units (CEUs) to be obtained on an annual basis for renewal.*

# POSTING AND NOTIFICATION OF PESTICIDE APPLICATIONS

The IPM Coordinator shall be responsible for annually informing the TAMU campus of the procedures for requesting notification of planned and emergency applications of pesticides in facility buildings and on facility grounds. The IPM coordinator(s) and applicators shall be in compliance with Texas Department of Agriculture/Pesticides/ Structural Pest Control Service codes; TAC Subchapter H, Division 3 **§7.144, §7.146 & §7.147**.

When pesticide applications are scheduled in buildings or on grounds, Service Providers and staff shall provide notification in accordance with Texas Administrative Code which requires forty-eight hours (48) posting notification prior to any application.

1. Provide a “Notice of Pest Control” sign to appropriate personnel with the date of application in an appropriate area and including contact information for additional details. **Code §7.146**
2. Provide this information to all individuals working in the building with consumer information sheet. **Code §7.147**
3. Provide this information to all students, faculty, staff and visitors who have requested notification of individual applications of pesticides. **Code §7.147**
4. Service providers will obtain a signature on “Posting Notification” from appropriate personnel as insurance that staff in the area received a “Notice of Pest Control” sign and a Consumer Information Sheet. This Posting Notification sign-off sheet will be maintained with all service invoices, so that in the event of persons being unaware of a Notice of Pest Control sign, the Posting Notification can be provided to said persons to indicate that all protocols were followed.

Where pests pose an immediate threat to the health and safety of persons on campus, SSC may authorize an emergency pesticide application, and shall notify by telephone, email, or text any guardian who has requested such notification. Disinfectants and anti-microbials applied to inaccessible areas are exempt from posting, notification, and the re-entry requirement.

# RECORD KEEPING & PUBLIC ACCESS TO INFORMATION

SSC will maintain records of all service visits and pest control treatments for a minimum of two (2) years.

**Code §7.144**

## TRAINING

Staff will receive advanced training on identifying pest infestations and pest-conducive conditions. This training will improve the ability of our staff to manage and oversee compliance of SSC/TAMU's IPM policy and plan.

## GENERAL IPM STRATEGIES

Pest management strategies may include education, exclusion, sanitation, maintenance, biological and mechanical controls, and pre-approved, site-appropriate pesticides. An IPM program shall consist of the following steps:

1. Identify pest species
2. Estimate pest populations and compare to established action thresholds
3. Select the appropriate management tactics based on current on-site information
4. Evaluate the results of the treatment to ensure proper control
5. Keep appropriate records

Decisions concerning whether or not pesticides should be applied will be based on a review of all available options. Efforts will be made to avoid the use of pesticides by adequate pest proofing of facilities, implementing sound sanitation practices, selecting pest-resistant plant materials, and using appropriate horticultural practices. When it is determined that a pesticide must be used in order to meet pest management objectives, the least-hazardous, most effective material, will be chosen.

All pesticide storage, transportation, and application will be conducted in accordance with the requirement of the Federal Insecticide, Fungicide, and Rodenticide Act (7 United States Code 136 et seq.), Environmental Protection Agency regulations in 40 CFR, Occupational Safety and Health Administration regulations, SSC/TAMU's policies and procedures, and local ordinances.

No person shall apply, store, or dispose of any pesticide on TAMU's managed property without an appropriate pesticide applicator license. All pesticide applicators will be trained in the principles and practices of IPM and the use of pesticides approved for use. All applicators must comply with the IPM policy and follow appropriate regulations and label precautions when using pesticides in or around TAMU's facilities.

Pest-specific strategies are included in this book.

## **SSC FACILITIES SERVICES TEAM MEMBERS & SERVICE PROVIDERS**

SSC services, including custodial services, pest control, and grounds management will be guided by these IPM program specifications for structural pest control providers.

Service providers will be directed to provide special attention to pest-vulnerable areas, including food storage, food preparation and serving areas, washrooms, restrooms, custodial closets, mechanical rooms, and entryways into the building.

IPM specialists will be asked to provide input on any facility renovation or reconstruction projects including reviewing plans for pest-conducive conditions, suggesting pest-proofing measures, and inspecting construction to prevent and avoid pest problems.

### **TAMUS ROLE(S)**

TAMU/ SSC administration will provide support to assist the IPM Coordinators in maintaining an IPM program that relies on minimal pesticide use. Such support will include efforts to promptly address any structural, horticultural, or sanitation changes recommended by the coordinator to reduce or prevent pest problems.

Furthermore, TAMU/ SSC administration will assist the Coordinator in developing and delivering materials and programs for staff, students, and the public to educate on the importance of good sanitation and pest control.

Facilities Services Grounds management is responsible for ensuring staff compliance with the IPM policy and plan.

# MEANS OF APPLICATION

There are several different means in which chemicals can be applied for pest control. The safety of the technician, people, and surrounding areas are the primary concern prior to any application. All applications will be completed in a manner that is compliant with the laws and regulations of the location and the product label. The technician will be properly outfitted for a pesticide application, adhering to personal protective equipment protocol as set by the pesticide label and SSC. Unless the work is exempted under an emergency work order, all pesticide applications in occupied spaces will take place after the 48 hour advanced notification has past. This allows adequate time for persons present to ask questions and determine if they choose to be present during the application.

## Bait Applications

Bait applications will be utilized whenever possible. Baits will be applied in cracks, crevices, and void areas where they are not visible, in appropriate bait dispensers, or in a granular form on the exterior of a building.

## Dust Applications

Dust applications are primarily limited to cracks, crevices, and void treatments. Dusts will not be applied in areas that are open, and where people can potentially breathe in dusts and damage lungs/mucous membranes. Dusts will not be used in areas where drift can occur.

## Aerosol Applications

Aerosol applications are primarily limited to cracks, crevices, and void treatments, but can be used on flying pests such as wasps and bees on the exterior of a building, or for occasional flying insects indoors when circumstances warrant their use. Aerosol applications will be carefully administered, and the area being treated will be vacated by people prior, during, and after a treatment.

## Liquid Applications

Liquid applications will be made when other options have been exhausted, or when there is a pressing need for immediate action. When applied to the exterior of a building, liquid applications must follow the label to determine if the wind is too strong to properly apply the chemical. Liquid applications will not be applied to off-target areas.

# ACCIDENT PROTOCOLS

The IPM coordinator will be contacted immediately after an accident occurs. If the coordinator is not able to respond immediately, the technician will coordinate with staff capable of handling the accident/emergency.

## Pesticide Related Accidents

In the case of ingestion or inhalation, 911 and poison control will be contacted immediately. The pesticide that has been ingested/inhaled will be communicated, and the SDS book that is located in each vehicle, and in key areas on campus, will be consulted. If a person has eye, or skin exposure, the area will be immediately rinsed with clean water. If clothing is contaminated, it will be removed immediately and the skin around the area of contact will be washed. Contaminated clothing must be washed separately from other clothes. If necessary, the exposed individual will be taken to a hospital or clinic. The SDS book will be consulted on what action is most appropriate. In all exposure incidences, a report will be filed with the company for insurance and record keeping.

## Fire

If a vehicle or pesticide storage facility catches on fire, the police and fire departments will be called immediately. First responders will be informed that pesticides are involved and will be provided with a copy of the SDS book. All products used by SSC Pest Control are catalogued and saved on file for easy access. The product list is updated each time a product is added or deleted from storage.

## Vehicle Accidents

In the incident that a pest control vehicle is involved in an accident, persons involved in the accident will be assessed for injury, and receive medical attention if needed. If pesticides are leaking from the vehicle, the material will be contained. It is integral to prevent fire from coming in contact with pesticides, and all vehicles come equipped with a fire extinguisher. If first responders are on scene, they will be informed of potential pesticide contamination and hazards. Consult the SDS book for proper protocol to follow. A report will be filed with the company for insurance and record keeping.

## PEST PREVENTION

Preventing pests from becoming an issue on the TAMU campus will be a coordinated effort between SSC Pest Control, building maintenance, sanitation, landscape construction, custodial services, HVAC, irrigation, arborists, grounds maintenance, lawn and ornamental, students, staff, and visitors. If a pest control technician notices an issue that needs attention or repair, such as leaking pipes, appropriate measures must be taken to fix the issue and prevent future issues. All departments and people must work together to create and maintain a safe and healthy environment. Pest management takes people management.

## ACTION THRESHOLDS

Action thresholds are based on the level of pest damage, or number of pests observed causing damage. Once the threshold is reached, action is deemed necessary. Action thresholds are established to prevent pests exceeding a tolerable level and causing damage. Action thresholds may be an established number, or work on a sliding scale. They vary depending on the season and location, and are meant as a guideline for when pesticide application is necessary. For example, when a stinging insect is present in a room, the action threshold may be one live insect, due to the presence of a person who is allergic to the insect. However, in the instance of a pest such as a sugar ant, which cannot bite, and is attracted to a food source, the action threshold may be much higher, and tolerance much higher. An IPM plan puts action thresholds into practice in an effort to prevent under and over-reactions to a pest problem. Persons on TAMU campus must be educated to understand that the presence of a pest does not necessarily require immediate action, and that immediate action can, at times, later cause greater issues. All thresholds provided in this book are working thresholds, meaning they are subject to change, and can be adjusted when needed.

## **PEST SPECIFIC EXAMPLES**

**Ants**

**Red Imported Fire Ant**

**Carpenter Ant**

**Bed Bugs**

**Bees and Wasps**

**Carpenter Bees**

**Booklice, Silverfish, and Firebrats**

**Centipedes and Millipedes**

**Cockroaches**

**Crickets**

**Fleas**

**Flies**

**Ground Beetles**

**Mosquitoes**

**Pillbugs and Sowbugs**

**Rove Beetles**

**Scorpions**

**Spiders**

**Stored Product Pests**

**Termites**

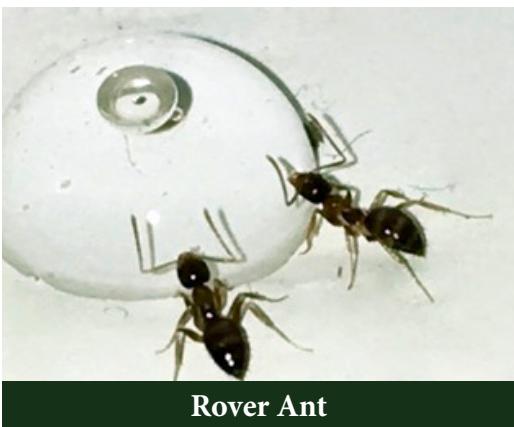


## Ants

### Red Imported Fire Ant, Carpenter Ant, Pharaoh Ant, Crazy Ant, Acrobat Ant, Little Black Ants, Pavement Ants



Pharaoh Ant



Rover Ant



Rover Ant Swarmer

Ants are a common pest in and around buildings. They are social insects, and are divided into three different castes: (1) reproductives, consisting of drones and queens, (2) soldiers, and (3) workers. Ants, like all insects, are characterized by their three body segments; the head, thorax, and abdomen. Ants can be physically distinguished by their pair of elbowed antennae attached to their head, and the area between the thorax and abdomen which is constricted, or pinched, which is called the petiole. The petiole has either one or two bumps/nodes on it, and is used to help distinguish between ant species. Queens and drones are the reproductive members of the colony. Both can have wings, but the queen loses hers after she is mated<sup>6</sup>. Males are approximately the same size as workers, but the queen is much larger than both males and workers, and she can live several years. Workers are female and are commonly encountered within structures. Worker size can vary depending on the ant species, age, and role within the colony.

Reproductive ants are often mistaken for termites. There are three defining characteristics that can be used to distinguish between flying ants and termites. First, an ant has a petiole; termites have a thicker tube-like body. Second, ants have elbowed antennae, and termites have straight antennae. Lastly, ants have hind wings that are smaller/shorter than the front wings, while both sets of termite wings are the same size<sup>7</sup>.

Ants can have different food preferences depending on the species and season<sup>8, 9, 10, 11</sup>. It is important to identify the species encountered, and have knowledge of the ant species behavior and preferences, prior to attempting to control them. Ants are generally a nuisance pest, and can often be controlled through a combination of sanitatizon and bait. Chemical control via spraying baseboards and cracks and crevices is often not necessary, and in the instance of pharaoh ants, can actually cause the ant colony to split, or 'bud', forcing pest control technicians to combat multiple colonies<sup>12</sup>. However, chemical control may be necessary for ants that can cause structural damage, such as carpenter ants, or ants that sting or bite, such as fire ants.

## Inspection

After ants have been located, determine where the ants are gaining access to the building. If ants are trailing, follow the trail to their access point. If the ants trail to an exterior wall, check outside to see if an ant mound is visible. If a mound is visible, and within 10 feet of the building, a structural pest technician can provide a chemical application if deemed necessary. Determine if the building is structurally sound, or if the ants are gaining access via a weep hole, crack in the foundation, faulty caulking, poorly sealed windows/doors/walls, etc. Perform the same inspection for the interior of the building. Note any repairs that need to be addressed, and contact the appropriate personnel to repair problem areas. Locate what the ants are gravitating towards, i.e., food, garbage, etc.

## Communication

Maintenance should be contacted if there is excessive moisture in the area. Leaking pipes, condensation, and improper ventilation in rooms are not sanitation issues, but building issues. Contact appropriate personnel to address these issues.

