CASA GRANDE RUINS NATIONAL MONUMENT

INTEGRATED PEST MANAGEMENT PLAN

June 2009

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INTEGRATED PEST MANAGEMENT PLAN

JUNE 2009

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EXECUTIVE SUMMARY

INTEGRATED PEST MANAGEMENT PLAN
CASA GRANDE RUINS NATIONAL MONUMENT

This Integrated Pest Management (IPM) Plan for Casa Grande Ruins National Monument (CAGR) in Coolidge, Arizona provides basic pest management guidelines to help preserve the stored cultural museum resources, structures and Monument grounds, and assist in protecting the health and safety of staff and visitors. As new information and IPM methods will develop over time, this plan should be reviewed and updated periodically.

The Superintendent is responsible for pest management at the site and designates an IPM Coordinator to implement the IPM Plan. The IPM Coordinator will work with Maintenance, Interpretive, Administrative and Resource Management Staff in the implementation as outlined in NPS-77 (Natural Resources Management Guidelines).

Any use of pesticides at CAGR will be in accordance with servicewide policies as found in NPS-77. All pesticides used will be applied by or under the direct supervision of an Arizona Office of Pest Management certified pesticide applicator. All pesticides used on the site by residents, contractors, special use permittees, agricultural issues, or non-NPS personnel will confirm to NPS policies and guidelines, and will be approved before use (on NPS IPM PUPS software). It is the goal of CAGR in compliance with NPS policy to use low-risk pesticides, if necessary, that will accomplish the desired objectives.

At the end of each year, the CAGR IPM Coordinator is to compile a list of the pesticides and quantity of each pesticide applied on the site and forward a copy of that report to the Washington Area Support Office IPM Coordinator.

Descriptions and low-risk pest management methods of museum and other pests potentially present in CAGR structures, displays and landscapes are provided. The Monument's main pest concerns are round-tailed ground squirrels and other rodents, and birds. Other pests including ants, bats, coyotes, feral dogs, snakes, spiders, termites, bees, flies, crickets, cockroaches and exotic plants are mentioned briefly. Preventive methods such as exclusion, sanitation and habitat modification are described, as well as direct actions such as trapping and the use of directed pesticide applications. Inspection and monitoring of pest populations and conducive conditions will determine the extent of pest presence and direct pest management actions.

The staff of Casa Grande Ruins National Monument is committed to the implementation of the IPM approach for those pests threatening the resources and the health and safety of staff and visitors.

INTRODUCTION

Casa Grande Ruins National Monument (CAGR) was established to protect and preserve monumental, earthen architecture dating to Hohokam cultural occupation. Archeological evidence indicates that the Hohokam people lived here during the Colonial Period (A.D. 775-950), Sedentary Period (A.D. 950-1150, and Classic Period (A.D. 1200-1500). The Hohokam had an agriculturally-based economy that utilized canal irrigation to raise corn, beans, cotton, tobacco, squash and other crops. The Casa Grande Great House is an excellent example of their accomplishments in architecture and engineering. The Casa Grande Great House was documented in 1694 by Father Eusebio Francisco Kino, the first European to do so. The Great House soon became a landmark for early Spanish travelers.

Casa Grande Ruins National Monument in Coolidge, Arizona encompasses a 480 acre section of land set aside in 1892 to preserve the ruin and surrounding area for its protection. Between 1906 and 1908, major excavations and repair work on the ruins was conducted. In 1918, it was placed under the protection of the National Park Service by President Woodrow Wilson. The National Park Service built the roof over the ruin to protect it from further erosion. However, wood portions of the ruin had already been scavenged for firewood and other uses.

The National Park Service has the jurisdiction to preserve and protect the ruins and site. Several native and exotic species have inhabited the site and are causing damage to the ruins and other aspects of the Monument. This low-risk pest management plan is designed to mitigate the potential damage from these pest animals.

During the 1930s, a visitor center and several adobe buildings were constructed. These buildings are now listed on the National Register of Historic Places. The preservation of the ancient ruins, the cultural and natural resources, the museum and grounds will enable the Monument to be enjoyed by this and future generations.

This low-risk pest management plan provides insight into the continued protection and preservation of the Monument from the potential and actual adverse effects by the presence of pests. Pest birds, rodents, badgers, insects and exotic invasive weeds are addressed in this pest management plan.

The benefits of an effective IPM plan, fully implemented, provide a system of protection for the structure, museum collections, supporting structures (visitor center, housing and other historic buildings), as well as enhance staff and visitor safety. The management of pest species reduces potential damage to the Great House, structures, museum artifacts archeological features, landscaped areas and; therefore, reduces park resources needed to repair, replace or modify environmental areas. The IPM approach provides an efficient and environmentally conscious strategy for the preservation of historic collections, structures and landscapes. Low-risk IPM approaches include excluding potential pests from entering structures, eliminating pests that may already be present in the managed environment, implementing procedures prior to pest population build-up, and the elimination (or at least minimization) of placing pesticides in the staff's environment. Such tactics provide a flexible and varied approach to managing the natural and landscaped site and the prehistoric and historic structures, and curatorial environment to reduce or eliminate pest populations.

This National Monument has an excellent staff with tremendous experience and intimate knowledge of the park's workings. The staff has a key role in protecting the Monument resources and providing for visitor safety, and will use this low-risk pest management plan to continue to accomplish these objectives. Maintenance and custodial staffs have already made important contributions toward reducing pest populations. Additional directed efforts by the Maintenance and Resource Management staff will further reduce the potential adverse pest impact upon the protection of the Monument contents and visitor enjoyment.

LEGAL AUTHORITIES AND REQUIREMENTS

The National Park Service has decided to use integrated pest management (IPM) methods as the preferred means for managing pests based on federal laws, regulations, executive orders, presidential memorandum, NPS policies and guidelines, and state regulations on pesticide use.

FEDERAL LAWS AND REGULATIONS

Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) of 1947; amended by P.L. 92 516 (82 Stat. 973) and P.L. 94-140 (89 Stat. 751)
Federal Environmental Pesticide Control Act of 1972 (7 U.S.C. 135 et.seq.)
President Carter's 1979 Executive Order requiring all Federal Agencies to use integrated pest management technology for pest control and to reduce use of toxic pesticides
President Clinton's April 26, 1994, Memorandum concerning economically beneficial practices on Federal landscaped grounds
Secretary Babbitt's July 12, 1994, Memorandum concerning the Department of Interior and the Federal Insecticide, Fungicide, and Rodenticide Act
Executive Order 11870 concerning Animal Damage Control
Executive Order 11987 concerning Exotic Organisms
Executive Order 12088 concerning Pollution Control
Resource Conservation and Recovery Act (40 CFR 165) dealing with pesticide disposal
Migratory Bird Treaty Act of 1918 implemented the 1916 Convention between the United States and Great Britain (for Canada) for the protection of migratory birds
Endangered Species Act of 1973 which provides broad protection for species of fish, wildlife and plants that are listed as threatened or endangered in the United States or elsewhere
Occupational Health and Safety (OSHA) Hazard Communication Standard (29 CFR 1910.1200) and Respiratory Program Standard (29 CFR 1910.134)

NPS POLICIES AND GUIDELINES

Guide for Pesticide Use in the National Park Service, WASO, and Director's Order 77-7:

NPS Management Policies 2001

> *The decision to incorporate a chemical, biological or bio-engineered pesticide into a management strategy will be based on a determination by a designated IPM specialist that it is necessary, and that all other available options are either not acceptable or not feasible.*

NPS Natural Resources Management Guidelines (NPS-77), Chapters 2, 4 and 5

Additional guidelines relating to the park's IPM program appear in other chapters of NPS-77:

Chapter 2: Vegetation Management; Native Animal Management; Freshwater Resources Management; Endangered, Threatened, and Rare Species Management; Exotic Species Management; Hazardous Waste Management; and Public Health and Safety.

Chapter 3: Agricultural Use, Right-of-Way and Easements, and Backcountry Recreation Management.

Chapter 4: Environmental Compliance

Chapter 5: Special Use Permits and Collections.

The NPS Museum Handbook, Parts I and III, Museum Collections, affords guidance on instituting a museum IPM program, identification of museum pests, and proper actions to take if pests are discovered in a museum.

ARIZONA LAWS AND REGULATIONS

On July 7, 2008, Governor Janet Napolitano signed legislation (House Bill 2822) into law eliminating the Structural Pest Control Commission (SPCC) and replacing it with the Office of Pest Management (OPM), which will continue to be housed at the same location in Scottsdale, Arizona. The law goes into effect immediately.

All applicable Arizona laws and regulations are located within Title 32, as follows:

Article 1	General Provisions
32-2301	Definitions
32-2302	Structural pest control commission; appointment; qualification; terms
32-2303	Organization; meetings; compensation
32-2304	Powers and duties; executive director
32-2305	Structural pest control commission fund
32-2306	Annual and informational reports
32-2307	Notification of pesticide applications to school and child care facilities; exemptions; definitions
32-2308	Joint responsibility for supervised persons

Article 2	Certification, registration and licensure
32-2311	Persons not required to be licensed; civil penalties
32-2312	Applicator licenses; application; categories; renewal; inactive licenses
32-2313	Business license; renewal; financial security; definition
32-2314	Qualifying party; license; examination; inactive status; temporary license
32-2317	Fees
32-2319	Continuing education
32-2320	Integrated pest management; reporting requirement; guidelines; definition

Article 3	Regulation
32-2321	Disciplinary action; grounds, procedure, judicial review
32-2323	Wood-destroying insects; treatment proposal; registration form; fee
32-2324	Wood-destroying insect inspection reports
32-2324.01	Fungi inspection reports
32-2325	Unlawful acts
32-2327	Injunctive relief
32-2329	Summary suspension

MANAGEMENT STRATEGIES

LOW-RISK PEST MANAGEMENT ACTION PLAN OBJECTIVES

Plan Objectives: A low-risk integrated pest management (IPM) action plan is designed to provide guidance to staff in the care and protection of the historic site, the important historical materials within, and the surrounding environment from pest presence and subsequent damage.

This plan describes:

- observed evidence of pest activity (and damage),
- potential pest species that may interfere with the site's objectives,
- potential public health issues, and
- most importantly the procedures and actions necessary to prevent pest access and methods for their elimination.

This plan will help meet goals to preserve CAGR resources: Cultural resources and associated values at CAGR are protected, restored and maintained in good condition and managed within their cultural context.

Many facilities deal with pests in a reactive sense, treating for the pest after the infestation has occurred or with routine monthly sprays. Pests in a museum, library or archive environment can cause serious damage to highly valuable, and many times, irreplaceable materials or artifacts. IPM is proactive – work must be done to prevent pest activity rather than react to pest damage to artifacts. Damaged artifacts are NOT replaceable, and the extent of damage may preclude effective restoration.

IPM is proactive – how long does a pest presence take to damage cultural resources (feeding, fecal droppings, nesting, etc.)? Prevention is equally as important as response and may preclude having to respond!

Museum, library and archival collections contain many materials, including composites of various organic and inorganic substances. Materials such as paper, glues, leather, sinew, fur, hair, wood, cotton, wool, hemp, linen, silk, casein, grass, reed, pine needles, or fabrics contaminated with sweat, blood, urine, feces and so on, are organic materials susceptible to the ravages of insects and other arthropods, rodents, mold, and bacterial pest organisms.