## Sanitation

If the ants are present due to a sanitation issue, advise staff or students who are in the area on how to address the issue. Suggest that food is stored in pest proof containers, sinks and counter-tops are wiped down with soap and water, trash is removed regularly, and tables and floors are free from crumbs and food debris. Pest proof containers may not always be effective against ants, which can find their way into small crevices. Under these circumstances, if there is a refrigerator available, suggest that food be stored there.

## Mechanical Control

If ants are actively trailing within a room, or are present and spread out within the room, vacuum the area to remove them. Vacuuming is faster and safer than trying to apply a contact pesticide, which would require the floor to be wet for a period of time, or baiting, which requires the ants to find the bait while continuing to forage within the room. If the floor is carpeted, add a small amount of baking soda or cornstarch to the floor prior to vacuuming to help desiccate the ants. Clean all surfaces and empty the vacuum bag after the job is complete.

## Pesticide Options

Determine whether a chemical application is necessary, or if the other measures exacted (sealing building, removing source of attraction, etc.) is enough to control the ants. This step should only take place once the numbers of ants detected meet or exceed the action threshold. There are multiple options for chemical control. This list begins with the most basic and moves towards the most involved. It does not break the chemicals down into specific classes and doses. Please read product labels for all chemical application specifications.

- **Soap:** Soap, in any basic form, whether it is dish soap, bleach, or hand soap, can be mixed with water to remove ants. It is an effective way of removing a pheromone trail left by foraging ants, and can remove ants that are present in small numbers from an area. This is a good option when the ants present are attracted to food in an area, or if there are only a few present.
- **Dusts:** Dusts can be blown into cracks and crevices using a hand bellows or a power duster. Dusts are long lasting, and can be effective at preventing ants from entering and establishing threshold levels within a facility.
- **Baits:** Baits, and bait stations, are an effective means of controlling ants. Baits draw existing

ants in with an attractant which is ingested or carried back to the colony. The bait, which also contains a pesticide, is then shared with other ants in the colony, and kills multiple ants. Baits can be purchased in premade bait stations, or empty bait stations can be purchased to make a buffet of ant baits. Baits not already encapsulated within a station should be placed in areas where the chance for human contact is minimized. It is important to know the species of ant present to determine what type of bait is most attractive during each period of the year (protein, sugar, fat). Many empty bait stations have multiple indentations so multiple types of bait with a variety of active ingredients can be loaded inside. This can help reduce the risk of bait aversion and pesticide resistance. Baits are most effective when competing food sources have been removed, leaving only the bait placed out by the pest control technician as a food source. Baits should only be placed for an existing ant population, and should be removed after the ant population decreases below the action threshold level. This will help prevent more ants from being attracted to the area.

- **Broadcast pesticides:** When ants persist after exclusion, sanitation, and baiting, a broadcast pesticide application can be considered. The label of the pesticide is the law, and must be followed for each application. Choose your product carefully; a product that works effectively against one species of ant may not effectively control a different species. In instances where fire ants or carpenter ants are present, this option might be the first and most effective option.

- **Miscellaneous:** Diatomaceous earth, silica gels, and botanical products are additional options available on the market. These products may be requested by the client you are servicing. These options are relatively non-toxic to humans, and are often considered 'green' options, but often applications of these products lack success. It is important to provide not only efficient service to a client, but comfort and peace of mind. If a client has a low infestation of ants, and requests one of these options, they could be efficient at decreasing populations to a tolerable level. For a



Fire Ant

large infestation of ants, these may not be the best options.

## Red Imported Fire Ant

Due to the aggressive nature of this insect, few IPM options are available for control. The red imported fire ant (RIFA) can be a major pest in the southern United States. If RIFA is found indoors, it is important to find the colony. Always try to control the pest at its source. If you can control the nest of the ant, you can have more complete and effective control of foragers that have made their way into a building.

## Pesticide Options

- **Bait:** Depending on the time of the year, outside temperatures, weather, and current behavior of the ants, baits can be applied directly to the ant mound.
- **Granular applications:** Granular pesticides that can be applied to a mound, but that are not bait, can be an effective measure against RIFA. These products are applied to the mound, depending on the product, are watered in, and can provide fast acting, effective control. These products release a toxin which kills the colony.
- **Broadcast pesticides:** If the weather does not permit, timing is inopportune, or the period of the year is ineffective for baits and granular



Carpenter Ant

applications, a broadcast spray can be applied directly to the ant mound. Various options exist on the market. It is important to apply enough chemical to thoroughly soak the mound, but not cause side effects from run-off. Read and follow all product labels.

- **Miscellaneous:** Other means of control, such as biocontrol for RIFA via phorid flies, baiting large swaths of landscape (such as quads, green spaces, gardens, landscaping, etc.), are not controlled by structural pest technicians, who only apply chemicals up to 10 feet out from a building, but by Agricultural, Forest, or Lawn and Ornamental pest technicians. This book is a reference guide that applies most directly to Structural Pest, and any insect issues that do not directly apply to this category must be directed to the appropriate department.

## Carpenter Ant

Contrary to popular belief, carpenter ants do not feed on wood. Instead, they hollow out the wooden structures they are living in, i.e. logs, branches, timber, posts, railroad ties, and wood used in homes and other structures. Carpenter ants keep their galleries clean. After tunneling into wood, they push the waste material out of the nest. Waste material is a coarse, sawdust-like material that can accumulate outside of the nest in a conical shape. Control is most effective when the colony is located and directly addressed. If the colony is not located within a structure, but rather is outside the structure, try to remove material that is allowing access to the building by pruning vegetation and trees. If the colony is located within a building or within 10 feet of a building, chemical control is likely needed. Carpenter ants can cause structural damage and need to be eliminated. It is imperative to locate the colony, because satellite colonies can exist and contribute to structural damage.

## Pesticide Options

- **Bait:** Carpenter ant diet varies, and baits are usually not effective.
- **Dusts:** Nests can be concealed within wall voids, hollow doors, in attics, or in floors. It may be necessary to drill small holes into walls, floors, or ceilings to access the colony. Dusts should not be applied indiscriminately. Instead, the colony should be located and dust should be applied directly to the

colony.

- **Liquid Formulations:** Spraying ant trails, or spraying visible ants is not an effective means of control. Carpenter ants have large colonies, and control is most effective when the nest is targeted. An exception to this rule is when a transfer liquid insecticide is used. Products such as these do not kill the insect immediately, but instead is carried back to the colony and transferred to nestmates via antennating and rubbing.

<b>Ants (Common House-Infesting) Action Threshold</b>	
Classrooms and Public Areas	Five (5) ants per room
Medical Facility	Five (5) ants per room
Kitchen	Five (5) ants per room
Maintenance and Storage Areas	20 ants per 100 square feet
Grounds	Two (2) field ant mounds per 250 square feet
<b>Fire Ant Action Threshold</b>	
Classrooms and Public Areas	Three (3) ants per room
Medical Facility	Three (3) ants per room
Kitchen	Three (3) ants per room
Maintenance and Storage Areas	10 ants per 100 square feet in two (2) successive monitoring periods
Grounds	Any fire ant mound
<b>Carpenter Ant Action Threshold</b>	
Classrooms and Public Areas	Three (3) ants per room
Medical Facility	One (1) ant per room
Kitchen	Two (2) ants per room
Maintenance and Storage Areas	Three (3) ants per room
Grounds	One nest within 25 feet of building

## **Bed Bugs**

Bed bug infestations are defined as any unit/room that currently has active bed bugs present at the time of inspection. Bed bug protocol is taken very seriously at TAMU, and a separate policies and procedures document has already been written for and approved by Residential Life. This protocol is followed during an inspection and treatment, and the resident(s) receive a copy when a bed bug is detected in their dorm/apartment.

Since the late 1990s, bed bugs have resurged globally<sup>18</sup>, and are a growing concern in hotels, lodging establishments, hostels, retirement homes, hospitals, apartment complexes, and on campuses in dormitories and residential life facilities. These tiny insects can hide in cracks and crevices smaller than the width of a credit card, are mobile, and are excellent travel companions. If a person is exposed to them, they can catch a ride on clothing, bedding, pillows, luggage, furniture, and personal items, and be moved to the next location where they can rapidly reproduce<sup>18</sup>. They can live for months without feeding<sup>19</sup>; so even if an area is unoccupied for months, they can still be present when new residents/persons move into the area.

Bed bugs have three distinct life stages, egg, nymph, and adult. The eggs can be laid singly or in a group. Development, as is with all insects, is temperature dependent, meaning the more optimal the temperature and humidity, the more quickly the insect will develop. After hatching from the egg, the nymph goes through five developmental stages before molting into an adult<sup>18</sup>. Adults are small, reddish-brown, wingless, and approximately 5mm long<sup>20</sup>.

All nymphal stages and adults of both sexes feed only on blood<sup>19</sup>, which is necessary to develop into the next life stage, and in order to reproduce. Bed bugs usually feed at night when people are sleeping<sup>18</sup>. Reactions to the bites range from no detectable reaction to allergic reactions. Typical symptoms include a raised, inflamed, reddish welt on the skin, similar to a mosquito bite, which may itch for several days. Bed bugs typically bite in a linear pattern and are characterized by several itchy bumps in a row<sup>19</sup>. Bed bugs may void the remains of earlier blood meals. These spots, which are brown or red fecal and blood matter, are indications of an infestation.

Bed bugs are associated with 28 diseases, but have not been found to transmit diseases to humans while taking a blood meal<sup>21</sup>. A possible exception to this could be the etiologic agent, *Trypanosoma cruzi*, which causes Chagas disease<sup>22</sup>. There is the possibility that pathogens could be transmitted from mechanical transmission, contact, or while the bed bug is feeding and near open skin tissue.

Due to their cryptic nature of hiding, biting at night, and small size, bed bugs can be difficult to control. Described below are two different control mechanisms used by SSC Pest Control, and an outline of the monitoring process.

## **Monitoring and Prevention**

- In late summer, prior to the start of classes, and before students are back on campus, a company which is contracted by SSC Structural Pest Control comes to campus to perform bed bug inspections. This company has trained bed bug detection dogs which walk through vacant dormitory facilities sniffing out live bed bugs and eggs. If a dog signals an alert on a room or area of a room, a pest control technician is sent out to perform an inspection of the area. If bed bugs are found, one of the treatment options is chosen for controlling the pest.
- When a resident moves out of a campus apartment unit, Residential Life staff places a work order for SSC

Structural Pest Control to perform an inspection for general insects, including bed bugs. If any bed bugs are detected, it is reported to Residential Life, and appropriate action is taken.

- Once students arrive on campus, Residential Life staff dispenses bed bug information sheets to educate students on signs of bed bug infestations. This information includes basic bed bug biology, what to look for when determining if bed bugs exist in the dorm, who to contact if there are possible bed bugs in an area, and what to expect for a response and treatment.
- Residents or staff on campus who suspect the presence of bed bugs place a work order with Aggie Works Services. All work orders for bed bugs are addressed within 12 hours. If the work order is placed after hours, and SSC Pest Management staff on call is contacted to determine when an inspection will take place.
- If a work order for bed bugs is placed, but no bed bugs are found during inspection, and the location is a dorm room or residential room, a bed bug monitor is placed in the suspected location. This monitor runs for one week. After one week, an SSC Pest Management employee will check the monitor for bed bugs. If no bed bugs are in the monitor, no action will take place. If the location suspected for bed bugs is not a dorm room or residential room, but instead a classroom, office, etc., a thorough inspection takes place. If no bed bugs are found, no monitor is placed in the room.

## Control Tactics

If bed bugs are detected either during the inspection, or after the monitor has been checked after one week, there are three options that are evaluated for action.

- Heat Treatment:** Heat treatment is considered to provide the most comprehensive means of bed bug control. Heat kills all life stages of bed bugs; eggs, nymphs, and adults. Various studies indicate temperatures at which bed bugs begin to die<sup>23, 24, 25</sup>, but even the most conservative indicate that eggs, which are the most resistant to heat, experience mortality when exposed to 48°C for 71.5 minutes<sup>25</sup>. SSC Structural Pest Control heats the area to 120°F and maintains that temperature for 3 hours. Heat units, fans, and temperature sensors are used to ensure that the heat is evenly distributed, and that all areas of a unit are reaching and maintaining optimal temperatures. Heat treatments are the primary means used to control bed bugs on this campus, and are utilized whenever space and electrical power is available.
- Chemical Treatment:** There are a number of insecticides that can be used to control bed bugs when it is not possible to provide a heat treatment. Dusts, aerosols, insect growth regulators, and liquid residual insecticides can all be used to kill and control bed bugs, either individually or in tandem. The entire unit must be vacuumed thoroughly to remove bed bugs and caste skins that are present, but eggs, which are glued to surfaces, are difficult to see and remove, and the areas where they are likely to be present must be targeted with chemicals. Chemicals must be applied to resting and hiding locations of bed bugs, including furniture frames, seams on bedding, baseboards, kick plates, cracks and crevices, etc.
- Combination of Heat and Chemical Treatments:** In certain circumstances, a combination of heat and chemical control may be necessary. If heating units and fans cannot be set up to treat an area due to limitations of cords, space, and electrical needs, certain items, such as clothing, rugs, and furniture can be removed to a separate location and treated using heat, while the location itself can be treated with a chemical application. SSC Pest Control determines when it is safe for students or staff to re-enter the area and will either directly communicate with the students/staff, or will post a re-entry notice.

## **Resident's Responsibility**

If the bed bugs are detected within an apartment or dorm, residents are made aware of all preparations that must take place prior to any kind of treatment. The bed bug protocol that has been approved by Residential Life is given to the residents. This protocol contains a preparation checklist that the resident must follow prior to treatment occurring for each type of treatment. Contact the IPM Coordinator to request a copy of the checklist.

## **Evaluation**

Regardless of what control means is utilized, a monitor will be placed in the area that was affected. The monitor will be checked seven days post placement. If no bed bugs are found in the monitor, it is assumed that the treatment was successful, and no follow-up treatment will be performed. If bed bugs are found in the monitor, a retreatment will take place to kill the remaining bed bugs.

<b>Bed Bug Action Threshold</b>	
Dorm/Residential Facility Presence of live bed bugs, any life stage	Treatment required. Treatment will be determined based on how resources can best be utilized
Classrooms and Public Areas	Spot treatment may be necessary, but heat treatment will not take place
Medical Facility	Treatment contingent on circumstances
Kitchen	Treatment contingent on circumstances
Maintenance and Storage Areas	Treatment contingent on circumstances

## Bees and Wasps



Bumble Bee

Bees are one of the most beloved and socially defended insects in modern society. They are popular, economically important, beneficial, and well known across the globe. Wasps, on the other hand, strike fear in most people, and are renowned for their sting. Despite the differences in public opinion, both wasps and bees are beneficial and problematic. Both are categorized as social insects. The name “wasp” can include, but is not limited to, hornets, yellow jackets, paper wasps, and mud daubers. Bees most commonly include honeybees, bumblebees, and carpenter bees.



Carpenter Bee

There are several characteristics that can be used to distinguish between wasps and bees. Wasps typically have smooth, slender bodies, while bees are hairy and have wide bodies<sup>26</sup>. Wasp and bumblebee stingers are not barbed, and thus they can sting multiple times, but honeybees have a barbed stinger, can only sting once, and the stinger is torn out after the bee stings<sup>27</sup>. All bees have two sets of clear wings, but not all wasps have wings.

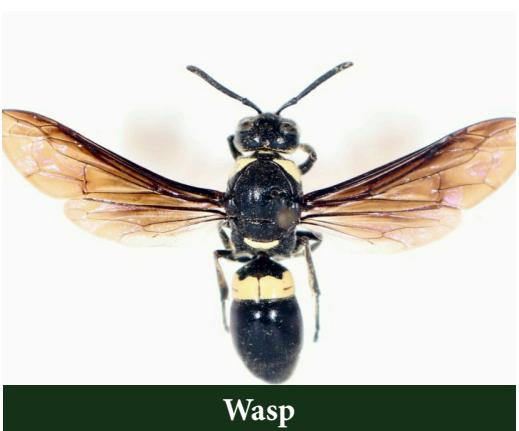
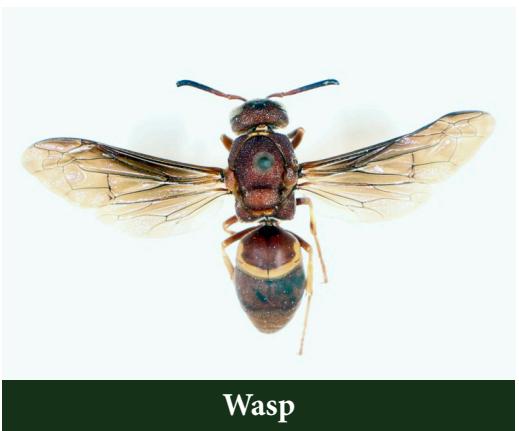
Both wasps and bees undergo complete metamorphosis, meaning that they pass through four stages of development; egg, larva, pupa, and adult. Not all bees are social; there are various levels of this behavior, ranging from non-social, solitary individuals of both wasps and bees, to the characteristic social honey bee that lives in a highly organized hive.

Highly organized hives are broken down into a caste system consisting of a queen, drones, and workers. Although queens control the colony via pheromones, their primary function is to reproduce. Queens can be long lived, ranging from 1-8 years<sup>28, 29</sup> before aging and being replaced by a young queen. Drones develop from unfertilized eggs. Their primary function in the colony is to mate with the fertile queen. They do not have stingers, and do not assist in collecting nectar or pollen. Because they do not contribute towards feeding the colony, but instead use resources, they are often kicked out of the hive when temperatures drop. Workers are all female. Their function is to maintain the colony by cleaning, caring for the developing larvae, producing wax, collecting food, and defending the colony<sup>26</sup>. More specialized functions exist depending on the type and species of the colony.

Wasps and bees become abundant and are more active spring through fall when the temperatures rise and more food sources are available. Wasps, which are predacious, play an important role in controlling other pests, and feed primarily on protein sources, such as spiders, caterpillars, and flies, but will feed on sugar sources



Honey Bee



as well. Food preferences of wasps place them in proximity to humans, as garbage and food are sources of protein and sugar. Bees feed on nectar and pollen from flowering plants, are excellent pollinators, and produce resources such as honey and wax.

Although the sting of a bee or wasp is notorious for its pain and discomfort, most bees and wasps avoid or ignore humans when occupying the same space. Circumstances where a wasp or bee is provoked into stinging typically include if the foraging individual or colony is threatened or disturbed. When these circumstances occur, individuals or colonies will defend themselves until the threat dissipates. Stings may be painful, but typically they are not life threatening. Stings usually cause localized pain, swelling, redness, and irritation, which can last for a few hours to a week. In approximately one percent of children, and three percent of adults, symptoms are exacerbated by an allergic reaction. Doctors typically prescribe an epinephrine pen which is used when a person with allergies to wasps/bees is stung.

Due to their beneficial nature, and public perception, it is important to find alternative means of managing wasps and bees whenever possible. Described below is SSC's protocol.

## Prevention and Sanitation

Wasps and bees can be kept from becoming a nuisance by limiting availability to optimal conditions and resources. Resources include food, water, and a nesting site. Take precautionary steps to prevent their occurrence in an area.

Prevention can begin with sanitation. Wasps and bees may forage near food and water resources. Avoid this by coordinating with sanitation crews to empty trash receptacles regularly. Have receptacles cleaned so no residue exists in or around the area to attract foraging pests. All trash receptacles should have lids, and lids should be tightly closed when not in use.

Remove or exclude outdoor furniture, appliances, etc. Bees and wasps may try to build a nest inside structures such as a barbecue grill. By removing harborage from areas near people, the chance of potential exposure to wasps and bees is reduced.

If bees or wasps are nesting inside a void, and the entrance(s) to the void is small, and the hive does not appear to be large, the entrance(s) can be sealed using a product like expanding foam or copper mesh. It is optional to apply a chemical to the area before

sealing the entrances for a quick knockdown. Doing so can protect the applicator while they perform the exclusion work. The insecticide label is the law, and contains directions for where, when, and on what insects the product can be used.

## Communication

- Have maintenance repair leaky faucets, manage areas where water pools, direct water away from facilities, and level or fill in low spots around foundations that can cause foundations to crack.
- Repair or fill holes around the exterior of buildings where pests can gain access to a facility. Bees will often try to overwintering inside a structure, such as an attic, where temperatures fluctuate less, and they are not exposed to the elements. Screen off holes, caulk around windows, seal electrical boxes, and seal vents leading to the exterior of a building. Older building may need extensive tuckpointing to prevent bees and wasps from entering and establishing a colony.
- Coordinate efforts with grounds management to plant and maintain plants that are not as attractive to bees and wasps to decrease the likelihood of pests foraging near high trafficked areas.

## Mechanical Control

- Supplement corrective work orders by inspecting for nesting sites. Nests can be built in many different areas, including underground, under eaves and awnings on buildings, in wall voids, in attics and roofs, and in trees and shrubs. Inspect the perimeter of a structure, paying close attention to protected areas where a nest would not be disturbed. Begin inspections in the spring when temperatures increase. Small nests can usually be removed without applying a pesticide by scraping the nest off of the substrate.
- When nests are large, particularly for wasps,

a plastic bag can be slipped over it in the early morning or late evening when activity is at its lowest. The bag should be tied shut and either left in the sun to kill the colony, or placed in a freezer to kill the colony.

## Education

- Educate students and staff to watch for bees and wasps during warm weather, to avoid disturbing nests, and report nests to SSC Pest Management. Students and staff should not attempt to remove or apply a pesticide to the bees or wasps on their own. Make efforts to educate the campus on the importance and benefits of these insects.

## Physical Removal

- When bees are a danger to people in the area and need to be removed, the first attempts of control will be to evaluate if the bees can be safely relocated to a different location. The apiary on campus will be contacted and consulted to determine if relocation is feasible. If it is, trained staff will remove the nest. SSC Pest Management will assist staff as needed, and will coordinate efforts to control traffic and pedestrians around the area. SSC will attempt to coordinate removal times for early morning or late evening when insects are most likely to be in the nest and not out foraging.
- Wasps and bees that accidentally fly into a room or building should not be treated as a pest requiring a chemical application. Stray individuals can be caught and removed, swatted with a fly swatter, shooed out, or vacuumed up.
- In areas where insecticides cannot be utilized, vacuuming is an option. Remember to seal the vacuum bag quickly to prevent pests from escaping.

## Pesticide Control

When the nest poses a danger to humans, and is inaccessible for removal, measures will be taken to eliminate the pests from the area in the safest means possible.

- If the nest is in an inaccessible area, or requires an immediate removal and the apiary staff are not available to relocate the nest, the nest may need to be controlled via chemical application. There are many options for controlling wasps and bees located in a wall void.
- Aerosol sprays can be used to quickly knockdown nests.
- Ground nesting wasps and bees can be knocked down by dusts. Scout the area for secondary entrance/exit holes and seal them prior to applying a pesticide.

wooden surfaces can discourage bee activity, as does constructing susceptible areas of a building with hardwoods instead of softwoods<sup>30</sup>. Unoccupied holes should be filled with caulk or steel wool, or covered by wire screening or metal flashing. Control is not easily found during the late spring and summer, because the adult female seals the brood chamber with wood particles. Exclusion is key in controlling this pest.

## Carpenter Bees

Carpenter bees are a common spring and summer pest. Females can be seen excavating holes in wooden structures, and males buzz aggressively at people and other potential threats that pass by their nests. These attacks are not dangerous because males do not have a stinger<sup>30</sup>. Females are generally not aggressive, and won't sting unless threatened or provoked. Carpenter bees do not eat the wood, but rather tunnel in and use the wood residue for nesting material. They are similar in appearance to bumblebees, but have a shiny, bald abdomen instead of a hairy abdomen like bumblebees. Like bumblebees, carpenter bees are important pollinators. They are largely solitary insects, but many can be found gregariously in the same area and they can have semisocial behavior or social nesting<sup>31</sup>. They overwinter in their excavated sites<sup>31</sup> and mate in the spring<sup>32</sup>. Carpenter bees can cause structural damage from tunneling, and expose wood and structures to secondary pests, such as beetles.

Carpenter bees can excavate many kinds of wood, even if protected by paint or stains<sup>31</sup>. Coating

<b>Bumble Bee and Honey Bee Action Threshold</b>	
Classrooms and Public Areas	One (1) per room
Medical Facility	One (1) per room
Kitchen	One (1) per room
Maintenance and Storage Areas	Three (3) per room
Grounds	If students or staff in area are threatened
<b>Carpenter Bee Action Threshold</b>	
Classrooms and Public Areas	One (1) per room
Medical Facility	One (1) per room
Kitchen	One (1) per room
Maintenance and Storage Areas	Three (3) per room
Grounds	If students or staff are threatened; one per 5 linear feet
<b>Wasp Action Threshold</b>	
Classrooms and Public Areas	One (1) per room
Medical Facility	One (1) per room
Kitchen	One (1) per room
Maintenance and Storage Areas	One (1) per room
Grounds	Ten (10) seen in ten minutes at trash, or if threatening students and staff in the area

## **Booklice, Silverfish, and Firebrats**

Due to their similar natures, these three pests are grouped together. They occur in the same habitats, preferring dark, humid, warm environments<sup>33</sup>, and eat starchy foods, glues, pastes, books, and molds<sup>33, 34</sup>. They can live indoors or outdoors, and can enter buildings on packing materials, such as storage boxes, or can wander inside on their own. Silverfish and firebrats are fast moving, but stay close to food sources<sup>34</sup>. Generally they cause very little damage, but are unsightly, and can attract secondary pests that will feed on them, such as spiders and scorpions.

Booklice are soft-bodied insects with long antennae and no wings. Their color ranges from clear/opaque yellow to gray. They are small, approximately 1/25" to 1/12" of an inch long as an adult. They are most numerous in the spring and summer, and primarily feed on mold and mildew<sup>34</sup>.

Silverfish and firebrats have three long, tail-like appendages at the end of their abdomen which are approximately the same length as their body. They are wingless, have long antennae, and their bodies are covered in scales<sup>34</sup>. They are approximately ½" inch long as an adult. Silverfish bodies are shaped like a carrot<sup>34</sup>, and are grayish to greenish colored. Firebrats are shaped similarly, and have a patchy black and white color pattern<sup>34</sup>. Both silverfish and firebrats eat foods high in protein, sugar, or starch, and are active at night or in dark places.

## **Inspection and Monitoring**

- Monitor damp and warm areas for insect activity. Check behind and inside bookcases and closets, in wallpaper, windows, doors, bathrooms, and kitchens. Firebrats can molt 45-60 times<sup>34, 35</sup> during their life, and leave their caste skins behind. Appearance of these can indicate their presence, as can irregular holes found in books, fabrics, and wallpaper.
- Place sticky traps in an area where damage is suspected, and identify any insects that are caught on the trap.