The benefits of an effective IPM plan, fully implemented, provide a system of protection for the structure, collections, and staff from close encounters with pest species. The absence of pest species reduces potential damage to museum objects and, therefore, reduces resources needed to repair and replace museum objects. Benefits of implementing a low-risk IPM approach include excluding pests from entering the structure, eliminating pests that may already be present, implementing management procedures prior to pest population buildup, and the elimination (or at least minimizing) of placing pesticides in the staff's environment. Additionally, it provides an opportunity to provide a flexible and varied approach to managing the museum environment so the pest does not want to be there. The IPM approach provides an efficient and environmentally conscious preservation of historic collections.

In addition to the potential for actual damage to materials in the displays and collections, some pests pose potential health risks to staff and visitors. Rodents (rats and mice) are known vectors of many disease organisms to humans, including the deadly Hantavirus. Cockroaches produce

fine exuviae and pheromones which may trigger asthma attacks in sensitive individuals. The cast skins of dermestid beetle larvae also contain fine barbed hairs that can be very irritating. Ants, bees, wasps, spiders, dust mites, and other insect pests and molds, both inside and outside, may cause some health risks to the general public. Ticks can transmit disease and other maladies to staff and visitors. Managing all these potential pest issues where the public has access, as well as staff-accessed areas, is an important consideration in a low-risk integrated pest management plan.

Monument staff has a key role in protecting the historic fabric present in displays and storage areas, and will use this low-risk pest management plan to accomplish this objective. Maintenance and custodial staff have already made important contributions toward reducing pest populations. Additional directed efforts by the maintenance and custodial staff will further reduce the potential adverse pest impact upon the protection of the site contents and visitor enjoyment.

IPM is defined as follows:

Integrated Pest Management (IPM) is the coordinated use of pest and environmental information with available pest management methods to prevent unacceptable levels of pest damage by the most economical means, and with the least possible hazard to people and the environment. The goal of the IPM approach is to manage pests and the environment so as to balance costs, benefits, human health and environmental quality. IPM systems utilize a high quantity and quality of technical information on the pest and its interaction with the environment (site). Because IPM programs apply a holistic approach to pest management decision-making, they take advantage of all low-risk pest management options, emphasizing natural biological methods, and the appropriate use of selective pesticides. IPM strategies incorporate environmental considerations by emphasizing pest management measures that minimize intrusion on natural bio-diversity ecosystems. Thus, IPM is:

- A system utilizing multiple methods
- A decision-making process
- A risk reduction system
- Information intensive
- Biologically based
- Cost effective, and
- Site specific

A short definition is:

IPM is risk reduction: reduction of the risks from the presence of the pest, as well as the risks from the means used to manage the pests.

Low-risk IPM considers the acute and chronic toxicity of the pesticide that may be employed as well as the potential exposure from the treatment to staff and visitors (especially more vulnerable children).

NATIONAL PARK SERVICE LOW-RISK INTEGRATED PEST MANAGEMENT PROCESS

The National Park Service has developed an effective and advanced process for developing and implementing an IPM strategy for pests on park sites. An 11-step process has evolved since 1979 to its current form. A brief discussion of these 11 steps as they relate to Casa Grande Ruins National Monument follows.

Step 1 Set Site Pest Management Objectives and Priorities

The mission of Casa Grande Ruins National Monument is to preserve, conserve, protect, and maintain those resources within its charge for the enjoyment of this and future generations.

Priorities: The Great House, the ball court, visitor center and museum, administrative offices, housing, library, maintenance area, VIP campground, collections storage areas and workspaces.

- Protect historic resources from pests and other hazards
- Protect structural integrity to maintain historic ambiance and form
- Provide an educational, safe and pleasing experience for visitors
- Maintain an aesthetic (and historic) landscape on the grounds
- Protect the cultural landscape from damaging pests

Step 2 Build Consensus

Establish communication links between interested or concerned parties (occupants, pest managers, decision makers) and agree on mutual pest management approaches, methods and priorities.

- Occupants: public, visitors, community, Monument staff
- Pest managers: IPM Coordinator, custodians, curatorial staff, maintenance staff
- Decision makers: Superintendent, Cultural Resources Manager, Chief of Maintenance, IPM Coordinator

(1) Provide signage and other interpretive information on pest management issues and procedures through interpreter staff, news releases, seminars or conferences.

(2) IPM Coordinator to hold periodic meetings (short) to discuss findings by staff, track progress toward goals and provide praise for jobs well done.

(3) IPM Coordinator to provide briefing for supervisors and/or superintendent, two times per year on critical issues, progress and successes.

Step 3 Document Decisions and Maintain Records

This pest management plan will help with pest management decision making and will become part of the site's IPM records.

- Installation of environmental (temperature/humidity) sensors in artifact displays and storage areas is suggested to gain environmental information of a specific room.
- Collect monitoring data from all pheromone or sticky traps and record findings (pest ID and numbers).
- Placement of traps can be indicators of access routes into the sites by pests.
- Provide pest sighting logs for critical sites, museums, displays, break rooms, etc.
- Collect pest impact monitoring data to determine impacts to archeological sites.

- Record all data collected, information on remedial actions taken to eliminate pest access, and any pesticide treatment actions.

Step 4 Know The Resource

The CAGR maintenance, curatorial and custodial staffs and the IPM Coordinator have intimate knowledge of the site and its contained historical and exhibited materials.

- The resource consists of archeological sites, historic structure(s), storage areas, offices, public areas, landscaping and public grounds.
- The Monument has a moderate to heavy human occupancy (public) and staff, and pest pressure from the surrounding encroaching town and farms.
- A weed environmental assessment for invasive plants has been developed for the Monument.

Step 5 Know The Pests

This pest management plan provides detailed information on the pests, their biology and behavior, and low-risk pest management measures.

Potential and known pests:

- Museum pests – firebrats, silverfish, crickets
- Structural pests – ants, subterranean termites
- Public health pests – bats, birds, mice, flies, American and desert cockroaches, black widow spiders, bees and wasps
- Grounds pests – badgers, coyotes, feral dogs, rabbits, round-tailed ground squirrels and other rodents, snakes and invasive exotic plants.

Step 6 Monitor Pests and Environmental Conditions

Monitoring for pest presence will be done through several methods: observation or sighting logs, GPS recording of animal damage, sticky trap captures, observation of damage, tracks, droppings, etc.; indoor environmental conditions are monitored with temperature/humidity recorders, and housekeeping sanitation measures. Line transects and grids can be set up to monitor pest presence in landscaped and natural areas, etc.

- Set up monitoring regimens to inspect regularly and record and report findings.

Step 7 Establish Action Thresholds

In a museum or curatorial storage setting, “Action Thresholds” are set very low to prevent pest activity from damaging cultural resources.

- The presence of a single pest in a critical area calls for an immediate remedial action (physical removal, cleaning, trapping, etc.). For example, a single pest in the “Administrative Facilities” zone may require immediate treatment while no treatment may be required in the “non-Public Areas” unless the count is higher than 20 animals or resource damage is documented.
- Prevention is a key component: one larval dermestidae in historic artifacts needs immediate action (exclusion, sanitation, habitat modification).

- Non-invasive weeds may not require any action other than routine removal and appropriate monitoring. Invasive weeds (exotic) may need remedial action.

Step 8 Review Available Tools and Best Management Practices

Exclusion, sanitation and habitat modification are effective tools to manage museum, structural and public health pests. Some low-risk pesticides and traps may be necessary in some instances. The Exotic Invasive Plant Management Team can assist with invasive plants.

Step 9 Select Effective, Low-Risk IPM Strategies within Laws, Regulations and Policies

This IPM Plan addresses IPM strategies taking into account Federal and State laws, and National Park Service regulations and policy.

Step 10 Obtain Approval, Define Responsibilities, and Implement Strategies

Responsibilities of the IPM Coordinator, curatorial, resource management, interpretive and custodial staffs are included in this IPM plan. Action threshold levels will determine management strategies to be implemented and responsibilities of different divisions will determine the staff involved. Information provided to the public through signs and interpretive staff can also make visitors aware of how their actions can help in preventing pest presence. When pesticide applications are deemed necessary, proposed use plans will be submitted by the CAGR IPM Coordinator to the IMR IPM Coordinator for approval prior to the performance of any application.

Step 11 Evaluate Results, Follow-up and Adjust Strategy if Needed

Observation, monitoring, exclusion, sanitation and habitat modification utilized in appropriate strengths make this plan easily adjustable to manage most pests likely to be encountered. Following pest management actions, the affected resource will be monitored for continuing presence of the pest. The conditions found will be evaluated to determine the success of management actions. In the event a pest remains above an action threshold level, additional or alternate strategies may be selected and implemented following the appropriate approval and use procedures. Pesticides or other pest lethal force may be necessary.

INTERPRETATION AND IPM

The interpretive staff has a great responsibility in providing the visiting public with information on the history of the Great House and its surrounding area. In addition to all this, it is useful to inform the public about how the park preserves and protects the structures, artifacts, landscapes and the site from pests and their potential damage. The public can use IPM information in their homes, and become aware of how their actions can help prevent the presence of pests.

The interpretive staff can provide information on some of the specific pests that have been encountered at the site, pest's basic needs (air, water, food, shelter, adequate temperature), and how the IPM approach manages pests through exclusion, sanitation and habitat modification. A discussion of the influence of pests on the cultural and natural resources, how pests interfere with natural processes, and how exotic invasive plant species may displace native species should be included. A display can be developed to identify pest species and exotic invasive plant species, including how people have a role in providing or preventing pests.

ROLES AND RESPONSIBILITIES

It is essential for all operations to support staff and visitor health and safety, as well as preservation and protection of resources. The integrated pest management (IPM) program has similar responsibilities and should closely interact with all personnel. Most CAGR staff will be involved in pest management activities at one time or another. To make the IPM program most effective, the entire staff (and several non-NPS persons) should participate as a member of the pest problem-solving team.

SUPERINTENDENT

The Superintendent has overall responsibility for site functions, including the IPM program. The Superintendent may delegate the IPM program implementation to the IPM Coordinator and other divisions. The Superintendent may also make reasonable attempts to provide adequate staffing and funding to implement and sustain the IPM program and provide for monitoring, exclusion and pest management needs.

The Superintendent must understand the principles and practices of IPM and realize how the broad scope of IPM tactics relate to site resources and activities; designate and train a curator to oversee collections management; inform employees, through memos, of the need for vigilance and to practice IPM methods; annually review with the IPM Coordinator the low-risk IPM plan for necessary changes or additions; provide for proper and necessary training for the IPM Coordinator and other staff; and ensure that all IPM treatments are done by certified pesticide applicators who meet both state and federal requirements. Annual funding is needed to support IPM training, monitoring and treatments. Implementation of this plan will require an annual allotment of supplies and a dedicated staff whose primary duty is to address IPM and other resource issues. The Superintendent is responsible for ensuring that the Chief of Resource Management, Supervisor Facility Management Specialist, and Chief Ranger have adequate staffing levels to implement this plan.

CHIEF OF RESOURCE MANAGEMENT

The Chief of Resource Management has responsibilities for management of both natural and cultural natural resources at CAGR. This individual is responsible for oversight, review and support of the pest management program, including this IPM plan. The Chief must also understand the principles and practices of IPM and annually review the IPM plan for any necessary changes or additions. The Chief of Resource Management is responsible for balancing the needs of both natural and cultural resources, ensuring that the Superintendent is well informed of resource needs, and issues regarding legal compliance with IPM, NEPA and NHPA legislation. The Chief of Resource Management is also responsible for (or responsible for supervision of staff whose collateral duties include) Curation, IPM Coordination, Biological Science and other associated natural resource duties.