## **Communication**

- These pests are present in areas of high humidity and excess moisture. If moisture is not controlled, the pests will persist, and additional pests may appear. Coordinate with building maintenance to fix moisture issues by mending leaky or broken pipes, ventilate rooms by opening doors and windows, run a dehumidifier, use fans to dry up excessive moisture, eliminate standing water, and replace old windows that collect moisture and condensation.
- Seal cracks and crevices.

## **Sanitation**

- Dispose of items that have mold or mildew damage.
- Vacuum around baseboards, and areas suspected for pest activity to remove caste skins and insects that are present.

- Clean up food/moldy areas with soap/detergent to remove the food source.

## Pesticide Control

Eliminating excess moisture should solve the problem, but if it does not, there are several pesticides available that can control these pests.

- Dusts: Dusts can be applied to cracks and crevices, in crawl spaces, in wall voids, or in areas undisturbed that are not accessible to humans and animals. If the area has dried out, a product such as diatomaceous earth can be used to desiccate the pest.
- Baits: Some baits, such as ones that use boric acid, can be attractive to these pests, and when ingested, disrupts the stomach and nervous system of the pest.
- Broadcast Sprays: There should be no circumstances where this type of control is necessary, but if a problem becomes out of hand in a high profile area, there are several products with a residual that can be used in areas where these pests are most commonly found.

Booklice, Silverfish, Firebrat Action Threshold	
Classrooms and Public Areas	Five (5) per room
Medical Facility	Two (2) per room
Kitchen	Two (2) per room
Maintenance and Storage Areas	Five (5) per room
Grounds	N/A

## **Centipedes and Millipedes**

Centipedes and millipedes are not insects, but are related to insects. Key differences between these arthropods and insect arthropods center on body segmentation and amount of legs. Insects have three body segments and three pairs of legs, whereas centipedes and millipedes do not have a set number of body segments and legs.

Centipedes and millipedes differ in that centipedes have one pair of legs per body segment<sup>61</sup>, their last legs extend backwards, they tend to move more quickly than millipedes, and will bite when provoked. Millipedes typically have two pairs of legs per body segment, move in an undulating, wavelike manner while walking, and curl up when prodded, provoked, or at rest<sup>62</sup>.

Both centipedes and millipedes can be considered beneficial. Centipedes are often general predators to small insects<sup>63</sup>, and millipedes break down organic matter by feeding on dead and decaying leaves, wood, and plant matter<sup>64</sup>. Both can be found in damp, dark places. Neither pest causes structural damage to a building. Detection of either of these arthropods is an indication of moisture and potential decaying organic material, or insect pests.

Centipedes can bite when provoked, whereas millipedes do not bite, but can exude a defensive toxin that can irritate skin and eyes.

## **Inspection, Sanitation, and Exclusion**

- Centipedes rarely need to be controlled. Keep moisture low, remove debris around the exterior of the building, and seal off access to buildings by installing door sweeps and caulking cracks, crevices, and areas around pipe entries.
- Millipedes typically cannot survive within a building. They desiccate unless there is decomposing material and excess moisture, or die due to lack of food. Seal cracks and crevices, and install door sweeps to prevent access to the building. Remove decaying organic material around the exterior of the building, maintain mulch, and air out moist areas.
- Invaders can either be swept up with a broom or vacuum and be placed outside, or be squished by a sturdy shoe. No chemicals are necessary to control these arthropods.



## Cockroaches

### American Cockroaches, German Cockroaches, Brown Banded Cockroaches, Oriental Cockroaches

Cockroaches can be found throughout the United States, and have adapted to living in conjunction with people. Cockroaches are physically fit insects. They can exist in tiny cracks and crevices, need very little food to thrive and reproduce, and, depending on the species, can survive from several days up to a month without food or water<sup>1</sup>. Because they are so hardy, it is essential to identify the species of cockroaches present, to determine the pests' behavior, food and habitat preferences, life span, and fecundity.



German Cockroaches

Cockroaches generally have a flattened, oval shaped body. They secrete oil that gives them a musky smell. They feed on many different sources of food, including sugars, starches, meats, and grease. They can eat the glue on old cardboard boxes and wallpaper pastes. They prefer warm, dark, humid environments, and are typically found in bathrooms, kitchens, mechanical rooms, and sewers.

Cockroaches have incomplete metamorphosis, which is characterized by three life stages: egg, immature/nymph, and adult. Developmental time depends on the species of cockroach, temperature, and resources available. Eggs are laid collectively in a capsule called an ootheca. Once the eggs hatch, the cockroach undergoes multiple molts before becoming an adult.

Although cockroaches are not direct vectors of disease, they can mechanically vector disease causing organisms, such as bacteria, via movement through food prep areas, with their fecal matter and oily secretions. Their caste skins, or skins which are shed after the insect molts to a later nymph or adult, and fecal matter have been linked to asthma in urban environments<sup>2,3</sup>. To detect the presence of cockroaches, look for the characteristic musty odor produced by the oily secretions, egg cases, caste skins, dead or live cockroaches, and fecal matter. Cockroaches produce an aggregation pheromone that is produced in the rectal pads, and passed with the feces<sup>4</sup>. This pheromone can attract other cockroaches to gather in an area. Immature cockroaches, which feed on adult fecal matter, can be exposed to a food source. This food source may have a pesticide present in it if the adult has fed on cockroach bait, and can cause secondary and tertiary death in cockroaches<sup>5</sup>.

## Inspection

When cockroaches are reported, begin by identifying possible habitats. Cockroaches can easily move within a building via pipes, drains, cracks, crevices, around plumbing, vents, windows, and under doors. Identify what species of cockroach has been seen and where. Determine how the cockroaches had access to the building.

Determine what is attracting the cockroaches to the area. Look for food and water sources, and warm, humid, dark areas. If the location is a kitchen, look for available food sources around the stove, floors, in pantries, and around refrigerators. Check for grease sources on surfaces, along the sides of appliances, in toasters and microwaves, along the sides of refrigerators, crumbs in drawers and cupboards, and food on the floor. Determine if garbage's are emptied regularly, have a liner, and are clean on the interior of the canister. Check faucets for leaks, and look for food that is not stored in pest proof containers. If this area is clean, determine if there is an adjacent area that is not clean. Check the exterior of the building for excessive plant cover, open pipes, missing bricks, incomplete construction, open windows, and missing screens.

## Communication

If the area is maintained by custodial staff, either contact the staff, or ask staff in the area to contact custodians and have in-depth cleaning performed in the area when needed. If there is excessive moisture, speak with building maintenance about fixing leaky pipes and cleaning pooled water and spills.

## Sanitation

Cockroach oil secretions and caste skins can contribute to or cause asthma issues. Other predatory insects may be attracted to cockroach waste and residues in an area, causing secondary pest issues. Cockroaches that are visible can be vacuumed or swept up with a broom. Vacuum attachments can

be used to get into cracks and crevices, and should have a HEPA filter attached to protect anyone in the area from airborne particles. Dust masks and respirators are other options when infestations warrant their use. All surfaces, and the undersides to the surfaces, should be wiped down with soap and water. Pull appliances out to clean the sides and back, and inspect the interior for food crumbs or grease.

## Exclusion

Sealing possible entry points can prevent further spread of existing populations. Communicate with the customer so they are aware of possible entry points, then either seal and secure the areas, contact building maintenance to do the work, or request the customer defer the work to building maintenance.

## Pesticide Options

Determine whether a chemical application is necessary, or if inspection, communication, sanitation, and exclusion is enough to control cockroach numbers. This step should only take place once the numbers of cockroaches detected meet or exceed the action threshold.

There are multiple options for chemical control. This list begins with the most basic and moves towards the most involved. It does not break the chemicals down into specific classes and application rates. Please read product labels for all chemical application specifications.

- **Soaps:** If conventional means of control (i.e. swatting them with a shoe, fly swatter, etc.) is not possible, the most basic form of chemical control is to mix a solution of soap/detergent and water that is sprayed directly on cockroaches. Soap will act as a desiccant and dry out cockroaches.
- **Dusts:** Dusts, such as Boric acid, can be blown into cracks and crevices using a hand bellows or a power duster. Dusts are long lasting, and can be effective at preventing cockroaches from entering and establishing action threshold

levels within a facility.

- **Baits:** Baits, and bait stations, are an effective means of controlling cockroaches. Bait draws existing cockroaches in with an attractant, and then kills the cockroaches with the pesticide that is included in the bait formulation. Baits can come within premade bait stations, or empty bait stations can be purchased to make a buffet of cockroach baits. Baits not already encapsulated within a station should be placed in areas where human contact is minimized. By experimenting with multiple baits, or rotating the baits used, you can help reduce the risk of bait aversion and pesticide resistance. Baits are most effective when competing food sources are removed, leaving only the bait placed by the technician as a food source. Baits should only be placed for an existing cockroach population, and be removed after the population decreases below the action threshold levels. This will help prevent more cockroaches from being attracted to the area.
- **Broadcast pesticides:** When cockroaches persist after exclusion, sanitation, and baiting, a broadcast pesticide application can be considered. The label of the pesticide is the law, and must be followed for each application. Choose your product carefully; a product can lose its efficacy when used inappropriately, and cockroaches can develop resistance to pesticides.

Cockroach Action Threshold	
Classrooms and Public Areas	Three (3) per room post sanitation and exclusion
Medical Facility	Three (3) per room post sanitation and exclusion
Kitchen	Three (3) per room post sanitation and exclusion
Maintenance and Storage Areas	Five (5) per room post sanitation and exclusion

## Crickets



Cricket - Field



Cricket - House

Crickets are a common household invader. They spend most of their life outside where they feed, and reproduce. They can wander indoors and become a noisy nuisance during late summer and early fall. Crickets have a characteristic chirping sound that most males make to attract a female mate. Chirping sounds are created by stridulation. A file-like structure is located on the edge of the large vein that runs down the center of the forewing, and a scraper is located on the end of the forewing. The cricket rasps the two structures together rhythmically, and the sound is resonated and amplified by a 'harp,' which is the heavily sclerotized, center part of the forewing<sup>42</sup>. The sound is fairly loud, and attracts females. Several different songs are used in some species of crickets to deter other males, call, mate, and celebrate mating. Cricket chirping can also be used as a tool to determine what temperature it is. The rate of chirping can increase at higher temperatures, and decrease at lower temperatures<sup>42</sup>.

Cricket bodies are cylindrically shaped, have long antennae, and large, powerful hind legs that are used for jumping. They range in color from white, green, brown, tan, and black. They can be found in many habitats, and are usually nocturnal. Most crickets can fly; some efficiently, some clumsily. They are omnivorous, and have strong mouthparts that can chew a wide range of organic food, including flowers, fruit, leaves, seedlings, grasses, fungi, and other insects. Crickets have not been implicated in carrying diseases.

Beyond chirping, crickets can be a nuisance for their gregarious gathering near building foundations and doors. They will enter buildings through cracks and crevices, and are typically found in moist, dark areas of a building, such as kitchens, bathrooms, basements, and mechanical rooms.

## Inspection, Exclusion, Sanitation

Because crickets are a seasonal issue, most control is centered on prevention rather than corrective maintenance.

- Determine where crickets are entering the building. Caulk or repair all cracks, crevices, and gaps that could provide entrance into the building. Concentrate attention around the foundation, windows, and doors. Install door sweeps to prevent crickets from crawling under doors.

- Repair leaky plumbing both indoors and outdoors. Moist environments provide ideal conditions for insect growth and survival success.
- Address moisture issues by ventilating the areas affected, and using a dehumidifier when necessary.
- Reduce clutter indoors by removing unnecessary boxes, paper, and storage material. This can minimize areas where crickets will hide.
- Place sticky traps or glue boards on the interior of structures around entrances to determine how large the invading population is, in order to determine if a pesticide application is necessary.
- Keep all doors closed. Do not prop doors open, especially at night.
- Have the area around the facility regularly maintained. Mow grasses, control weeds, and maintain mulch. Plants should be spaced 18" out from the building.
- Remove debris and objects that are located near a facility that the crickets can use as a refuge. Examples include piles of wood, building materials, and garbage cans.
- Crickets are strongly attracted to light. Have unnecessary lights turned off, and switch bulbs to yellow lights, which are less attractive compared to white light.
- Crickets that are found inside can be swept up or vacuumed to remove.

## Pesticide Control

Occasionally preventive maintenance is not sufficient for cricket control. Weather, habitat modification, and food and water resources can all influence survival. When chemical means must be used, pesticides labeled to control adults should be used. Crickets generally do not lay eggs inside, thus adults are the life stage to target. Interior applications

are generally ineffective, and treatments should be limited to the exterior of a facility.

- **Dust:** Dust cracks and crevices where you have observed crickets hiding and resting.
- **Bait:** Granular baits can be used to kill crickets that are present on the exterior of a building. Baits can be an effective means to control this pest. Note that if a low population is present, baits should not be used as they can attract crickets from other areas, causing a surge in population at a facility. Baits used to control crickets are generally spread around the perimeter of a building, and fall into grass, and cracks and crevices, preventing technicians from removing the bait. Do not bait unless populations are high enough to justify the action, and if there are enough crickets to eat the bait.
- **Liquid Pesticide:** Perimeter barriers can be used as a temporary means of control. The pesticide should be applied on the exterior of a facility, and only when numbers warrant its use. Always read and follow label directions.

<b>Cricket Action Threshold</b>	
Classrooms and Public Areas	Three to five (3-5) per room
Medical Facility	Three (3) per room
Kitchen	Three (3) per room
Maintenance and Storage Areas	Five to seven (5-7) per room
Grounds	N/A unless threatening to enter building when opening doors



Cat Flea

## Fleas

Fleas are common pests on both wild and domesticated animals<sup>43</sup>. They can become a problem on campuses when students or staff brings them into their dorms and offices from an outside source, when service animals are infested, or when a wild population of cats, squirrels, skunks, raccoons, or rodents reside in, near, or under a building<sup>44</sup>.

Most fleas encountered are cat fleas<sup>43</sup>. The adult of this insect is small and difficult to see. They can be reddish-brown to black, are wingless, laterally compressed, and good jumpers<sup>45</sup>. They are an ectoparasite, and pierce their host to take a blood meal. Cat fleas stay on or near a host, where feeding, mating, and reproducing occur. Eggs and larvae of this insect are extremely small and difficult to see. They need a moist, humid environment to develop, and will reach adulthood more quickly at higher temperatures<sup>43</sup>. Under cooler temperatures, fleas can enter a quasi-dormant state until temperatures increase. In urban environments, vibrations, such as from the floor being vacuumed<sup>43, 46</sup>, walked on, etc. stimulates fleas to move. Flea populations tend to be greatest in spring and summer when climatic conditions favor development.

A flea bite typically appears as a small, red spot, which can be surrounded by a reddish halo. These spots can range from being a minor skin irritation, to excessively itchy rash in people with sensitive skin. Secondary infections can occur in people with sensitive skin who itch a bite, and allergic reactions can occur when a person continues to scratch the bites. Fleas have been implicated in transmitting a disease to humans, cat flea rickettsiosis, a bacterial infection that causes fever, rash, headache, confusion, and muscle pain<sup>43</sup>.

## Inspection

- Fleas are not typically difficult to detect. Simply walking into an area, pausing, and looking down at light colored clothing, while shining a flashlight, can be enough to detect a flea presence. Glue boards can also be used to monitor flea presence.
- Determine why the fleas are present. Ask students/staff if animals are present, or if someone has fleas at home. Check to see if an animal has burrowed under a building and may be introducing fleas to the area. Ask students and staff if they have

pets at home, or if their backyards have fleas.

- After determining the source of the fleas, and (if applicable) recommending how students/staff rid their personal, off-campus area of fleas, determine if there are enough fleas to warrant a pesticide application. Cat fleas do not prefer humans as a host. If populations are low enough, they may die before building up the existing population, or can be controlled by vacuuming regularly and immediately emptying the vacuum bag.

## Exterior Prevention/Control

- If fleas are present because there is an animal present in the area, trap and remove the animal to remove the flea source. A localized flea treatment may be needed for where the animal was located.
- Occasionally an animal may die under a building, in an attic, or behind a wall. Foaming agents mixed with pesticides that control fleas may be needed to control fleas that leave their localized areas (a nest or burrow) to search for their next blood meal (dorms, offices, classrooms, labs).

## Pesticide Preparation and Control

Once it is determined that the flea population must be controlled, the area must be prepared for a treatment, and a 48 hour notification must be given to all persons in the area who could be affected by the pesticide.

- Person(s) in charge of the area must prepare the space receiving treatment by vacuuming the area thoroughly. Person(s) must lift/move furniture, vacuum all floors, baseboards, and furniture. Vacuum contents must be immediately disposed of by either throwing the bag, or emptying the canister and tying the trash bag shut, then washing the canister. Failure to do so could introduce fleas back into the area, or into a new area.

- If pets are in the area, all bedding must be washed in hot water, and dried on a high setting to kill all life stages of the insect.
- All contents must be moved off of the floor in the area to be treated. If children are in the area, all toys/playthings that children will come in contact with must be washed after the treatment has been performed.
- If pets are in the area, remove all food and water sources and dishes. If no pets are present, check that no food or water is in the area that humans will use.
- If there are fish in the area, unplug the fish tank and cover it with a damp cloth, or remove the fish prior to the scheduled treatment. All people and pets must stay away from the area as well.
- The pest control technician will likely spray all floor surfaces with a combination of chemicals. This combination will contain a pesticide to provide a quick kill to existing adult fleas in the area, and a pesticide that contains an insect growth regulator, which will prevent developing fleas from becoming adults and perpetuating the life cycle. These chemicals will leave a residual that will continue to work post application.

- The area must be allowed to dry completely before allowing anyone back into the area.
- If the affected area is in a wall void, or under a building, a dust application may be used to control the fleas.
- Continue to vacuum regularly to remove any emerging fleas.

<b>Flea Action Threshold</b>	
Classrooms and Public Areas	Three (3) per room
Medical Facility	One (1) per room
Kitchen	One (1) per room
Maintenance and Storage Areas	Three (3) per room
Grounds	N/A Determined on a case by case account depending on where fleas are located in relation to a building



## Flies

### House Flies, Drain Flies, Fruit/Vinegar Flies, Fungus Gnats, Phorid Flies

Flies are a common nuisance pest around humans. Flies undergo complete metamorphosis and have four life stages; egg, larva, pupa, and adult. Many of these pests breed in waste and organic material. The female lays her egg in a moist location, like rotting garbage, and the developing fly will complete its development at or near this site. Because developing flies largely remain in place while developing, immature stages are the most effective time to target for pest control. Focusing pest control at early stages can break the life cycle of the fly, and prevent adults from developing and breeding.



Most flies that are encountered and reported by people, such as fruit flies, drain flies, and house flies, breed in food, organic material, or animal waste. They have sponging mouthparts and cannot bite; however, they can be a health hazard for their ability to contaminate food, cooking utensils, and food preparation surfaces in homes, kitchens, cafeterias, and restaurants. Flies can walk across a surface and pick up pathogens, then mechanically transmit the pathogens to a new surface, exposing people to surfaces and food that are not clean. Flies also defecate and regurgitate on wall surfaces where they rest. These marks contaminate an area and are unsightly.



## Inspection

Most flies that are present in a facility came from the outside, and control efforts should concentrate on preventing access to a facility.

- Improper maintenance, poor cleaning, and available organic material can all lead to the presence of flies. Begin by finding the flies that have caused the complaint. Identify what type of fly is causing the disturbance. Correctly identifying the pest is important for determining what behavior they are exhibiting, where they are most likely to be found, where they are potentially breeding, and how they can be controlled.



## Communication

- If the flies are attracted to garbage that is stored outside of a facility, coordinate with grounds maintenance to have the garbage's moved upwind of the facility. Flies will follow a scent

trail from the garbage's to the doors where the garbage is regularly taken out of, and enter the facility. Arrange for the garbage's to be cleaned regularly, and identify if flies are breeding in the soil next to the where the garbage's are being cleaned.

- Coordinate with custodial staff, or grounds management to ensure that drains are properly cleaned and flushed out, and that disposal units are functioning properly to prevent breeding sites from occurring.
- Coordinate with students and staff in the area to ensure that all recycling is being properly rinsed, and that recycling is being removed regularly.

## Sanitation

- If garbage's have lids, ensure that they are tight-fitting. This aids in minimizing odors from escaping. If garbage's have liners, ensure that the liners are installed properly and are not allowing food waste to leak into the bottom of the bin.
- If the facility has a loading dock, have the dock and drains cleaned regularly to avoid attracting flies to large roll up doors.

## Exclusion

- Keep all doors and windows closed during the day, and repair any broken or missing screens and door sweeps.

## Prevention

- If flies are known to enter via doors in a specific area, install fly traps or air curtains. Fly traps should not be visible from the exterior, which will prevent attracting flies inside. Air curtains should blow out, preventing flies from entering a building.

## Mechanical Control

- If fly populations are low enough, remove flies mechanically with a fly swatter.

## Pesticide Control

In most situations, non-chemical means of control, i.e. sanitation, exclusion, and elimination of breeding sites, are sufficient to obtain control of flies. Occasionally circumstances may warrant the need for chemical use.

- **Microbial enzymes:** Gel substances can be used in drains to eliminate organic material that has built up and is providing a breeding ground for flies.
- **Fly bait:** Baits can be sprayed or painted onto a surface near an existing fly population. Baits should be used to rid the area of current flies, and then removed to prevent attracting additional flies to the area.
- **Traps:** Fly traps can be visual, pheromone, or baited. Traps can kill, capture, or capture and kill flies.
- **Aerosols:** Non-residual aerosols can be used for small localized treatments as a quick knock-down. This is only a temporary fix, and should not be used as a means of long-term control.

<b>House Fly/Filth Fly Action Threshold</b>	
Classrooms and Public Areas	Five (5) per room
Medical Facility	Two (2) per room
Kitchen	One (1) per room
Maintenance and Storage Areas	Five (5) per room
Grounds	Ten (10) per trash can; Twenty (20) per dumpster
<b>Drain Fly Action Threshold</b>	
Classrooms and Public Areas	Five (5) per room
Medical Facility	Three (3) per room
Kitchen	Three (3) per room
Maintenance and Storage Areas	Five (5) per room
Grounds	N/A



Cigarette Beetle



Confused Flour Beetle



Dermestid Beetle, top view



Drugstore Beetle



Ground Beetle, Carabidae

## Ground Beetles

Ground beetles are variable in size, shape and color. They can be found worldwide, and are generally considered beneficial insects due to their predaceous nature. Beetles undergo complete metamorphosis, with an egg, larva, pupa, and adult stage. Ground beetles overwinter as larvae or adults. The eggs are laid in the soil, and the developing larvae and pupae complete development in the soil. Adults are typically nocturnal, and can be attracted to light.

Eggs are small, oval, and lightly colored. The larvae are long, have large heads, and sickle-shaped mandibles that point forward. Pupae appear similar to other beetle pupae, and have a wrinkled appearance. The adults have hard wing covers that have ridges.

## Inspection, Exclusion, Monitoring

Control is generally not necessary. Although large amounts can be present seasonally, they die off on their own, and cause little to no damage. They are more of a nuisance pest.

- Beetles that are found indoors can be swept up and brought outside.
- Determine how they are accessing the building, whether it is around pipes, in windows, or under doors.
- Determine if the beetles are attracted to a particular food source, such as large populations of armyworms, snails, or slugs.
- Reduce light, or change the light bulbs from white and blue LED to yellow lights on the exterior of buildings to reduce attraction.
- Monitor beetle movement by using sticky traps around doors, pipes, and windows.



Ground Beetle, Carabidae



## Mosquitoes

Of the approximately 167<sup>50</sup>-176 species of mosquitoes that exist in the United States<sup>51</sup>, three genera, *Aedes*, *Culex*, and *Anopheles*, are considered medically important. These pests can be divided into two categories; nuisance species and vector species. Most mosquitoes are simply nuisance species. They may bite voraciously or be present in large numbers, but carry a low risk of transmitting a disease. Species that fall under the vector category, however, should be taken more seriously for their ability to transmit diseases to humans and animals.



Aedes Aegypti, Male



Aedes Aegypti, Female

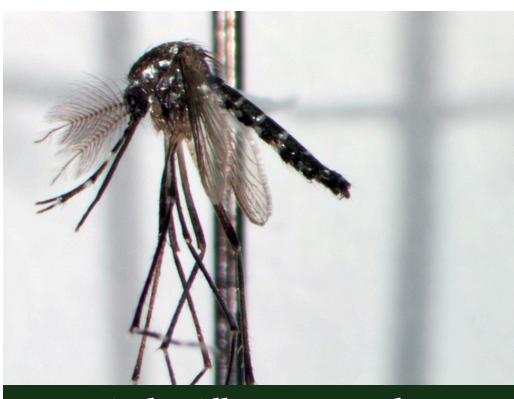
Adults are the most commonly encountered life stage of a mosquito. They are delicate, have two wings that are covered in small scales, long legs, and long mouthparts. Females differ from males in that their mouthparts are adapted for piercing the skin for a blood meal, while male's mouthparts are evolved for sucking plant juices. Almost all female mosquitoes require a blood meal for added nutrients, which allows them to reproduce. Males do not require a blood meal, and do not bite<sup>52</sup>.

Depending on the species, females may lay eggs singly, or in batches of eggs called rafts. Mosquitoes undergo complete metamorphosis. The egg develops into larvae, also known as a wriggler<sup>53</sup>, which is characterized by their worm-like appearance. Most larvae feed on organic material, but a few are predaceous. They have special brush-like features around their mouths that they use to strain and filter out small particles of plant and animal material<sup>54</sup>. After several molts, larvae develop into pupae, also known as tumblers<sup>55</sup>, which are characterized by their comma-shaped body. Pupae do not feed, but are active and present at the water surface. It is important to distinguish between the life stages in order to determine the best means of control.

Male mosquitoes typically begin to fly over a swarming arena prior to females joining them<sup>56</sup>. When the females emerge, the adults will quickly mate, after which the female appears to be unresponsive to males' attempts to mate<sup>56</sup>. Most mosquitoes feed at dawn and dusk, and spend the day resting<sup>57</sup>. The blood meal females seek is integral because it is in this time that she can acquire and transmit microorganisms to her host. Most viruses that people become infected with do not drastically affect their health. However, even when symptoms do not exist or are mild, secondary infections, allergic reactions, pain, irritation, redness, and itching may occur. Mosquitoes can breed and develop any time from spring to fall, with populations being highest in summer.



Aedes Albopictus



Aedes Albopictus, Male



Aedes Albopictus, Female



Anopheles Quadrimaculatus

and early fall. Depending on the species, temperature, and rainfall, there can be multiple generations per year.

Integrated pest management in mosquitoes is driven by surveillance, source reduction, control, and public education. All normal means of exclusion (light reduction, screens over windows, air curtains) apply to this insect. Prevent the insect from entering a building, and prevent part of the problem. To prevent mosquitoes from biting, encourage people to wear pants, long sleeved shirts, and insect repellents.