FACILITY MANAGEMENT SUPERVISOR

The Maintenance Division staff has very important roles in CAGR pest management. The Maintenance staff provides all the repairs to buildings to ensure there are NO entryways for pests to have access to the inside spaces. Total exclusion of pests from entry into structures is the first line of defense in this pest management plan. Maintaining screens on windows and chimneys, tight door sweeps, closing cracks and crevices, repairing leaks, cleaning offices and other spaces, and generally keeping structures in good repair; reporting observations of pests or

their activity to the IPM Coordinator for action is also important as maintenance staff may work in areas not frequented by the IPM Coordinator or other pest management personnel; will train maintenance staff to be alert to conducive conditions and signs of pests and pest damage and report findings; assure good sanitation procedures (the second line of defense in this pest management plan) are carried out to eliminate food, water and shelter conditions that encourage pests; and punctually schedule repairs to structures, utilities or vegetation that support pest infestations.

CHIEF RANGER

The Ranger Division serves an important role in public education and maintenance of exhibit areas within the Visitor Center. Interpretive Volunteers, Fee Collectors and Rangers have the most interaction with members of the visiting public. Their offices are often open to the outdoors as visitors walk through the Visitor Center, giving pests better access to interior spaces. Ranger Division staff are ideally situated to educate visitors about public safety hazards and also to discourage visitor activities that may pose a safety hazard. Examples include educating visitors why they should not be hand feeding wild round-tailed ground squirrels in the picnic area, and advising visitors to watch their step while participating in back-country tours. Interpretive staff are the eyes and ears that inform the IPM Coordinator about visitor and pest interactions. Reporting observations of pests or their activity to the IPM Coordinator is important to inform the IPM Coordinator or other pest management personnel of potential problems. Continued monitoring of birds within the Casa Grande Great House, reporting of bee and spider concerns in visitor use areas are essential to the success of this plan.

CURATOR

Since most of the Monument collections are stored off-site at the Western Archeological Conservation Center in Tucson, CAGR does not currently employ a full-time curator. Instead, CAGR staff works closely with the curatorial staff at WACC who have their own Integrated Pest Management Plan for that site. However, CAGR does currently employ an Archeologist with part-time curation duties, and a Biological Science Specialist. The Biological Science Specialist works closely with interpretive rangers and archeologists to ensure that IPM related curation concerns are addressed. Curation duties related to pest management are important for the preservation of historic artifacts and displays, pest monitoring within the collections, and performing an effective museum cleaning program. The curator has the responsibility to inspect, at least semiannually in early spring and late summer (preferably monthly) museum areas, storage and curatorial areas, collections, and the interior and exterior of all buildings containing collections or stored museum artifacts. Inspections will record pest presence and conditions conducive to supporting pests. Needed repairs or maintenance will be identified and reported to the Chief of Resource Management and the IPM Coordinator. With their approval, maintenance requests will be submitted to the Supervisor Facility Management Specialist to schedule needed repairs.

IPM COORDINATOR

The responsibilities of the IPM Coordinator are described in NPS-77 Natural Resource Guidelines and in the March 10, 1997 IPM re-engineering Memorandum. The CAGR IPM Coordinator serves as the focal point of all activities that directly (or indirectly) relate to pest management, including maintenance, resource management, interpretation, planning and design, and other park responsibilities. The IPM Coordinator is responsible for compiling IPM related information and continuing education on IPM techniques, methods and pesticide safety

to staff and residents; will be responsible for performing IPM activities in this plan, assisting staff with solving pest problems, reviewing pest monitoring reports, and training employees with pest management duties; will prepare monitoring forms and conduct inspections, and document needed repairs and structural deficiencies for action by maintenance staff; will with the Superintendent and other program managers, annually review the IPM plan for necessary changes or additions; ensure personnel applying restricted-use pesticides work under direct supervision of a certified applicator; ensure all reports, requests, and pesticide use logs are accurate, complete and submitted in a timely manner; will maintain the locked pesticide cabinet, pesticide labels and material safety data sheets (MSDS) on all approved pesticides; informs the Superintendent on all pest management issues and pesticide use; will semiannually (early spring and late summer) inspect the exterior and interior of all buildings and record inspection findings; if inspections show evidence of pest activity, will increase monitoring actions, and if action thresholds for the site are met, will initiate further pest management actions, and assure staff is provided the latest information concerning health and safety matters on pests and pesticides.

BIOLOGICAL SCIENCE SPECIALIST

CAGR currently employs a part-time natural resource technician to coordinate and implement IPM monitoring and treatments. The duties of this job reflect those of an IPM Coordinator, but also include additional natural resource management tasks. CAGR does not have a secure source of funding to provide full-time natural resource staff. This biological science position is the only one that is solely dedicated to address IPM and natural resource needs within CAGR. Support of a full-time natural resources position such as this one is needed to implement the recommendations of this plan at CAGR.

DOCUMENTATION

INSPECTIONS

The initial inspection of the site and a written report may be the first official record of a specific pest problem. The inspection report (with photos if possible) should identify conditions conducive to supporting pest presence, as well as ID of pests that are present. The inspection report should document the findings, and include the key location and potential distribution of the pest or pests, the resources (water, food, shelter) available to the pest(s), and the remedial actions necessary to manage the situation. The inspection provides a snapshot of pest activity at that time.

MONITORING

Monitoring provides information on pest activity over a specified period of time while no one is watching. Methods of monitoring will vary, depending upon the pest of concern. Crawling insect activity can be monitored by placing sticky traps and bait in strategic locations and checking them for captures after a specified time period. If the crawling insect population is suspected to be large, sticky traps should be checked each day to obtain species identification and relative numbers. If the population is small, traps can be checked weekly or at least monthly. A series of sticky traps may be placed near all possible sources of water, food, entry access or shelter to delineate population size, extent of location and whether the population is growing or declining. Monitoring for flying insect pests may require special sticky traps with an appropriate pheromone that is attractive to the male, female (or both) of the flying insect pest(s) of concern (Insects Limited, Inc. is a source). The flying insect pest pheromone traps can be placed in a grid pattern to pinpoint the area of the pest harborage or food source, and thus limit the area and amount of treatment necessary to manage the pest. Monitoring devices should be placed during the inspection in areas where evidence of pest activity is observed.

Talc or diatomaceous earth patches placed in rodent runways can be used to determine rodent population size and if the runways are active. Rodents tend to dribble urine as they run along, which can be detected by using a UV light showing urine as a bluish-green fluorescence. Rodents also run next to vertical surfaces and leave a mark of body oils and dirt where they rub. You can determine if the rub marks are fresh (soft) or old (brittle). Food material, usually a block, can be monitored periodically to determine the amount of food taken by weighing it or by measuring the actual remaining dimensions. Knowing the amount of food the target rodent species takes in a day (or other time frame) can give you an idea of the size of the population.

Monitoring for plants that are undesirable in the site can be conducted by observation, line transects, meter grids and other means. Identification of the species and its location can be placed on a map of the site. Observations over a period of time or seasons can determine the plant’s rate of spread or population increase. If an action threshold has been determined, the monitoring record can show when the action threshold has been reached, and remedial action for removal can be taken. Some exotic invasive species may require the presence of even a single plant to be removed. Hazard trees may require pruning or removal as well.

Good records of all monitoring results are important for a successful IPM program. Comparing monitoring data from before treatment actions and after can provide evaluations of the relative success or lack thereof for the treatment. If treatment action (exclusion, sanitation, habitat modification, physical trapping or pesticide application) are effective or only partially effective in

managing the pest, re-evaluation of the approach may be necessary. Recording the results of monitoring data should include the following:

- Location or site
- Purpose for monitoring
- Target pest population being monitored
- Frequency of monitoring (daily, weekly, monthly)
- Number and description of monitoring locations
- Monitoring procedures (counting, weighing, identification, etc.)
- Record of findings and subsequent management decisions
- Treatment efficacy on target pest (and nontargets)

PESTICIDE USE PROPOSALS (PUPS)

Pesticide use under this low-risk IPM plan must go through an approval process by the Regional IPM Coordinator or the Washington Office IPM Coordinator, depending upon the desired product, pest and site. The PUPS NPS IPM software must be used. The proposed pesticide use approval must be obtained before the pesticide application can be made. The site IPM Coordinator has a password to enter the PUPS intranet database. The Director's Order 77-7 (DO 77-7) provides information on the allowed use of pesticides, approval process and restrictions. The Regional IPM coordinator can approve most PUPS. Aerial applications, water applications, restricted use pesticides, and areas with threatened and endangered species must be approved by the Washington Office IPM coordinator.

PESTICIDE USE LOGS

The Monument will keep records on all pesticides; amount used during the year, and will submit pesticide use reports (PUPS) on NPS pesticide management software to the regional IPM Coordinator at the end of the year. The State of Arizona may also review the pesticide use logs.

LABELS AND MATERIAL SAFETY DATA SHEETS

Copies of all pesticide labels and MSDS of pesticide products used or stored on the site will be kept in the CAGR IPM Coordinator's office. Copies of pesticide use records and pesticide labels will also be kept in the pesticide applicator's notebook or file.

PEST MANAGEMENT ACTIONS TAKEN

The National Park Service has instituted a nationwide IPM software program to facilitate recordkeeping and tracking pest management actions. Pesticide applications are entered into the software at the end of each year.

PURCHASING, DI-1s

Staff and visitors should NOT purchase pesticides for use on the site. Only products authorized by the IPM Coordinator may be purchased for use within the boundaries of CAGR. Any product that has a U.S. EPA registration number must go through the approval process. This includes insect repellants as well, even when sold by concessions within the park.

IPM POLICY

The Monument should establish a procedure and incorporate the pest management approach into any agreement (written or oral) with any outside party who wishes to conduct any activity within the jurisdiction of the site. It should be made clear that NO pesticides are to be used while on Monument premises. The participant must take appropriate action to avoid providing water, food or shelter for any pest. These factors must be included (preferably in writing) in any agreement, special use permits, concession contract, right-of-way instruments, leases, contracts and any other document which allows an activity to occur on park jurisdiction which may attract pests (of any kind) or effect the IPM program. It must also indicate the user's responsibility to exclude pests, eliminate water, food and shelter from pest access, and to immediately remediate any such adverse conditions that may occur.

COOPERATIVE AGREEMENTS

CAGR, through its IPM Coordinator, may elect to develop a cooperative agreement or contract to engage the assistance of a local expert in the management of pests that may be problematic for some portion of the site. Candidates could be experts from the cooperative extension office, university, independent consultant, agricultural crop advisor, landscaper, tree service, orchardist, archivist, curator, structural pest management company or other pest management expertise critical to the site. The agreement or contract must state that no pesticides will be utilized without the full approval process being completed. Selection criteria should encourage the ability to think outside the pesticide box; and use exclusion, sanitation and habitat modification as the focus.

ANNUAL WORK PLAN

The general management plan for the Monument directs that the preservation and protection of the prehistoric Great House, supporting structures, housing, visitor center and the surrounding grounds be a guide for the site. This section provides guidance on monitoring and maintenance activities to address IPM concerns for the collections, structures and Monument grounds.

Daily Activities

- Early morning set Victor rat snap traps for RTGS in critical sites.
- Check set rodent (mice, rat) snap traps each morning; remove captures and reset traps.
- Remove dust from all exposed displays.
- Monitor bird activity in the Great House and update the daily bird count.
- Monitor sensitive areas near the Great House and middens for pest activity.
- Thorough cleaning of floors, restrooms, break rooms and entry ways.
- Remove all trash and organic material from the structures at the close of business.
- Interpretive staff includes IPM information in presentations.
- Eliminate clutter.
- Empty all outside trash containers at close of business.
- Late evening (COB) check RTGS snap traps and remove captures.

Weekly Activities

- Check Great House for bird presence. Install or repair ¼ inch hardware cloth if necessary.
- Check all insect sticky traps and pheromone traps and record findings. Replace traps that contain numerous captures.
- Clean all trash containers (and dumpsters) as needed (weekly).
- Inspect for insect or rodent damage (holes, gnawing, rub marks, nests) and clean or repair as necessary.
- Inspect structures for pest access, food, moisture and harborage; modify habitat.
- Perform exclusion of RTGS with ¼ inch hardware cloth and 1 inch gravel, 4 inches deep wherever necessary.

Monthly Activities

- Install 45° angles or ¼ inch hardware cloth exclusion on all areas where unwanted birds are roosting.
- Download data loggers for all museum and artifact storage sites; analyze data anomalies (temperature or humidity). Adjust air conditioning as necessary.
- Download structural data loggers and record structural changes evidenced in the Great House; analyze data anomalies and contact Vanishing Treasures Structural Engineer if necessary.
- Inspect and clean all natural organic materials (hides, cloth, etc.) in displays.
- Check for and fill holes in sensitive sites where coyotes or badgers have dug dens.

Seasonal Activities (whenever time and labor are available)

- Install geo-textile cloth, ¼ inch hardware cloth and 1 inch gravel, 4 inches deep over sensitive sites.
- Train staff in important roles in implementing IPM practices.
- Prepare for insect, rodent or exotic plant invasions.
- Rake up and remove fallen seed pods from trees in the Visitor Center parking lot, picnic area and administrative area.
- Remove ripe cactus fruit from prickly pear plants in Visitor Center parking lot.

Seasonal Activities (whenever time and labor are available) - continued

- Remove grasses and other weeds from the interior architecture of Compound A before the grasses produce seed.
- Check the underground drip irrigation system and repair any leaks or areas that pool water.
- Seal and/or repair the holes in historic buildings.
- Clean floor/wall junctions of wax, dirt and grime in all structures.
- Inspect and clean all storage cabinets.
- Thoroughly inspect and clean all organic material in displays to remove contaminants, eggs, larvae or insects (preferably spring and fall).
- Install bat houses for excluded bats from the Great House (season with guano).
- Install ¼ inch hardware cloth in canopy over Great House to exclude birds.

January

- Monitor curatorial displays and storage rooms for insect or other pest activity. Treat cracks and crevices with diatomaceous earth (DE) or borate dust if necessary.
- Place pheromone traps and monitor for museum insect pests.
- Prepare and submit PUPS for anticipated (known) pesticides projected to be used on the Monument properties to the Regional IPM Coordinator for approval.
- Set and monitor rodent snap traps daily.
- Conduct maintenance and cleaning daily.
- Monitor sensitive sites for RTGS burrowing activity and install exclusion materials.
- Install exclusion materials in cracks and crevices for migrated bats.
- Build and install bat houses (season with bat guano).

February

- Prepare bat houses for returning bats.
- Monitor curatorial displays and storage rooms for insect or other pest activity. Treat new cracks and crevices with DE or borate dust if necessary; caulk.
- Set and monitor rodent snap traps daily.
- Set and monitor crawling insect sticky traps weekly.
- Conduct maintenance and cleaning daily.
- Maintain vegetation 3 feet from all buildings.
- Monitor sensitive sites for RTGS burrowing activity and install exclusion materials.

March

- Monitor curatorial displays and storage rooms for insect or other pest activity. Treat new cracks and crevices with DE or borate dust if necessary; caulk.
- Set and monitor rodent snap traps daily.
- Set and monitor crawling insect sticky traps weekly.
- Conduct maintenance and cleaning daily.
- Maintain vegetation 3 feet from all structures; monitor for impact on buildings.
- Monitor sensitive sites for RTGS burrowing activity and install exclusion materials.
- Monitor Monument grounds for exotic, invasive plants and remove them.

April

- Monitor curatorial displays and storage rooms for insect or other pest activity. Treat new cracks and crevices with DE or borate dust if necessary; caulk all cracks and crevices.
- Monitor all pheromone traps and replace if many captures are found.
- Set and monitor rodent snap traps daily.

April – continued

- Conduct maintenance and cleaning daily.
- Maintain vegetation 3 feet from all buildings.
- Monitor Monument grounds for exotic, invasive plants and remove them.
- Monitor sensitive sites for RTGS burrowing activity and install exclusion materials.

May

- Monitor curatorial displays and storage rooms for insect or other pest activity; treat all cracks and crevices with DE or borate dust; caulk.
- Conduct thorough inspections of all structures for insect, spider and rodent activity.
- Conduct exclusion actions to prevent insect and rodent entry into all structures.
- Set and monitor rodent snap traps daily.
- Maintain vegetation 3 feet from all buildings.
- Conduct maintenance and cleaning daily.
- Monitor sensitive sites for RTGS burrowing activity and install exclusion materials.
- Monitor Monument grounds for exotic, invasive plants and remove them.

June

- Monitor curatorial displays and storage rooms for insect or other pest activity; treat new cracks and crevices with DE or borate dust; caulk.
- Monitor all structures for insect, spider and rodent activity.
- Search for emergence of carpenter bees, wood borers; treat infested wood beams or other wood with borates.
- Monitor and reset rodent snap traps daily.
- Maintain vegetation 3 feet from all buildings.
- Conduct maintenance and cleaning daily.
- Monitor sensitive sites for RTGS burrowing activity and install exclusion materials.
- Monitor Monument grounds for exotic, invasive weeds and remove them.

July

- Monitor curatorial displays and storage rooms for insect or other pest activity; treat new cracks and crevices with DE or borate dust; caulk.
- Monitor all pheromone traps and replace if many captures are present.
- Monitor all structures for insect, spider and rodent activity.
- Monitor and reset rodent snap traps daily.
- Maintain all vegetation 3 feet from all buildings.
- Conduct a thorough inspection and maintenance of structural integrity, repairing all holes allowing insect or rodent entry.
- Conduct maintenance and cleaning daily.
- Monitor sensitive sites for RTGS burrowing activity and install exclusion materials.
- Monitor Monument grounds for exotic, invasive weeds and remove them.

August

- Monitor curatorial displays and storage rooms for insect or other pest activity. Treat new cracks and crevices with DE or borate dust. Caulk all cracks and crevices.
- Monitor and reset rodent snap traps daily.
- Maintain all vegetation 3 feet from all buildings.
- Conduct maintenance and cleaning daily.
- Monitor sensitive sites for RTGS burrowing activity and install exclusion materials.
- Monitor Monument grounds for exotic, invasive weeds and remove them.

September

- Monitor curatorial displays and storage rooms for insect or other pest activity. Treat new cracks and crevices with DE or borate dust; caulk.
- Monitor and reset rodent snap traps daily.
- Inspect all wood members in each structure for carpenter bees, termites, wood borers, mold or other wood-destroying organisms and wasp nests; spot treat with borates if necessary (spring and fall).
- Maintain vegetation 3 feet from all buildings.
- Conduct maintenance and cleaning daily.
- Monitor sensitive sites for RTGS burrowing activity and install exclusion materials.
- Monitor Monument grounds for exotic, invasive weeds and remove them.

October

- Monitor curatorial displays and storage rooms for insect or other pest activity. Treat new cracks and crevices with DE or borate dust; then caulk.
- Monitor and reset rodent snap traps daily.
- Maintain vegetation 3 feet from all buildings.
- Inspect all door sweeps for tight seal to prevent pest entry.
- Conduct maintenance and cleaning daily.
- Monitor sensitive sites for RTGS burrowing activity and install exclusion materials.
- Monitor Monument grounds for exotic, invasive weeds and remove them.

November

- Monitor curatorial displays and storage rooms for insect or other pest activity. Treat new cracks and crevices with DE or borate dust; then caulk.
- Monitor and reset rodent snap traps daily.
- Maintain vegetation 3 feet from all buildings.
- Monitor all pheromone traps and replace if many captures are found.
- Conduct maintenance and cleaning daily.
- Monitor sensitive sites for RTGS burrowing activity and install exclusion materials.
- Monitor Monument grounds for exotic, invasive weeds and remove them.

December

- Monitor curatorial displays and storage rooms for insect or other pest activity. Treat new cracks and crevices with DE or borate dust; then caulk.
- Monitor and reset rodent snap traps daily.
- Prepare and submit the past year's pesticide use amounts and other required data to the NPS Regional IPM Coordinator via PUPS.
- Maintain all vegetation 3 feet from all buildings.
- Conduct maintenance and cleaning daily.
- Conduct exclusion in cracks and crevices used by bats while they are on southern migration. Build bat houses for their return.

INSPECTION FINDINGS AND RECOMMENDATIONS

NON-PUBLIC AREAS

MAINTENANCE COMPLEX

Check all doors to be sure that they can exclude pests. Repair broken kick plates and install door sweeps to exclude rodents and insects. If "historic" door sweeps are not functional, replace them or back them up with sweeps that do work. Use Victor-brand snap traps at the floor/wall junction to remove rodents. Check traps every morning to remove dead rodents, then reset them.

Building 8 – IDLCS #06603 – Paint Storage Building and Wash Bay

This building is alleged to have had scorpions in it. The building was dark and the room was full of paint and materials, and was essentially inaccessible for a thorough inspection. The doors are relatively tight. Set Lo-line crawling insect sticky traps along the floor/wall junction to capture insects and scorpions. This building was treated for termites in 2007 and no evidence of termite activity was observed during this inspection.

Building 9 – IDLCS #06604 – Maintenance Office, Storage Rooms

This building was treated for termites in 2007. There are no visible mud tubes from subterranean termite activity in the north storage room. However, there are mud tubes on the beams on the east wall of the southwest storage room. There is a hole in the window frame to the outside by the southeast corner. There is a mud dauber nest on a beam in the heavy storage room. There are door gaps under the two doors that should be fitted with door sweeps. The air vent on the south side has a gap which is not screened with ¼ inch hardware cloth. Re-treatment of this building for termite activity has been scheduled for April 2009.

The north storage room has some old rodent droppings at the floor/wall junction. There is a gap at the entrance door which can allow rodent entry. Install a door sweep. Set Victor snap traps at the floor/wall junction near the doors on both sides, and every ten to twelve feet along the walls. Check the traps every morning to remove dead captures and reset the traps.

The two air vents have gaps and ½ inch screens. Fill the gaps with Stuf-Fit and cover the screens with ¼ inch hardware cloth to exclude rodents.

The Maintenance Office has gaps under the doors which need door sweeps installed to prevent rodent entry. The air vents need to have ¼ inch hardware cloth installed to cover the ½ inch screen to reduce rodent entry. There are rodent

droppings by the north door to the office at the floor/wall junction. Set Victor snap traps to remove rodents; check the traps every morning to remove captures and reset. There is a hole in the ceiling of the bathroom that needs to be repaired.