## Sampling

- **Surveillance:** Surveillance is an integral portion of mosquito management; without it, you cannot determine whether control is justified. Surveillance is accomplished by sampling for both immature and mature mosquitoes. It can reveal which mosquito species are present, which can determine which diseases have the potential to be passed to the populace. If it is determined that control is needed, continued surveillance can gauge the effectiveness of the treatment.

Sampling should take place at least once a week, and always on the same day, at the same sites, and at the same time. Counts of species, sex, and life stage should be recorded.

- **Larval Dipping:** Dippers can be purchased or made. A dipper is a cup attached to a long handle. Quickly and smoothly scoop up larvae and pupae. Do not cast a shadow over the area you are dipping in, or they will dive to the bottom. Dips are typically taken in multiples of ten: five from open water, five from the water's edge. When taken near vegetation, dips are more likely to contain specimens.

- **Adult Trapping:** Light traps and carbon dioxide traps are the most common types. Light traps run from dusk to dawn, and need a power source. They can be supplemented with dry ice, which provides carbon dioxide. Traps contain either a fan or a funnel that leads the mosquitoes to a kill jar. Traps are set in the evening and collected in the morning.

## Prevention

- **Source Reduction:** Source reduction is the first stage of control. If it is not possible to execute, or does not control populations, more tactics can be employed. All mosquitoes

require water for development. The first components of reduction is to fill low spots of ground where water can collect, drain pots or artificial containers where mosquitoes can breed, fix leaky pipes, etc. Source reduction controls all life stages of mosquitoes by eliminating breeding sites. If storage ponds or drainage ditches are located near a building, control may be necessary.

## Control Mechanisms

Biological control via mosquito eating fish, *Gambusia affinis*, is an option for standing water. The water must be deep enough to be able to sustain a fish population. These fish should be introduced only when they can be properly managed and will not displace or outcompete native fish.

*Bacillus thuringiensis israelensis* is a bacterium that is known to kill mosquitoes and several fly species. It is available in granules, briquettes, or powder form, and is not hazardous to humans, animals, fish, and most other insects. This product is consumed by larvae, and not effective against late stage larvae and pupae which do not eat.

Predators, such as birds, bats, amphibians, and other arthropods, naturally help control mosquito populations, but will not eliminate them. Encourage predator survival in areas where mosquitoes are known to breed.

Petroleum and mineral oils can be used to create a thin film of oil over the surface of a body of water. Eggs, larvae, and pupae will suffocate if the oil is not broken up by choppy water or rain.

When populations of adults explode, space spraying for adults can provide a quick knockdown in high profile areas. This control is temporary, and will not kill developing mosquitoes. This control should only be used as a last resort. It also will not prevent other adult mosquitoes from entering the area.

## Education

Public education is integral in mosquito control. Persons on campus should be aware that mosquitoes exist in the wild, and that it is impossible to completely prevent mosquitoes from existing on campus. Instead, persons should know to take precautions against being bitten. Long pants and sleeves deter mosquitoes from biting. Cleaning up refuse around buildings that can collect water and where adult mosquitoes can rest will prevent their existence around a building. Wearing insect repellent while outside and reapplying when outside for over four hours can prevent bites, as can sealing buildings and placing air curtains around building entrances.



Pillbug

## Pillbugs and Sowbugs

Pillbugs and sowbugs are not actually insects, but rather isopods, which are categorized within Crustacea. They are crustaceans that are adapted to living in terrestrial habitats, and spend their entire lives on land. They do not have wings, are gray to brown colored, oval-shaped, and have bodies that look like overlapping armored plates. Although typically found outside feeding on decaying organic matter<sup>40</sup>, they can be occasional pests if found indoors near sources of water. Generally pillbugs are beneficial to the ecosystem for their ability to break down organic material. Pillbugs are also commonly known as “rolly-polys,” for their propensity to curl tightly into a ball. Sowbugs, or “woodlice,” can be distinguished from pillbugs in their inability to assume this position, and for the two tail-like projections at the end of their bodies.

Both pillbugs and sowbugs are most active at night, move slowly, and can be found near moisture<sup>41</sup>. They can readily be found under rocks, logs, leaves, trash, and vegetation, in topsoil, mulch, and grass clippings. Without moisture, they will quickly die.

## Inspection and Mechanical Control

- These occasional pests are indications of excess moisture and a need for more complete exclusion. Focus attention on how they are accessing the interior of a facility. Seal cracks and crevices, replace door sweeps, and seal around drains.
- On the exterior, aerate mulch by raking, don't overwater plants, clean up debris around the facility, and fix water leaks.
- Individuals that do make their way inside can be swept up and removed.

## Rove Beetles

Rove beetles are rarely a pest in buildings; however, unique circumstances came together in 2015-2016 in new residence halls that were built on campus where they became a profound pest. Physical characteristics of this pest include slender, flexible bodies, and short elytra, which allow the insect to enter narrow crevices. These attributes render the insect prone to desiccation, and they are therefore largely dependent on humid habitats.

The residence halls where the beetles became an issue opened in 2015 and were built using carton form construction. Construction at this site was hampered due to heavy late spring/early summer rains. The first floor of all buildings flooded, resulting in sheetrock and walls needing to be cut out half way up the wall and replaced. It is possible that the beetles began breeding and exploiting the carton form, which is made out of corrugated paper, and were unnoticed during early construction.

Pipes for plumbing penetrate the substrate, which allow access to the void below the slab where the carton forms are located, before running into the base substrate and switching to lateral movement. Although concrete is poured on top of the carton forms, a void area exists around the pipes that run perpendicular to the slab. It is likely that if the rove beetles were breeding in the carton form, they then had access to buildings via plumbing. The beetles were concentrated in bathrooms where drains and pipes run up through the floor for the shower, toilet, and sink, supporting this hypothesis.

Due to the excessive amounts of beetles present, chemicals were immediately used in attempts to rid these buildings of pests. After three separate chemical applications, which were spread out over three months, and included all bathrooms and kitchens on the first floor of all three facilities, control was achieved. The entire process is documented for the monitoring and pesticide applications, and the literature is available for review. Contact the IPM coordinator to be directed to the articles.



Scorpion

## Scorpions

Scorpions are not insects, but Arachnids. They live in a variety of habitats, but in the United States they are most readily found in southern states. They are easily recognized for their pincers, eight legs, and long tail that end in a stinger<sup>58</sup>. Scorpions cannot see well, and rely on sensations to navigate<sup>58</sup>. Scorpions can range in size, color, and longevity. All scorpions are considered beneficial creatures because they prey on, and help control insect and spider populations. Large scorpions are known to feed on insects, spiders, and rodents<sup>59</sup>. They generally hunt at night, and may use their stinger to paralyze prey<sup>58</sup>. Scorpions are mostly nocturnal creatures, and hide during the day in woodpiles, under loose bark on trees, or under rocks and other debris. Occasionally they may enter homes while searching for water or a place to hide. When this happens, they can typically be found in cool, dark areas in kitchens, bathrooms, crawl spaces, etc.

Of the many species found in North America, only one is typically considered medically important for its sting: the bark scorpion. Antivenin may be necessary in extreme measures where a person reacts violently to a sting. The bark scorpion is characterized by the way they hold their tail and stinger at rest. Rather than holding the tail upright over the body, bark scorpions hold their tail curled to the side. Bark scorpions are also unique in that they can be found in gregarious groups known as a hibernacula, rather than being solitary like most scorpions.

## Inspection, Exclusion, Sanitation

- Scorpions can enter buildings via cracks, crevices, and gaps. Maintain areas around pipes and plumbing, replace door sweeps and door thresholds as their integrity is compromised, adhere windows to frames, seal cracks, crevices, and gaps. Caulk around eaves of buildings, and check if window screens are torn or unattached to the frame. Inspections can be supplemented by inspecting the interior and exterior of a building at night while shining a blacklight<sup>60</sup>. Scorpions glow under black light, so if they have been found in a building, but you are unable to determine entry points, track them using this tool, and carry a caulking gun to seal holes that you find.
- Seal weep holes with copper mesh, and place screens over ends of pipes.

- Place sticky boards around doorways to track scorpion movement.
- Reduce or replace outdoor lighting that may attract insects to an area. Outdoor lighting should be yellow bulbs rather than blue or white which can attract insects. Scorpions are predators, and are more prevalent around food sources.
- Remove harborage areas outside of the building. Clean up trash, piles of wood, building materials, and loose piles of rock. Prune back branches and bushes from the building; both can provide access to roofs, and can harbor scorpions.
- Use caution when removing a scorpion from a building. These are beneficial pests, so when possible, the scorpion should be caught and relocated. Place a jar over the scorpion and slide a piece of paper under the lip of the jar to remove it, or pick it up using leather gloves and tongs. If a scorpion stings someone, and the specimen must be identified for medical purposes, drop the scorpion in a jar of alcohol or soapy water to kill it.

## Pesticide Control

Pesticides are an ineffective means of controlling scorpions, and the products used could have off target effects. Scorpions hide in cracks, crevices, and under brush and debris during the day, making it difficult to determine where to most effectively spray. Adult scorpions have a thicker cuticle, and may not be affected as drastically as a young scorpion. If they must be used, they should be applied to the exterior walls as a perimeter barrier, or around potential entry points such as window eaves.

Scorpion Action Threshold	
Classrooms and Public Areas	Two (2) occurrences in the same area
Medical Facility	One (1) per room
Kitchen	One (1) per room
Maintenance and Storage Areas	Two (2) occurrences in the same area
Grounds	N/A unless an exterior treatment is necessary to deter them from entering a building



Black Widow Spider

## Spiders

Spiders are a common nuisance in and around buildings, and often elicit pest control requests. Although there are many different kinds of spiders that can be found in Texas, it is important to note for pest control purposes that all spiders are predatory<sup>47</sup>, and either passively hunt by catching food within their webs, or hunt and stalk their prey. The majority of spiders are considered beneficial due to their assistance in controlling insect pests. Typically, the more insects present in an area, the higher the chance that spiders are present<sup>47</sup>. Spiders are also more likely to be found after rain<sup>48</sup>.

Spiders resemble insects, but have only two body segments, and eight legs rather than six. Spiders do not have wings or antenna. Their colors and size can vary dramatically, and they can be hairy or smooth bodied<sup>49</sup>. Many spiders have venom, which is used to subdue and kill their prey; however, most spiders prey on arthropods<sup>49</sup> and will not bite humans unless disturbed. Spiders most commonly cited for their toxic venom are the black widow and the brown recluse.

## Inspection, Exclusion, Sanitation, Monitoring

As previously mentioned, most spiders are beneficial, and thus ones located outside buildings which are not harming or disturbing people should be left alone.

- Inspect the building for cracks and crevices that spiders can use to gain access to a building. They can hitch a ride on boxes, wood, and plants, crawl through cracks and crevices, enter through unsealed windows, or walk under doors that lack proper door sweeps. Seal all access points. Preventing spiders from accessing buildings will also prevent many other insects from entering. Without a potential food source, spiders will be less attracted to an area.
- If items must be stored, seal boxes properly with tape, or place items in pest proof containers. Remove unnecessary clutter.
- Identify areas that spiders are attracted to, such as dark corners and undisturbed debris. Vacuum and sweep corners of rooms, vacant areas, storage places, accessible wall voids, attics, and basements. Knock webs down with a broom, or vacuum webs with a vacuum hose attachment. Kill spiders

that are knocked down with a shoe, broom, or by vacuuming, or remove them using a glass and piece of stiff paper.

- Place sticky traps near access points, such as windows and doors. This can help determine if spiders are accessing the building via potential entry points, and can help determine if additional exclusion and chemical treatment is needed.
- Exterior lights are typically positioned near entrances/exits to buildings. Although this can help people feel safer and reduce accidents, it allows for more insects to be attracted to areas where they can access the interior of a building. On the exterior of buildings, manage lighting by replacing bulbs with yellow lighting rather than blue or white lighting. Insects have a harder time seeing this range of light, and if fewer insects are attracted to the area at night, fewer spiders will be attracted as well.
- On the exterior of buildings, keep the areas surrounding a building free from debris and clutter. Remove trash and organic build-up such as leaves and grass, and regularly knock down spider webs.

## Pesticide Control

Pesticide control is rarely effective or accurate for spiders. Efforts for control should be concentrated on sanitation, prevention, and exclusion. However, in sensitive areas, or under rare circumstances, pesticides can be used to control spiders.

- **Dust:** Dust cracks, crevices, under baseboards, and in wall voids. Dusts can dry spiders out, and remain viable for months after application.
- **Liquid and Aerosol Control:** Liquid and aerosol pesticide applications can be effective in areas where spiders and egg sacs are present. Always read and follow the pesticide label.

Spider Action Threshold	
Classrooms and Public Areas	Three-five (3-5) spiders per room
Medical Facility	One-three (1-3) spider(s) per room
Kitchen	Two (2) spiders per room
Maintenance and Storage Areas	Three-five (3-5) spiders per room
Grounds	N/A

## **Stored Product Pests**

Although the majority of TAMU campus is classrooms, labs, and residence halls, there are researchers who use grain products for animal feed, food storage for on campus dining, and many kitchens in residence halls and departmental kitchenettes that can all acquire stored product pests. Stored product pests most commonly include beetles and moths. These pests can become an issue in warehouses, rooms, and closets where products are stored, in kitchen pantries at dining facilities, in pantries and cupboards in department kitchens, personal residence kitchens, and occasionally in museum artifacts.

Two common types of stored product pests are the confused flour beetle and the red flour beetle. They are similar in appearance and have shiny reddish-brown bodies<sup>36</sup>. They can feed on many different food sources<sup>37</sup>. The female lays her eggs, which have a sticky secretion<sup>36</sup>, around or in flour or other food. Beetles undergo complete metamorphosis, and have four distinct life stages: egg, larva, pupa, adult. Larvae of these pests have few hairs, and have creamy white bodies.

Two other common types of beetle pests in stored products are the drugstore beetle, and the cigarette beetle. These two pests are similar in appearance, with cylindrical, oval, light brown colored bodies<sup>38</sup>. The cigarette beetle, which is more commonly found than the drugstore beetle, has smooth wing covers, whereas the drugstore beetle has wings with longitudinal grooves. Both will feed on most any available food source. Their larvae are small, white, and difficult to detect.

The Indian meal moth is a small moth, with a brown head and thorax, gray on the first half of the wings, and coppery with dark bands on the second half of the wings. The larvae are cream colored with brown heads<sup>39</sup>. The larvae spin silk from their mouthparts as they move, and when populations are high, can cover the top of food with their silken webs. Pheromones can attract flying moths, and are an effective monitoring tool in susceptible areas.

Carpet beetles, or dermestids, are typically not considered a stored product pest, but can be found on dried meats and skins<sup>37</sup>. They are mottled colored with yellow, white, orange, and black spots. They are responsible for textile damage, but can be found on carpets and rugs, around furniture, in mounted animals and birds in museums, and in bird nests. Their larvae are short and dark, and have dark bristly hairs.

All stored product pests are an unsightly nuisance. They damage food by contaminating it with their bodies and waste material, and can compromise the smell and taste of food. Secondary contamination can occur from these pests introducing bacteria and microbes into the food.

## **Inspection, Sanitation, and Monitoring**

Eliminating a building or residence of stored product pests is time consuming and requires persistent monitoring. The areas infested must be evaluated for how effectively they are being cleaned; unless the area is rid of the pests, it can be subject to re-infestation.

- Evaluate all food products for contamination. All infested food must be thrown out immediately.
- All remaining food must be stored in airtight, pest proof containers, or in a refrigerator or freezer. All food should be checked regularly for infestations that were overlooked. Food products that were open when

the pest presence was detected are more susceptible to pests than unopened products.

- Do not combine old and new food products. If one of the sources is contaminated, combining them can spread the infestation to other food.
- Clean containers prior to placing food inside.
- Vacuum and wash all storage cabinets and surrounding areas where pests were detected.
- Depending on the stored product pest detected, there may be a pheromone trap available. These traps attract pests to containers that typically have a sticky pad that the pests are then trapped on. Some traps only attract males. These traps can still be effective if they capture enough males so that the females do not have a mate. Check traps regularly, and reevaluate food sources for pests when trapped pests are present.
- Keep areas around food dry. Insects are attracted to moisture.
- Check surrounding areas for rodent and bird nests. Remove them if found. Pests can breed in these and migrate out to new areas.
- For dermestid beetles, regularly check mounted animals and animal hides. If possible, vacuum animal hides, or periodically place them in a freezer for several days to kill possible pests.

## Pesticide Control

Stored product pests can almost always be controlled using exclusion, elimination, and sanitation. However, you may occasionally need to apply a pesticide to control a stored product pest, such as the carpet beetle. If pests are being harbored in void spaces, apply a dust to the area. When this is not possible, various products can be sprayed as spot treatments beneath rugs and furniture, along baseboards, or around cracks and crevices. These should only be used in conjunction with sanitation, exclusion, and product elimination.

Stored Product Pest Action Threshold	
Classrooms and Public Areas	N/A
Medical Facility	One (1) per room
Kitchen	One (1) per room
Maintenance and Storage Areas	Five (5) per room
Grounds	N/A

## Termites



Soldier and Worker Termites



Winged Termite

Termites are the most important structural insect pest in Texas. They are social insects that live in a colony with three separate castes, or divisions. The reproductive caste is comprised of three different subtypes: primary, secondary, and tertiary reproductives.

Primary reproductives have wings, and are called alates. They have two pairs of wings, but after a short flight, the wings break off near the base. Their bodies are dark-colored, flattened, and they have large eyes. The queen has a large distended body, and can produce thousands of eggs depending on colony age, species, and size. Primary reproductives are responsible for the majority of egg laying in a colony. Primary queens can live many years and lay thousands of eggs a year. Secondary/second-form (more formally called neotenic or nymphoid) reproductives develop under certain conditions, i.e. when the king and/or queen die, or if the colony becomes too large, or if part of the colony is separated from another part. Secondary reproductives have wing pads, but no wings, and cannot fly. Secondary females can assist the primary queen in egg production. Tertiary/third-form (formally called ergatoid) reproductives are wingless, have no wing pads, but in the absence of primary and secondary reproductives, can mate and lay eggs<sup>13</sup>.

Reproductives are most commonly seen while ‘swarming’ or ‘budding.’ Swarmers are typically understood to be winged reproductives that are going out to establish their own colonies, either passively and gradually, or accidentally and suddenly<sup>14, 15</sup>. However, budding does not necessarily produce a colony division, but rather can produce colonies that remain connected to one another<sup>15</sup>. A nest grows and matures prior to producing swarmers. Swarmers are poor fliers, and quickly shed their wings, find a mate, and burrow into substrate to begin reproducing. Subterranean termites, which are the most damaging structural pest in the state, primarily swarm in the spring<sup>16</sup>. The occurrence of swarmers does not necessarily indicate there is an existing population of termites in a structure. Swarmers could easily be from a colony adjacent to a structure, or in the surrounding area.

The second caste of the colony is called soldiers. Only a small percentage of a colony’s population is comprised of this caste. Soldiers have a similar appearance to workers, but differ in that their head is greatly enlarged and rectangular, reddish-brown in color, and contains large scissor-like mandibles. Soldiers are

the defenders of the colony. Their primary enemy is the ant<sup>17</sup>. Depending on species, they may have several specialized adaptations that can be used to defend the colony. Adaptations include enlarged head morphology, various mandibular weapons that allow for biting, reaping, and snapping, salivary weapons, and frontal gland and pore weapons<sup>17</sup>.

Workers are the last caste. What they lack in prestige, they make up for in numbers. Workers are eyeless, wingless, soft-bodied, and a creamy, translucent color. Although they sound harmless in comparison to the other castes, worker foraging and feeding activities are what cause actual damage to structures. Workers carry out all the work within the colony; they build and maintain the nest, collect food, feed, groom, and care for the other castes, find and eat wood, and maintain the galleries within wood.

Termite workers have microorganisms living inside their digestive tract. These protozoans and bacteria are what allow the workers to convert cellulose, an insoluble substance that plant cell walls are comprised of, into usable food. Workers feed other members of the colony via a process called trophallaxis. Trophallaxis is a process by which workers either regurgitates, or passes their partially digested food through their anus, and feed the soldiers and reproductives, who are not capable of breaking down cellulose.

There are three different types of termites; drywood, dampwood, and subterranean. It is critical to identify the type of termite in order to determine the best means of control. Depending on the county within the state of Texas, there are different codes set for pre-treatment of building and construction sites for termites.

## Inspection

- Because most termites are prone to desiccation, the workers seal the colony off from arid conditions. This makes detecting a colony presence difficult. Presence of swarmers, mud tubes, or frass near a building is typically the first

indication of termite presence. Specimens should be collected and identified to the genus or species.

## Communication

If the termites are subterranean or dampwood, moisture must be nearby in order for them to survive. If termites have been found in an area, or if the area is prone to termites, moisture issues must be resolved. Building Maintenance must repair water leaks, including faucets, pipes, and air conditioning units. Gutters and downspouts must be cleaned yearly to prevent them from becoming blocked. Water should be diverted away from a building. Do not let water pool next to a building.

## Exclusion

- Seal around entry points such as pipes and drains.
- Do not have plants directly next to a building. Wood structures should not touch the soil, and wooden decks and fences should be checked regularly for damage. Arrange for tree stumps and wooden debris near structures to be removed, and do not allow lumber and waste products to accumulate near structures. Place screens over vents and place inserts into weep holes to prevent access into buildings. All cracks and crevices that are possible entry points to buildings should be filled.
- If a building is going to be constructed, there are several different options for protecting a structure prior to the construction beginning. Chemicals can be applied as a pre-treatment, and there are multiple forms of prevention/exclusion that can be utilized through companies such as Polyguard®.

## Pesticide Options

If termites are found despite prevention practices

being fulfilled, different control options can be evaluated for use.

- Baits:** Due to the social colony structure and known feeding practices of trophallaxis, baits can be an effective means of controlling termites. Additionally, there may be times when liquid pesticides cannot be applied around a structure, or where baiting may be deemed more effective. Baiting may be a better option if there is a drain, or cistern around the structure, if ducts are located under or in a slab, if applying a liquid pesticide would require extensive drilling into finished walls/floors, or when liquid pesticide applications are prohibited by law. In all situations, the label on a pesticide is the law. Baiting is a long-term approach to termite control. It works on the premise that the bait, which can be made out of sawdust, paper, or wood, and treated with a pesticide, is found by foraging termites. There is no way to determine when a termite will find the bait station, or even if the foragers will find the bait. However, the bait is placed out around the building, and in areas of suspected termite activity, which can increase chances of workers coming in contact with the station. Once the bait is found, worker termites will bring the bait back to the colony and share the pesticide via trophallaxis. It may take days, weeks, or even months before a substantial amount of the colony is killed by the pesticide. Baiting is a year-round program that must be maintained regularly for best results.

- Liquid Pesticides:** The same pesticides that can be used as a pretreatment prior to constructing a building can also be used later if termites are found on or in a facility. Liquid pesticides are used as a preventative measure, or a protective measure. If used prior to construction, they are a preventive measure. If used as a protective measure, the area of a building which is infested with termites is trenched and, if needed, drilled, before being treated with a pesticide. The pesticide acts as a blanket, killing the termites which are actively infesting the structure, or by stopping invading termites from causing damage. If the termites are inside and need access to the soil on the outside, or under the structure, the pesticide prevents their return, and the termites can die from dehydration. Liquid pesticides can either be repellent or non-repellent.

## Evaluation

If a baiting system is being used, stations must be regularly checked. If pesticides are used for control, a contract will be established between SSC Pest Management and the facility, or a subcontracted pest control company and a facility, which holds the company who performed the treatment liable for a certain number of years to retreat the facility if termites are found again.

Termite Action Threshold	
Classrooms and Public Areas	Presence of mud tube
Medical Facility	Presence of mud tube
Kitchen	Presence of mud tube
Maintenance and Storage Areas	Presence of mud tube
Grounds	N/A unless trailing into building

## ANIMAL PEST CONTROL

Occasionally wild animals will take up residence near or under a building, or are seen foraging near a building on a semi-regular basis. When this occurs, Pest Control receives a work order to remove the animal. Unless the animal is located within the building, Pest Control sets a cage trap of approximate size 10 x 12 x 36 inches, baited with an appropriate attractant, and checks the trap each morning for activity.

Several of SSC Pest Control staff hold certifications/licenses in Safe Capture/Release, and Euthanasia. These licenses were obtained through Safe-Capture International for Safe Capture/Release and Texas Academy of Animal Control Officers for Euthanasia. Although these licenses allows staff to perform duties associated with Safe Capture/Release and Euthanasia, SSC Services for Education does not currently practice either, has not obtained much of the needed equipment for performing these duties, and is not currently moving towards these activities at this time. If the need arises, SSC may move in this direction for the future.

### **Armadillos**

Armadillos rarely present a problem. They are excellent diggers, have poor eyesight, and have an excellent sense of smell. They are typically active dusk to dawn, and burrow in or around stumps, rock piles, and brush. They are beneficial in that they feed primarily on insects, earthworms, scorpions, spiders, and organic matter. Occasionally they are a nuisance due to their foraging, digging, and burrowing behavior. They are believed to transmit the leprosy bacterium. Cage trapping is most effective when long boards are used to funnel the animal into the cage. Remove harborage to discourage their presence, and control insect populations near a building to prevent foraging.

### **Opossums**

In urban environments opossums can be found in attics, garages, under buildings, and in maintenance sheds and storage facilities. They eat a variety of foods, such as insects, earthworms, and plants, but can also feed on rodents, snakes, snails, birds, and frogs. They will also scavenge in garbage's, and feed on pet food. They are capable of transmitting diseases, including rabies and murine typhus. To discourage their presence, keep garbage's secure, ensure that garbage lids fit tightly, and seal/cover access points into buildings.

### **Raccoons**

Raccoons are common in urban environments, and can be found foraging and damaging attics, small structures, maintenance sheds, and storage facilities. They are omnivores and will make a meal out of almost anything that is available. They are capable of transmitting diseases such as rabies, distemper, and mange. Discourage their presence by screening chimneys, attics, and around foundations of buildings, and keep garbage's securely closed. Raccoons are best removed by cage trapping.