Building 10 – IDLCS #06605

This entire structure is wide open to birds, rodents and insects. Birds and rodents can be excluded; however, there is substantial harborage for insects such as firebrats, ants and other starch and wood-feeding insects that like the harborage in cardboard boxes. The restroom shower is leaking and needs to be repaired to eliminate moisture for pests and mold. This building was treated for termites in 2007. Re-treatment of this building for termite activity has been scheduled for April 2009.

Such re-treatments would not be necessary if the wood is treated with BoraCare, injected into the wood. Property treated wood beams and other wood structural members are toxic to termites, wood borers, mold and fungi.

East Storage Room: The outer doors need a concrete sill installed and heavy duty door sweeps placed on the doors. Rodents have worn an entrance under each of the two doors. The gap between the doors is sufficient to allow rodent entry. A substantial amount of rodent droppings are present in the corners of the room. One of the ceiling beams (2nd beam from the east) has a termite tube extending downward. Light is showing through between the roof planks allowing rain into the room. Water damage is evident on the walls. Repairing the roof to prevent rain entry into the storage area is necessary. After the roof is repaired, treat the wood beams and roof planks with two applications (a day apart) of a borate solution to prevent termite and wood-destroying organism damage. Set Victor snap traps at the floor/wall junction and check them every morning to remove dead rodents. It was also reported that the cardboard boxes stored here contained firebrats before being treated by staff. Treatment consisted of relocating the infested boxes to an outdoor environment where they were exposed to heat and UV radiation. The infested area was cleaned before these boxes were moved back to their original storage location. Only a few boxes were opened and no firebrats were directly observed during the inspection. The back portion of the room was not accessible.

Southeast Equipment Storage Area: This area has a livestock wire fence front which is open to birds, rodents and insects. Birds are nesting in the ceiling joists and substantial bird droppings are on the power tools and other equipment below, creating a health hazard. There is also a nest in the string trimmer hanging from a metal ceiling joist. Remove the nests when there are no eggs or young present. Clean bird droppings from the ceiling structure and install ¼ inch galvanized hardware cloth to exclude birds. The open front wire wall could be screened with ¼ inch galvanized hardware cloth to prevent bird and rodent entry. Permanent structural walls would be better exclusion; however, would change the historic appearance. Set Victor snap traps at the floor/wall junction and check them every morning to remove dead rodents.

VT Resource Management Office, Lab, Storage Room: Doors have ample access for rodents at the bottom. Replace the broken kick plate and install door sweeps. After exclusion is accomplished, use Victor snap traps at the floor/wall junction. Check traps every morning and remove dead rodents. There is evidence of termite damage in the windows and frames of the lab area. Drill and inject a liquid or gel borate solution or sand off the paint and treat with two applications of a liquid borate solution. Paint window frames after the treatments have dried.

Lumber Storage and Parking Bays: The open area has four bird nests beneath the roof structure in the metal ceiling rafters and bird droppings on rolls of geo-textile cloth and stacked lumber. Remove the nests when no eggs or young are present. Clean up bird droppings on beams and tools with a sodium hypochlorite (bleach) solution to reduce possible exposure to *Leptospirosis* and other disease organisms. Install ¼ inch hardware cloth in ceiling area to exclude birds. This area is completely open to the front, so rodent exclusion in this area will not be effective. Place Victor brand snap traps at the floor/wall junction to reduce rodent population. Check traps each morning to remove dead rodents and reset traps. If rodents are chewing and getting into wiring of parked vehicles, leave the vehicle hoods slightly open just so the under-hood light does not turn on. Rodents will feel unsafe and avoid the vehicle.

Rest Room: This area was inspected for the presence of brown recluse spiders reportedly seen here. Lo-line sticky traps can be placed in the restroom to capture crawling insects and spiders. No brown recluse spiders were observed during this inspection.

<u>Building 11 – IDLCS #06606 – Workshop and Blacksmith Shop</u>

This portion of the workshop is clean and orderly. There is a water leak by the pipe from the removed sink area. Repair the leak to remove water access by pests and mold potential. There is a hole over the door that should be repaired to reduce access by rodents or insects. The broken window should be replaced.

The blacksmith shop portion of the building is clean and orderly. No evidence of pest presence was found. However, there are bird droppings on the beam over the opening between the shops and on the floor beneath.

<u>Maintenance Area Outside</u>

There is a substantial amount of harborage for potential pests such as rodents, snakes and insects. Large pipes stored behind the building are habitat for cottontail rabbits, which were observed entering and exiting the pipes. There were bird nests observed and RTGS holes present. Rodent droppings are present behind a large board leaning against the building. Remove or create better storage for these materials to eliminate clutter which provides harborage for pests.

VIP Campground

The motor home at the back southeast side of the Maintenance Complex has a substantial amount of boxes and other clutter outside the cement wall. This will provide harborage for and encourage rodent and other pest presence. This clutter should be minimized. RTGS holes were observed in this area.

Building 1 – IDLCS #58595 – Administration Building

There was no evidence of rodent activity within the building. There are insects present in the ceiling lights which may have access from above through the void below the roof. The presence of scorpions and spiders was reported; however, they were not observed. Odor noticed in this building, and reported by staff, indicates the presence of dead rodents, possibly in the vent system.

The kitchen is clean with no evidence of rodent or insect presence. There were spiders and crickets observed in the bathtub in the bathroom. The offices in the building contained an abundance of clutter which can be harborage and food for rodents and insects, especially silverfish, cockroaches and dermestid beetles.

Outside there are holes in the patio area which are usually occupied by lizards. Rodent droppings are present on the southeast and north window sills. Occupants mentioned noises like mice in the ducts. An American cockroach was caught in a spider web.

Building 4 – IDLCS #58596 – Residence / Office Building

Outside, there are several holes under the steps, probably from RTGS burrowing. There are bird nests present: one in the shutter on the north side; another on the northeast corner. Remove the nests when no eggs or young are present to prevent bird mites and parasitic insects from leaving the nest and entering the building to feed upon the occupants. The vent screen is off and on the ground on the south side. When the screen is replaced, place ¼ inch galvanized hardware cloth behind it to prevent rodent entry. No mud tubes were observed outside to indicate subterranean termite activity. Staff reported that janitorial staffing has not been consistent to ensure that this building is cleaned on a weekly basis. Vacuuming, dusting and trash removal are not being conducted on a regular schedule. Staff also requested that the Maintenance Division resume cleaning and trash removal duties for Building 4 instead of delegating this task to a member of the Interpretive staff.

The grate is off the ceiling vent. There is an abundance of dust, dirt and clutter present which provides harborage and food for dust mites, insects and rodents.

The bathroom closet has rodent droppings in the area below ground level. There is no screen on the bathroom vent. There is a hole in the wall behind the bathtub. These issues may be resolved as the bathroom is currently being remodeled.

No evidence of pest presence was found in the office in the southeast corner of the structure; however, there is clutter present which provides harborage for pests.

The main work area has spider webs in the window sills and clutter, providing shelter for insects and rodents.

The office on the north side has webs and spiders present. Use a Webster to remove the spiders and webs. There is also general clutter which provides harborage for spiders, insects and rodents.

The kitchen has clutter, including many plastic bags stored in drawers. There are rodent droppings found in the drawers. The screen is torn on the window on the west side. The adjacent utility room has debris behind the water heater. The debris should be removed and the area cleaned. The vent should be closed to prevent rodent and insect entry.

Building 6 – IDLCS #58597 – Unoccupied Residence

Outside, clockwise from the gate: There is a gap by the rain dial on the west side. This should be filled and repaired. The door on the north side needs the door sweep replaced. There is a nest against the house which should be removed. There is a hole beside the gas meter pipe that should be filled with Stuf-Fit and plastered to prevent pest entry. There is a hole into the interior near the roof vent which should be repaired.

The window on the northeast side has a hole next to it that penetrates to the inside. Repair the hole with Stuf-Fit and plaster. The vents need to be screened with ¼ inch hardware cloth to prevent rodent entry (1/2 inch screen is too large).

On the east side, the broken vent screen needs to be replaced or repaired and backed by ¼ inch hardware cloth. The taped cracks cover holes into the inside of the screened porch and permanent repairs should be made.

On the south side, there is a hole by the porch door that opens to the inside. Fill the hole with Stuf-Fit and cover with plaster.

Inside: This vacant residence has spider webs, spiders and bird feathers in the utility room, which should be cleaned up. An American cockroach was found in the storage closet, which indicates a moisture source and food present.

The ceiling and roof in the furnace closet are wide open to the roof and should be closed or repaired. There were dead insects on the window sill. There is a need for longer arms or longer brooms.

Building 15 – IDLCS #58598 – Open Garage

The installation of ¼ inch hardware cloth on the structure under the roof is excellent. This method eliminates bird roosting and nesting on the beams. Use this method on all other open buildings. Stacked boxes and assorted tarps provide harborage for spiders, insects, rodents and snakes. Three of the windows won't close. The electrical or circuit breaker box has nesting material on it which should be removed. Place a 45° angled metal sheet on the top to prevent nesting. The hole below the electrical box should be filled with Stuf-Fit and plastered. There is also a hole behind the electrical box to the west wall that should be filled.

The mesquite tree branch overhanging the roof at the northwest corner should be pruned back to prevent pests getting onto the roof. A pipe on the north side has a gap around it through to the inside that should be sealed. On the north side of the garage, RTGS have burrows that penetrate the soil and under the wall. Dig a trench next to the wall deeper than the burrows and place ¼ inch galvanized or stainless steel hardware cloth in the trench to prevent the burrowing.

There is an ant trail from the upper northwest corner, down the wall, below the electrical box, across to the west wall and down. Wash down the trail with soapy water to remove the pheromone. Then place Drax Liquidator or other borate-based ant bait stations near the colony to eliminate the ants if it is felt to be necessary.

Building 16 – IDLCS #58599 – Old Pump House / New Library

Outside: On the southwest corner is a hole that extends underground that may be a rodent burrow. If the burrow goes under the foundation, moisture can penetrate after rain and cause damage. The door frame is damaged and needs replacing. The door sweep is in good condition.

Inside: There is a spider and web in the northeast corner behind the computer. Use a Webster to remove the spider and webs. The Library is very clean and no other evidence of pest presence was observed during this inspection.

PUBLIC AREAS

Building 12 – IDLCS #60178 – Visitor Center

Outside: On the north (front) side, there are spider webs under the covered porch capturing flying insects that may be attracted to the lights. There is a hole by the front doors at the ground level. The caulk by the walkway may need to be replaced to prevent water intrusion. The front double doors have been recently replaced and are being adjusted periodically to obtain the correct fit.

The ladies' restroom has gaps by the pipes into the wall by the air conditioner vent. Caulk or plaster to fill the gaps to prevent pest entry. There are spider webs under the sinks. Use a Webster to remove the webs and spiders. An American cockroach was caught in the web. Both ends of the heat pipe in the handicapped stall need to have the gaps caulked.

The men's restroom custodial closet has gaps around the pipes and need to be caulked or plastered to close them. The spider webs under the sink should be removed with a Webster. Gaps around pipes by the air conditioner should be closed with caulk or plaster. On the east side, there is a hole between the wall and the sidewalk that should be filled to prevent water intrusion. The vents should be screened to prevent insect access.

The Plaza Area: There are cracks in the caulk around the pillars. Clean out the old caulk and re-caulk to prevent moisture intrusion into the base of the pillars. There are rodent droppings near the double door and in the corners of the patio area. Clean up the droppings daily at close of business. Set Victor brand snap traps and remove dead rodents each morning. There are holes at the floor under the drinking fountain that

should be caulked or filled with mortar. A pipe open to underground near the back door needs a cap put on it.

On the west side of the building, the vents are open for birds and rodents. ¼ inch hardware cloth should be installed. There is another open vent above the northwest corner. The hole at ground level between the windows should be filled with Stuf-Fit and covered with caulk or mortar. The tree limb overhanging the building with a nest on it should be pruned back (after the eggs and young are gone) to prevent the acidic bird feces from landing on the structure and sidewalk. Clean the feces using a bleach solution to kill any disease organisms that may be present.

There are holes behind the porch pillar in the northwest area that need to be repaired or filled. Above the hallway from the plaza to the picnic area is a bird nest that should be removed after eggs and young are gone. Clean up bird feces with a bleach solution.

Inside: In the bookstore there are spiders and webs behind the displays. Use a Webster to remove them. There is a hole in the wall above the TV on the ledge that should be repaired. The hole in the wall at the floor level beside the front desk should also be repaired. The insect sticky trap under the front desk was clean.

Dead flies were observed in the theater by the blocked-off door. A gap around the pipe between two shelves in the storage room should be filled with Stuf-Fit and plastered.

In the offices on the west side of the building, ants had been seen. None were collected for identification; however, they were reported to be very small. These small ants could be Pharaoh ants, however, none were observed here. A spider was seen on the wall. Remove spiders and webs with a Webster. The diatomaceous earth (DE) which had been applied to some areas around the floor-wall junction was too thick. Apply the DE with a duster to get a very thin layer for crawling insects to walk through. The DE kills by abrasion of the cuticle, leading to loss of body moisture and dehydration.

The Museum and Exhibit Area: Under the air conditioning unit, there is lint, seeds and other organic debris which is possible food for dermestid beetle larvae. Spider webs are high on the outer wall above the ledge. Use a Webster to remove spiders and webs.

Desert cockroaches *(Arenivaga genitalis)* were found on a sticky trap behind the touch screen. Tepary beans or seeds were found on the floor near a spider web. A sticky trap under the "touch" display near the back doors was full of various insects, spiders, a gecko and a frog. This is an indication that the door sweeps are not effective, or that the doors are being left open. If the trap had been monitored daily, the gecko and the frog could have been removed by using olive oil to dissolve the glue. A ceiling tile is missing at the ceiling/wall junction over the desk by the back door. This tile should be replaced. A spider web was found in the corner between the couch and the wall. Remove webs with a Webster.

Hohokam House Exhibit: There is a spider web over the door in the display room. There is also a web in the jar in the back area. Use a Webster to clean these areas. The sticky traps placed in the back area of the display have captured two firebrats, a mosquito and some ant reproductives (winged).

The small electrical room to the right of the Hohokam display had lots of Diatomaceous Earth placed in here, much too thickly. DE is labeled to be applied into cracks and crevices and as a fine dust layer on surfaces insects crawl upon.

Kitchen and Copy Room: Near the coffee pot, there were three insects found on the counter. An ant reproductive (winged) was observed on the air conditioner unit. There were mouse droppings by the doorway from the kitchen into the copy room. Set Victor-brand mouse snap traps at the floor/wall junction (use a small amount of chunky-style peanut butter or other food for bait), and monitor each morning for captures.

Visitor Center Offices: Diatomaceous earth (DE) had been applied much too thickly in small piles on the floor. This is much less effective than a very fine dusty layer. There is debris between the windows. A sticky trap held a cricket. Both sticky traps and mouse traps had been placed in the offices. Mice had chewed on the rubber roller ball on the computer mouse devices.

There is an over-abundance of clutter in these offices which provides harborage for mice and insects. It is suggested that the clutter be reduced and materials be properly stored to eliminate harborage for mice and insects.

COMPOUND A

The presence of round-tailed ground squirrel (RTGS) burrows in areas of Compound A where visitors are allowed to roam or on guided tours become trip hazards that may increase liability issues. Compound A may need to have RTGS excluded from burrowing. Fill burrows present with “sterile soil,” then cover with geo-textile cloth and ¼ inch hardware cloth. To make the walking area more aesthetically pleasing, cover with a light (1 – 2 inch) gravel. As the gravel compacts with use, more gravel may be added to maintain a safe walking surface.

An alternative inside the walled areas surrounding the Great House is to lay down geo-textile cloth covered with ¼ inch hardware cloth and gravel. In future years if archeological excavation is conducted, the known element of the RTGS barrier can be removed from within the walled compound (and replaced after the excavation is completed). There has been evidence of the RTGS burrowing into walls at the junction with the ground. Install the geo-textile and hardware cloth at least six inches up the walls from the ground to prevent further damage. The geo-textile cloth will prevent possible scratching of the prehistoric material on the walls by the hardware cloth. The geo-textile and hardware cloth can then be covered with a mud material to reduce the visual impact of the pest exclusion.

THE CASA GRANDE GREAT HOUSE

One of the objectives of this Pest Management Plan is to keep rodents and birds from living in and damaging cracks and other voids in the structure. Another objective is to prevent bats from living in and damaging the structure. There is a large amount of bat guano present on the walls and in the cracks and crevices. On October 30, 2008, observation of the bat flight at dusk saw an estimated 40 +/- bats leave the Great House. It was also noted that pigeons did NOT roost in the Great House, but in the trees at the west end of the picnic area. During the inspection, mud dauber nests were seen in the cracks and a mouse had been caught in the second room.

Although bats are considered to be beneficial for the amount of insects eaten each night, their presence in the Great House is considered detrimental. Using the exclusion technique developed for CAGR to exclude pest species from cracks and crevices with ¼ inch hardware cloth fitted with a light plastic edge that greatly reduces abrasion on the prehistoric substrate; provide exclusion on all unoccupied holes, cracks or crevices. Then before young are born, or after they are weaned and flying, work at night and remove all the guano (save it) and install the exclusion devices. Build several large (to hold 50 – 80 bats) bat houses and season them with the saved (fresh) guano. If they are placed near the Great House and under the canopy, the bats can easily relocate to the bat houses. The bats can gradually be displaced from the Great House to the bat houses and still be an interpretive item of interest for tourists. This will also put CAGR in a good light in preserving the Great House AND the bats.

THE CANOPY OVER THE GREAT HOUSE

The presence of birds roosting under the canopy on the beams and other structural supports provides the opportunity for bird urine and fecal material to fall onto the Great House. These acidic materials can react with the alkaline materials in the structure and cause deterioration. The only legal and practical means to prevent this is total exclusion. Use ¼ inch stainless steel hardware cloth for a permanent exclusion barrier. The canopy exclusion could only be necessary for the steel beam rectangle over the Great House. Bird droppings from the outer areas of the canopy would not fall on the structure. Apply ¼ inch stainless steel hardware cloth to the bottom of the rectangle of steel beams as well as up the sides to the canopy. Be sure there are NO gaps larger than ¼ inch at any of the seams or edges to ensure total exclusion of birds. Be sure to install a hatch door for access into the exclusion portion of the canopy for inspection or maintenance purposes. Bird netting could also be used; however, it would deteriorate over time and require replacement.

THE BALL COURT

There are several active RTGS burrows; however, not all are being used. As this portion of the Monument is NOT to be disturbed, physical exclusion of the RTGS from burrowing with ¼ inch hardware cloth may not be a good option at this time. The RTGS natural fear of native predators may be a method to move the concentration of burrows off of and away from the Ball Court. Perhaps a series of movable, opaque sight barriers that could hide potential predators would cause the RTGS to move the colony away from the sight barriers and, thus, away from the Ball Court.

The plants growing in the center of the Ball Court can be periodically removed by hand pulling or by treatment with Glyphosate. If approved for use within the Monument's Fire Management Plan, a propane-fired weed flamer may be another option. There are some models available that use propane-fired infra-red heat to kill weeds. Of course, there are several low-risk herbicides available from Eco-Smart Technologies that use plant oils for managing weeds and other plants. Refer to the Label section of the Appendix. The use of Glyphosate around the

outside perimeter of the boundary fence may be acceptable. Be sure to wear full protective gear as Glyphosate has been linked to non-Hodgkins Lymphoma.

COMPOUND B

There were numerous RTGS or other rodent holes around the structure in Compound B. Most of the more active holes were on the east and north sides. Perhaps this location is not as visible from the "visitor" area overlook; thus more attractive to the RTGS. On the other hand, it could be that the north and east sides get the early morning sun but are protected from the hot afternoon and evening heat.

An advantage Compound B has over Compound A is that Compound B does not have visitor traffic. There are significant structural remnants and significant artifacts present in the area. However, there is not likely to be people walking in the compound except for staff and researchers which reduces the trip and injury occurrence. The presence of RTGS on the site does pose the problem of disruption of the chronology of any artifacts that may be present. This poses the opportunity to determine if the RTGS can be moved out of Compound B by the placement of portable sight barriers. The objective is to move the RTGS out of the Compound B area to a less critical portion of the Monument. Portable opaque sight barriers can be developed that can direct the RTGS population away from the area to be protected. If this approach will accomplish the goal, then total exclusion of Compound B with the addition of sterile, backfill soil, geo-textile cloth, ¼ inch hardware cloth and gravel may not be necessary. A layer of 1 inch and smaller gravel may also help deter RTGS burrowing.

PICNIC AREA AND MEDIAN STRIP

A test plot in the picnic area to determine how effective the use of geo-textile cloth covered with gravel to prevent RTGS burrowing, compared with geo-textile and ¼ inch hardware cloth covered with gravel was established in January 2009. Pending the results of this test area over time (six months), perhaps only a layer of gravel would suffice.

Most ant species will feed on honeydew and other sweet materials, and transport these materials back into the colony. A slow-acting toxicant in a sweet bait may work. Drax Liquidator or other borate-based sweet liquid ant bait, works well for most pest ant species. Monitor the bait to be sure it is not totally empty. Replace the bait as required.

Several of the prickly pear and other succulent plants show damage from feeding by RTGS and possibly rabbits. Perhaps spraying the plants periodically with Bitrex (a taste deterrent) would reduce new damage. Bitrex was developed to prevent children from ingesting hazardous material, and preventing deer from feeding on ornamental foliage. This product would possibly deter RTGS and other rodents from feeding on succulent plants.

Current management includes the raking up and removal of fallen mesquite pods within the Picnic Area and Visitor Center vicinity. This practice, when combined with the exclusive use of drip irrigation and Bitrex may reduce the threat of rodent populations to human safety.

INTEGRATED PEST MANAGEMENT METHODS

Pest exclusion, sanitation and habitat modification are the most effective treatment practices.

EXCLUSION

Exclusion is the first line of defense in a good IPM program. Exclusion means making the structures physically unavailable to pests so that they cannot enter the structure to take up residence or detrimental activity inside. Some pests, especially in the larval stages, are very small and may be able to penetrate our tightest defenses. Exclusion procedures include keeping the external structure intact, by repairing all cracks, holes or other entry points into the structure that could allow insects, mites, spiders or rodents inside. Roosting, nesting or loafing sites for bats or birds must be modified to prevent these pests (spikes and glues don't work for long). Ledges and other level sites must be refitted with a 45º to 60º angled surface to prevent bird occupation. This can be accomplished on historic structures without ugly, distracting devices. Exterior doors can be fitted with "brass kick plates" and tight-fitting door sweeps to close the gaps between the door and the threshold to exclude crawling insects and rodents. Unused chimneys, air vents and other entry points into a structure should also be screened with 16 mesh or finer to prevent pest intrusion.