## **Skunks**

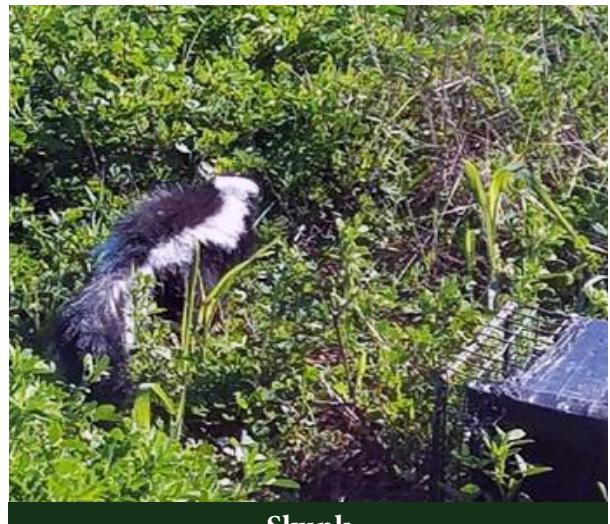
Skunks are shy animals that can spray musk from their anal glands when provoked or scared. They are generally considered beneficial because they feed on grubs and insects, but can be a nuisance when they feed on vegetation and garbage. They are rarely found indoors, but will take shelter under buildings, in sheds, and hollow trees. Skunks can transmit disease, and are a primary source for rabies. Safe capture and removal are integral with this animal. It is advised to use a cage trap that is covered in a material that allows air movement, but that can help block musk if a skunk sprays. Skunks are also less likely to spray when enclosed in a dark area. If the skunk does spray, use odor eliminators to mask or eliminate the scent.

## **Squirrels**

Tree squirrels can become a pest when they nest in attics and eaves, or eat vegetation and fruit. Squirrels nesting in buildings can cause damage to wood, insulation, and wiring. Squirrels typically enter a building by climbing on power lines and tree limbs that overlap a roof, and entering through an existing hole in the building. Squirrels are not linked to transmitting rabies, and generally pose little threat to humans. Squirrels can bite or scratch when provoked. Squirrels are more likely to carry ticks and fleas into a building where they nest. Exclude them from a building by screening vents and other openings. Prune back vegetation that can allow squirrels access to a building, and set a cage trap when necessary.



Opossum



Skunk



Bat

## Bats

Of the approximate 30 known bat species that are found in Texas<sup>66</sup>, the Mexican Free-Tailed bat, *Tadarida brasiliensis*, is the species most commonly found on the TAMU campus. The typical perception of bats is that of small, scary, fast moving, flying animals, that can spread rabies when they bite people. However, the TAMU campus and SSC is working towards changing this perception towards seeing bats as what they truly are, beneficial mammals that are excellent insectivores.

Bats can live and roost in a variety of places, including trees, caves, under bridges, and in buildings, and may return to roost in the same place year after year. The Mexican Free-Tailed bat is a migratory bat that spends the winter months in Mexico and typically returns to the Bryan/College Station area in March.

The Mexican Free-Tailed bat is a gregarious mammal that can be found in large colonies. Because of their social nature, they can become a nuisance from the sounds they emit, the odor of their urine and feces, and the odor from their oily rub marks that are produced from landing on surfaces, or squeezing into tight entrances/holes. Bats are also notorious for their association with rabies. Although the incident of infection is low, and bats rarely attack humans unless picked up or provoked, bat bites should always be treated as a potential for infection.

## Exclusion

Exclusion and bat proofing are keys to eliminating bats from roosting in buildings. The majority of exclusion work on TAMU campus has been contracted through larger pest control companies that have the means and manpower for carrying out large exclusion jobs. Please speak with the IPM coordinator for more details.

Bats may enter a building through open windows, doors, chimneys, and ventilation units, but they can also enter buildings through eaves and loose flashing. They do not require large openings, and can squeeze into cracks ~3/8" wide. If possible, exclusion should begin before bat proofing. Exclusion consists of hanging netting over entrance points, adhering netting to the area around the entrance, and placing cones in strategic points to allow bats to exit but not reenter the building. Large openings should then be covered with sheet metal or hardware cloth, while small openings should be sealed with a suitable material.

## **Chemical Repellent**

When attempting to seal off an open area where bats are roosting, naphthalene, a chemical repellent, can be used. Naphthalene is only effective for a limited amount of time; it is odorous and excites bats to leave their roost, but leaves no residual, and once the odor dissolves or is ventilated, the bats can return.

## **Education**

Students, staff, and visitors to the TAMU campus should be educated on the importance of bat conservation. When a bat is found indoors and is alive, SSC Pest Control should be contacted to remove the bat. It is a requirement that all workers on staff in Pest Control received the rabies vaccination, and are trained in removing bats safely. When persons come in contact with a bat, the bat must be collected for rabies testing, and person(s) affected must give their contact information. If the bat tests positive for rabies, the person(s) who came in contact with the bat must be advised to see a doctor for potential treatment. If the bat cannot be recovered, person(s) who came in contact with the bat are advised to seek medical attention. Bats are protected animals, and must be handled ethically and with care.



Bird Spikes

## Birds

Only a few species of birds are considered a pest in Texas. Birds are primarily an issue due to their roosting, defecating, noise, odor, and potential to spread disease and introduce secondary pests to an area. As many as 60 different diseases have been associated with birds and their droppings<sup>65</sup>. Excessive amounts of birds can become a health hazard due to their droppings. Droppings can also attract other pests and damage paint on vehicles.

It is important to determine what species of bird is present to determine whether the bird or the birds nest can be removed. Removing nests that contain eggs or young birds that are wild, native, non-game species is illegal under the Migratory Bird Treaty Act of 1918.

## Exclusion

Exclusion is the simplest and easiest way to prevent birds from roosting in an area. Buildings should be sealed by placing screens over openings, grates, and in eaves of buildings and on the undersides of staircases. Shock tracks are an optional form of exclusion in areas that birds tend to stand and rest. They use a low powered charger unit or solar charger to give off a pulsating electrical shock when birds land on the track. These can be used on window ledges, roof top ledges, and hand rails where birds tend to rest. In areas over lights, sprinkler heads, on top of pipes, and along ledges in low profile areas, porcupine bird spikes can be strung or adhered. These spikes range in size, and prevent birds from landing and roosting.

## Mechanical Control

When preventive measures have taken place, and birds are in the area, but have not laid eggs in the nest, the nests can be removed by knocking them down with a pole or broom. Performing this act several times a week in areas where birds are persistent, and where exclusion does not work can frustrate birds by their inability to build a nest and lay eggs. Eventually the birds will give up and move on to a different place. Areas where birds are building nests should be power washed or hosed down to remove feces and nest residue.

## **Deterrents**

Visual deterrents that are available include noise machines, fake birds or snakes, and flashy items that catch sunlight. Noise machines can either be on a timer, or can be produced by people. Different companies can be contracted to routinely scare birds off from an area of high traffic. Noise is not recommended in areas where it would be a distraction, or an auditory nuisance. Fake birds and snakes, or other predators, can be purchased. They can be effective during the beginning of a bird migration, but can quickly lose their scare tactic as birds become accustomed to seeing them. Flashy items, such as CDs, wire, ribbons, and tape, can provide a temporary relief from birds, but these items do not provide long term control, and birds will lose their fear of these deterrents quickly.

## **Bird Misters**

In areas where exclusion is ineffective or not feasible, and where other physical or visual deterrents do not work, installing a bird misting system may be an effective option. Bird misters release a food-grade bird repellent called Methyl Anthranilate. When birds fly through the mist, their mucus membrane becomes irritated. It does not kill birds, and causes no off-target issues, and gently displaces birds that might have nested in the area.

## **Education**

Education is the last component of bird management. If birds are present in the area, ensure that people are aware to keep windows and doors closed to prevent birds entering a building, to report birds that are building nests to custodians in the area, and to attempt to identify the species of bird nesting to prevent improper removal. If birds are being fed in an area, ask people to stop feeding birds to prevent more from flocking to the area.

## Cats

Feral cats can become a problem in urban environments when pet owners give up responsibility for their pet, or when stray cats are left to breed unchecked. In 1998, TAMU, which has one of the largest campuses in the US, was thought to have hundreds, if not several thousand, stray cats. A volunteer group of students, staff, and faculty formed the group Aggie Feral Cat Alliance of Texas (AFCAT) to find ways to check the growing population. AFCAT works to provide long-term management of feral cats by educating the campus and surrounding community, capturing cats, identifying cats, testing for infectious diseases, vaccinating cats, and spaying/neutering cats. AFCAT also works to connect cats that can be tamed with forever homes, and to feed and observe the cats present on campus. AFCAT is modeled after Stanford University's cat control program, and believes that their efforts have decreased the campus cat population to approximately 115 cats, many of which are commonly encountered and well known in their respective areas.

Occasionally cats are found in a cage trap that has been set for a different pest, such as a skunk. If cats are caught, AFCAT should be contacted to determine if they are available to take the cat for their monitoring purposes. The AFCAT coordinator and the AFCAT head veterinarian are both located in the Veterinary School on campus. They can be reached at 979-450-5467. Their regular work hours are from 8am-5pm Monday through Friday. If they cannot be reached, or are unable to remove/relocate the cat, University Police Department (UPD) should be contacted at 979-845-2345. UPD then contacts Animal Control on behalf of SSC Structural Pest Control. Once Animal Control has permission from UPD to be on campus, they will remove the cat if it needs to be relocated. If the cat is in an area where it can be re-released, the cat can just be let out of the cage.

All cats should be handled with care, particularly feral cats. Cats are capable of transmitting diseases such as cat scratch fever, parasitic, protozoan, and fungal infections, and viral infections, such as rabies.

## Rats/Mice

Rodents can be found ubiquitously across Texas and the world. Three primary pests that can collectively cause billions of dollars in damage are the Norway rat, roof rat, and house mouse. Each rodent has their own particular preferences and behaviors that characterize them, but generally they all can cause damage by visiting or nesting in a structure. Damage includes gnawing at building materials, chewing through cables and wires, eating food, contaminating areas with urine and feces, introducing secondary pests such as fleas, creating an entry for secondary pests by gnawing holes in a structure, and harboring and transmitting pathogens or disease.

Control is most readily achieved by identifying what type of rodent is causing the issue, and then responding appropriately. More in-depth information can be found in many resources, including the [Using Pesticides Commercial Applicator Manual Pest Control Category](#) created and published by TAMU AgriLife Extension. That and other resources should be referenced as supplemental material.

## Inspection

When a work request is placed for rodents, first determine where the rodent has been seen, and what might be attracting it to the area. Check for rub marks, fecal matter, urine, and chewed food or structural material. Attempt to determine where the rodents are entering and exiting an area. Look for pipes that give access to an area. Determine if rodent residue is old or new. Efforts should be concentrated where rodent activity is new. Rodents can easily climb up and down pipes, and are excellent jumpers. Look for garbage's that may not be removed regularly. Remove food and water sources.

## Sanitation

If you are unsure of whether rodents are currently present, have droppings swept up, floors washed, and clean up any residue from damage. Reassess the area regularly to determine if new droppings or damage is occurring. Wear personal protective equipment when working in areas that contain rodent droppings. Respirators should have a HEPA filter.

## Trapping

If rodents are in a building, set traps based on what type of rodent you believe is present. Choose bait and trap type/size appropriately. Rats are typically wary of new things in their environment and may avoid traps until they become used to their presence. Do not set traps over the weekend unless there is a special need for a staff member to be working.

## Exclusion

Rodents are best controlled using an exclusion program. All openings to the exterior should be sealed using

appropriate material such as sheet metal, hardware cloth, or cement. Begin trapping to remove rodents that are present in the area prior to beginning exclusion work, then seal entry points to prevent more rodents from accessing the area. In areas where rodents are difficult to control, products such as Liquitox and exterior bait boxes can be helpful.

## **Secondary Inspections**

All rodents are capable of transmitting diseases. As rodents are captured or killed, monitor and assess the area for pests such as ticks, and fleas. All areas where rodents were known to be present should be cleaned to remove droppings, and sterilized to kill potential pathogens.

<b>Rodent Action Threshold</b>	
Classrooms and Public Areas	One (1) per room
Medical Facility	One (1) per room
Kitchen	One (1) per room
Maintenance and Storage Areas	One (1) per room



## Snakes

There are few species of snakes in Texas that are considered poisonous. Snakes are not a commonly encountered pest, but occasionally they can become a nuisance in the spring when the temperatures rise and snakes emerge from their dens. They are most active in early morning, late evening, and at night. People can be frightened when they find shed skin of snakes, and become fearful of the presence of snakes. However, snakes are generally beneficial, nonpoisonous, reptiles that can help control rodent populations. They rarely bite unless provoked or surprised. Maintain your distance when in the presence of a snake, and wear sturdy boots when walking through tall grass in case you accidentally encounter one.

## Habitat Removal, Exclusion, Monitoring

Snakes find shelter in overgrown habitats, and are attracted to rodent populations, and cool, dark, damp, quiet areas of a building. To eliminate their presence, remove standing rock, lumber, and brush piles, keep grass short, remove vegetation or trim it away from buildings, and control populations of rodents that may attract snakes to the area. Seal entry points around plumbing, pipes, outlets, doors and windows to prevent snakes from entering buildings. On the interior of a building, place glue boards near entrances and pipes to monitor potential snake movement. Glue boards are also an effective means of tracking potential rodents or insect populations.

## Physical Removal

If snakes enter a building, contact SSC Pest Control to remove the snake. Snakes should be watched carefully. Staff should maintain their distance to monitor snake movement, and avoid provoking the snake. A Pest Control Technician will respond and remove the snake using approved equipment.

## Repellents

Chemical control is not registered against snakes except in the form of repellents. All repellents should be used in accordance with the label.

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## **INTEGRATED PEST MANAGEMENT PROCEDURE MANUAL**

SSC Services for Education  
600 Agronomy Road  
College Station, Texas 77843

Written by: Amanda J. Bakken  
Under the direction of: Bryan McGee  
Layout and Design by: Barbara Musgrove

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