Exclusion is defined as finding and eliminating all possible entryways (points of access) pests use to enter a structure or room. Those entryways may be as small as a hairline crack in a wall or as large as a gap under a door, openings around pipe and wire traces, or the absence of screens on windows. Exclusion is more important and effective for the management of most pests than even increased sanitation (availability of food). Pests simply cannot be present in a building or display case if they do not have an entryway. All possible routes of pest entry or attraction must be found and eliminated. Periodic inspection and monitoring will guarantee the prompt discovery and correction of any newly appearing entry points.

Correcting exclusion deficiencies is site-specific but is usually done by sealing them (i.e., caulking, carpentry repairs, installing door sweeps, netting, installing filters on air vents and hot air registers, etc.). Identify and seal all holes that could potentially allow insects (small cracks) or rodents (holes or cracks 1/4 inch in diameter or larger) to enter the structure or room. In storage areas, sequester sensitive items in metal, glass, or durable plastic containers and periodically monitor them.

Assure that pests are not inadvertently imported into the building in or along with infested products or supplies (i.e., museum items or displays, firewood, outdoor furniture, employee clothing, lumber, books that have been on loan, etc.). This should occur in the receiving quarantine area.

Bird netting is an effective measure to exclude birds from alcoves, porches, and attics. Fit all ledges or level areas that are attractive for bird nests with 45º angle surfaces as a preventative.

Note: Screening chimneys and stove pipes may cause soot to build up on the screen. Install proper chimney caps for bat and bird exclusion. Periodic scrubbing of screening with a nylon brush will clear the screen and restore fireplace or wood stove performance. Various commercial chimney caps are available which exclude rodents, bats, larger mammals, and birds.

Moisture in contact with untreated wood is an opportunity for wood decay fungi to become established and destroy the structural strength of the wood. Wood kept dry will never decay. Wood in contact with soil, cement or masonry is more susceptible to moisture and, thus, very susceptible to wood decay fungi. The local weather (rain) can also expose the exterior wood to moisture. Any leaks may also expose interior wood to moisture.

The IPM Coordinator should perform an inspection to identify specific areas to close and direct maintenance efforts to accomplish this. Routine maintenance to repair roofs, siding, windows, doors or other portions of the structure should be accomplished with pest exclusion in mind.

SANITATION

The second line of defense is sanitation; eliminating pest access to food, moisture and shelter. Food and moisture are basic biological needs for any living organism, and life cannot be sustained without them. Eliminating food and moisture from access by pests will cause them to either leave or die. Reducing the access to food and moisture will reduce the carrying capacity of the site for living organisms. Reducing the carrying capacity of a site to zero may not be realistically accomplished with today's technology. However, reducing resources for pests will limit population size and growth. Reducing or eliminating clutter may be a more realistic goal. The combined efforts of Curatorial, Maintenance and Custodial staff can make great strides toward eliminating clutter in critical portions of the structures.

Identify and remove all potential food sources (rotten wood, food, fabrics, organic materials, mold, mildew, fungus, lichens, plants, etc.) and all possible harborage sites (openings, cracks, crevices, stacked firewood, clutter, etc.) available to pests. Verify that employees (or visitors) are not accidentally or willfully feeding animals (birds, squirrels, etc.) around the building(s). Verify that any animal wastes are regularly removed from around the exterior of the buildings.

Eliminating most food sources available to pests is a responsibility of Monument staff that work in or otherwise occupy the buildings. Food can be eaten elsewhere out of the buildings, or any (all) food residues cleaned up immediately when noticed. Food stored in the structures must be in metal or glass containers with tight-fitting lids (rodents and some chewing insects can easily cut through plastic containers). Elimination of all food sources that are accessible to insects or rodents is required. Moisture sources (leaks, condensation) can be identified and requested to be remediated by the Maintenance staff. Drink spills must be cleaned up immediately by the responsible staff member.

Many pests can go for great lengths of time without feeding or are able to survive on lint, fabric fibers, mold, and other uncommon food sources. Verify that museum and curatorial storage areas are thoroughly vacuumed (floors, cabinets, windows, and walls; in, under, and around equipment and furniture; and all cracks and crevices) at least twice a month, and more frequently if possible, to remove accumulated lint and dirt. Cleaning denies pests food and harborage and reduces insect survival rates.

Be sure visitors or employees are not providing food and water sources to animals, and that the grounds around buildings are free from debris or stacks of stored items.

Museum Collection Storage

Preventive placement of sticky traps at the floor/wall junction on both sides of the entry doors will reduce access by crawling insects. The inside bottom surface of the enclosed cabinets (below the bottom drawer) can be dusted with diatomaceous earth as a deterrent for dermestid beetle larvae and adults. DO NOT overtreat – a very light layer of diatomaceous earth dust is sufficient. The installation of museum pest-specific pheromone traps in upper corners of the rooms for flying adult moths and beetles can provide monitoring information and is a management method. Periodic vacuuming within the rooms will eliminate dust and other organic materials that can support pests.

Administrative Offices

Trash and other organic refuse must be removed at close of business each day. Thorough cleaning of each office and the break room must be conducted at least once a week. A periodic (unannounced) “white glove” inspection by the IPM Coordinator is helpful to point out clutter and sanitation deficiencies. Occupants (staff) can be made aware of how their own actions (and care) are important to prevent conditions conducive to pests being present (while staff are gone or in the office).

Housing

Employees should be provided information on the role they have in managing pests by eliminating clutter, sanitation and assuring food or other organic material is not available to rodent or arthropod pests. Keeping their quarters clean, neat and orderly is their own responsibility.

HABITAT MODIFICATION

The third line of defense is habitat modification, which may include changing the behavior and activities of the humans that work and visit these historic sites. Habitat modification is a term used to describe changes made to a site in order to reduce the number of pests the site can support. Living organisms need to have air, water or moisture, food or nutrients, adequate temperature, secure hiding or resting areas, and light for plant growth. These things make up the habitat of a site. By manipulating the access or availability of these necessities, the "habitat" can be modified to such an extent that the site is no longer attractive to the pest, or the site no longer supports the pest's life. Habitat modification can take many forms and is usually directed toward the "life style" of a specific pest to be managed.

If possible (to keep insects from being attracted to lights near entryways), mount outside lights on poles located at least 30 feet from the building and shine the light back onto the building. High pressure sodium vapor lamps that attract fewer insects and are more energy efficient can be used for exterior lighting.

Controlling temperature and humidity in structures can be very important in reducing insect populations. Humidity and temperature in museums and curatorial areas should be kept as cool and dry (below 45% humidity) as practical. The closer temperatures approach 50ºF and below, the slower insect activity becomes, which lessens feeding and reproduction. Reducing humidity lessens survival of humidity-dependent pests like silverfish or psocids.

Exclusion and sanitation measures cited previously are important parts of habitat modification. An additional measure to make habitat modification effective is the elimination of clutter. Clutter provides shelter and hiding places for insect and rodent pests. The elimination of clutter creates open areas where pests prefer to avoid. Material (boxes, boards, etc.) stacked against walls or on the floor create hiding areas and pathways where insects and rodents can live undisturbed and unseen. Every person visiting or occupying the site is responsible for eliminating clutter. The introduction of predators or parasites into an area can also modify the habitat so that insects, rodents or other pests cannot easily propagate or survive.

Verify that all plants overhanging or touching the building are trimmed back at least 3 feet from the building so pests can not use them to move onto the building. If possible, establish a 3 foot wide vegetation-free zone around buildings. Use 3/4 – 2 inch rock gravel mulch (at least 4 inches deep) next to historic structures, picnic areas and planting beds. If a vegetation-free zone is not possible, keep grass, bushes, and trees next to buildings cut short.

Verify that all sources of moisture around the building are corrected. Eliminate any low spots in the ground that accumulate water run-off and all other water-holding sources (i.e., old tires, cans, refuse, and hollow trees).

BoraCare, a borate product with glycol to enhance penetration, is mixed with water to be applied to wood to protect from termites, wood boring beetles and all wood decay fungi, and is a fire retardant. Apply BoraCare as a spray to clean exterior wood. Apply a second treatment (the next day) to push the first moisture gradient totally throughout the wood beam. This makes all of the wood cells toxic to insects, fungi and molds. A moisture barrier can then be applied to further protect from moisture presence. WOODguard can be applied when wood moisture is 18% or below so it will penetrate to provide a transparent moisture barrier. Reapplication of the moisture barrier may be required every two or four years.

MAINTENANCE

Good maintenance practices should include habitat modification. Maintaining the structural integrity of a building is excluding pests from entering the building. The maintenance activities that repair leaks and other moisture management activities are modifying pest habitats that are reliant upon water. Temperature control can slow or increase the growth of insects, fungi and molds. A good example is interior humidity control. The lower the humidity, the fewer pests can live in a site. Good cleaning or sanitation practices will also reduce the carrying capacity of a site for pests.

Exclusion is another habitat modification that will reduce the capacity of a site for pests. Keeping food stored in pest proof containers such as glass or metal containers with tight fitting lids prevents pest access to food. Tight door sweeps keep crawling insects and rodents from entering. Similarly, repair of masonry and holes in walls and floors prevents potential pest access. The most effective way to manage rodents inside a structure is to keep them from entering the structure in the first place.

Changing the behavior of personnel who occupy the site is another means of habitat modification. Getting people to use trash receptacles, and removing trash at the close of business is necessary. Inspect trash cans or containers to verify that they are 50 feet or more from the building, raised on platforms off the ground, trash is being promptly removed, can interiors are being cleaned (use can liners), lids fit tightly, and can exteriors are clean. Removing or rearranging clutter can improve the habitat to make it less desirable for pests. Convincing occupants to clean up after themselves has great benefits. Habitat modification may also include behavior such as better cleaning practices, more frequent inspections and monitoring, and removing infested or contaminated materials from the structures.

Modification of the grounds can also prevent or reduce pest presence. Planting pest resistant varieties of turf and ornamental trees and plants also reduces pest presence and makes pest management easier. Proper watering regimens, fertilizing, and aeration of turf prevent insect, disease and weed pests on the site. Decorative rock mulch next to the building reduces suitable habitat for rodents, insects and other pests, and also helps manage moisture around the building.

Biological changes of the habitat can include interplanting to repel pests, encouraging the presence of bats (bat houses), introduction of lady bugs, lace wings, preying mantis, predator mites, parasites, other predators, diseases and entomophagus fungi.

Physical controls can be instituted to manage pest populations, such as: installing screens, air doors, light traps, fencing, proper pruning of foliage, netting or tension wires to exclude birds, sticky traps, lethal snap traps, chimney screens, metal flashing, weather stripping, caulking cracks and crevices, and mosquito nets. Other habitat modifications include moving stored firewood outside away from the building and moving lights away from doors or the building.

Identify and schedule the removal of stinging insect (honey bees, paper wasps, yellow jackets, mud daubers, etc.) and bird nests (English sparrow, swallows, etc.) from the structure as early in the spring as possible. Remove all organic debris (i.e., feathers, dead insects, excrement, etc.) from building ledges, gutters, and openings. Remove any spike or sticky glues used to deter birds and replace with a 45º ledge barrier to eliminate nesting and roosting.

Identify and remove the mammals from all burrows leading under building foundations. Verify that access doors and ventilation ports are tight and screened to exclude mammals and arthropods. Verify that holes, cracks, or gaps do not occur (or are sealed) in the foundation. If animals are using burrows, trap out the animals and securely close the burrow entrances. If animal nests are inside or under buildings and can be reached, it may be necessary to treat the nests for fleas, mites, and other parasites.

Rodent Traps

When managing rodents inside buildings, be sure to place a sufficient number of snap traps along all rodent travel routes and in all probable harborage areas. Place two traps 12 inches apart at each trapping station and locate stations every 10 – 20 feet along walls in suspected rodent harborage areas. Place traps with the triggers pointing toward the wall. Fewer traps can be used when larger rodents are present but there should be no less than two traps at each trapping station and at least one trapping station per room. Vary the baits used on traps by using food materials on some and cotton on others. Cotton balls are used by females to line the nest.

Snap traps: Because of Hantavirus and other disease concerns, the Center for Disease Control recommends only using snap traps (not live-capture type traps) for rodents because:

- snap traps prevent the possible spread of Hantavirus into unaffected rodent populations.
- snap traps limit the spread of rodent urine, saliva, and feces around trap sites.
- snap traps prevent human contact with disease organisms which may occur from bites or other physical contact with rodents.
- snap traps prevent human contact with disease-contaminated aerosols during trap handling.
- snap traps must be checked daily.

Glue Boards: Glue board traps are flat boards or trays coated with glue. Rodents become stuck to them and cannot escape. Glue board traps are not humane and must NOT be used for rodents.

Insect Traps: Low-Line, Mister Sticky and other crawling insect capturing traps can be placed at the floor/wall junction to remove (and monitor) insects from inside the buildings. Place them inside cabinets, shelving, under sinks and other dark areas where insect pests may seek food, moisture or shelter. Pheromone traps to capture adult (flying) moths and beetles that may attack historic fabrics, furs and other organic materials, can be placed near the ceilings or in corners away from critical or susceptible materials. Check blunder or pheromone traps at least weekly to monitor for the presence of pest insects that may have invaded the site.

Replace sticky traps or pheromone traps when they start getting full. Pheromone traps are most used in a museum setting to attract and capture carpet beetles, cigarette beetles, dermestid beetles, drug store beetles, Indian meal moths, clothing moths, and warehouse beetles (but other pheromones are being developed). Contact Insects Limited, Inc. for newly available pheromone traps.

There are many means to modify the habitat to make the site less attractive to pests, and to deny them the necessities for life.

PESTICIDES

Specific low-risk pesticides may be suggested to preserve and restore certain elements of the structures and historic contents from further damage by pests. Proposed pesticide use must be reviewed and approved by the IPM Coordinators at the regional and perhaps national level before application. Any suggested and approved pesticide applications must be conducted very carefully so as to not contact non-target surfaces. Any pesticides used should first be used on a like "test" surface to avoid any potential "mishap" to "historic fabric" such as wood, tile or plaster. Approved pesticide applications must be documented and kept in the IPM Coordinator's file.

PUBLIC SITES

Compound A (Arizona State Site Number AA:02:014) includes the Great House, associated structures and other archeological features. Compound A is not amenable to methods that may be used on modern or historic structures. The current exclusion approach using 1/4 inch hardware cloth with a flexible plastic mesh fitting cut to support the device without placing any pressure on the edges of structural cracks nor archeological features of The Great House is excellent. Coating the wire mesh with mud that has preset ventilation holes renders the exclusion almost invisible. The inherent flexibility of vapor permeable mesh inserts accommodates for cyclic expansion and contraction of earthen building materials without causing damage at the edges of excluded building features. A variation of this exclusionary device has been used for many years at CAGR and was relatively successful. The addition of this flexible support and vented mud plaster surface treatment improves both reservation and aesthetic values for these exclusionary devices.

There have been substantial and long-term discussions about how to protect the viga sockets from occupation, nesting and other bird activities. Several options have been brought forward.

The use of ¼ inch stainless steel or galvanized hardware cloth with an attached pliable plastic fitting has been used in the Great House to exclude bats and other critters from occupying cracks and fissures in the Great House. This technology is being used to protect the viga sockets until an "ideal" solution is discovered or developed.

The ideal solution must fit the following criteria to ensure that it does not negatively impact the integrity of the Casa Grande Great House (Barrow & Carr 2005).

1. Any treatment should be reversible as proven by testing off site.
2. This reversibility must be totally non-destructive.
3. The solution must be practical and not overly complicated (low maintenance cycle).
4. Other impacts must be considered such as moisture migration and material contamination.
5. The interpretive and presentation aspects need to be considered.
6. Material intervention should be the last resort at CAGR.
7. Any intervention should be as minimal as possible.

8. Materials should be compatible but distinguishable.
9. Side effects of the intervention need to be considered.
10. Prior to any intervention, the system should be tested in situ.

Some vertebrate pests such as bats may be more difficult to exclude as they only leave their roosts within the Great House at night. However, working at night after the bat flight, exclusion methods may be applied. Verify that there are no young left in the excluded area. Remove bat guano and other debris with a soft brush before applying the hardware cloth exclusion material. Use the bat guano to "scent" the bat houses provided to make them more attractive to the bats. The bats are a beneficial feature to the Monument and should be accommodated. Exclude bats after young are weaned and flying.

Historic wood beams that structurally support leaning walls within the Great House should be treated with a borate material to prevent wood rot, termites and wood-boring beetles from attacking them.

The area where round-tailed ground squirrels have burrowed at the soil/wall junction and upward into walls must be addressed to prevent further damage. If the damage is current (and occupied), drive out any rodents present and address any structural problems created where the rodent has excavated original material from the wall. Then rebury the soil/wall junction to prevent future access. The soil/wall junction can be covered with landscape fabric and 1/4 inch hardware cloth; then covered with 1 inch gravel to a depth of at least 2 – 4 inches if further exclusion is needed.

Other archeological sites that are interpreted to the visiting public include the prehistoric ballcourt, Compound B and Compound C. Due to their close proximity to the picnic area, landscape plantings and other public areas, these areas offer attractive habitats for pest species. These sites do not exhibit large amounts of exposed architecture but are still impacted by burrowing animals. Burrows have been documented in excess of 100 entrance holes within a single 10 x 10 meter survey plot (Carr and Girard, 1996). This level of damage displaces artifacts from their stratigraphic context and results in a loss of archeological information contained within these sites. The impacts of covering entire sites with ¼ inch hardware cloth or similar exclusionary devices would likely result in similar damages to archeological integrity from trampling features, staging area impacts, and creating roads to transport materials to work sites. Thus, alternative exclusionary methods are currently being considered.

Small rodents such as round-tailed ground squirrels, prairie dogs, mice and other small critters are very wary of larger predators. Obscuring the sight distance available may move a colony away from the sight barrier. Place a portable sight barrier on the opposite side of the group of RTGS burrows toward the direction you would like them to move. As the colony moves away from the barrier, move it periodically toward the preferred area for the colony. This process may take a long period of time to accomplish the goal. You may then need to provide exclusion measures to keep new RTGS populations from re-colonizing the area. Perhaps soaking the area with cougar urine, hot pepper spray, or other such deterrent periodically would help deter re-colonization.

INSPECTION AND MONITORING

Successful integrated pest management (IPM) depends on "inspections and monitoring" more than anything else.

Inspection is an action taken by a person (usually the IPM Coordinator) looking for (and seeing) evidence of pest activity in a structure, its surrounding environment, landscape or other areas. Anyone can conduct an inspection; however, it will achieve better results if the same person performs the inspection periodically, thereby noticing changes that may occur. Other staff can make observations and report them on a pest sighting log.

There are important tools that support the IPM inspector and assist in gathering information. One of the most important tools for the art of inspection is a powerful flashlight. Outdoors, a pocket mirror (reflecting the sun on sunny days) can take the place of the flashlight. The flashlight (and mirror) illuminates a relatively small area and helps the inspector to focus the vision in that small area to see more detail. Use a moisture meter to detect the level of moisture in structural media such as wood members, carpeting, plaster, shelving and cabinets to detect the presence of wood destroying organisms (WDOs) or mold. Be sure to record moisture readings and the media being tested. A UV light (black light) is useful for detecting rodent urine stains (they fluoresce) in runways, corners and other active sites. A notepad and pen, or working tape recorder and camera are necessary tools. Hand lenses, killing jars, plastic Zip Loc bags or envelopes for collecting specimens are also useful.

Consequently, non-chemical methods of managing pests become very important. When inspecting and monitoring for pests, information obtained will indicate effective non-chemical means for preventing, reducing, or eliminating pest infestations.

It may seem that "inspecting" and "monitoring" relate to similar activities; however:

> "inspection" refers to the initial discovery of pests or conducive conditions supporting pests and is a snapshot in time, and
>
> "monitoring" refers to watching or measuring changing conditions over time to quantify whether pest populations or the conducive conditions supporting pests are static, decreasing and improving, or increasing and worsening. The need for continual monitoring and prompt discovery of pests, especially arthropods and rodents, is urgent because these populations are able to rapidly increase in a short period of time and, when numerous, management requires significantly more effort, time, and expense.

Even though inspecting and monitoring may have different purposes, both activities examine similar things in similar ways. This describes a large number of things to look for and document on inspection and monitoring forms.

To be effective, low-risk pest management should never begin by applying a pesticide, but rather with an inspection that determines how the pest(s) entered, identifies the pest, and estimates the extent or seriousness of the infestation. There are always good (and usually apparent) reasons for every infestation and these must be discovered. Inspections (and monitoring) for pests and pest damage should always concentrate on obtaining information on:

- how pests entered (or, could enter)
- the location of harborage, food, and water available to the pest
- the existence, extent, and severity of the pest problem
- reproductive, life history, and behavioral information on the pest
- the safest and most appropriate management strategies, based on site limitations

INSPECTING AND MONITORING CASA GRANDE STRUCTURES

Exterior Inspections

Thorough inspections of the exterior portions of CAGR structures should be conducted at least twice a year – in early spring (March) and fall (October) when weather patterns change. Good exterior sanitation, exclusion, elimination of pest harborage and moisture, and management of exterior lighting will do much to keep pests away from and being able to enter the building. Use a bright flashlight (or mirror) to carefully look for pests, evidence of pests, equipment and structure deficiencies, and exterior cultural practices (clutter) that could potentially encourage or support pests. Carefully examine the building exterior from the ground to the roof, watching for locations where pests could enter the building (pest management efforts inside the building will not be effective until all exterior holes are closed). Locations sometimes overlooked include openings in and under equipment and inside electrical equipment and motors, openings in soffits, and in or around pipes and ducts (particularly those on the roof). Inspect cracks and voids by applying a flushing agent such as compressed air that forces insects out of hiding.

Inspect locations of lighting for attracted insect pests. Look for food and water sources near structures that may attract arthropod or vertebrate pest species. Check vegetation that may provide harborage or access via vegetation ladders to the structures. Inspect refuse containers for pest access or presence. Bird or wasp nests on structures must also be noted during the inspection. Check for burrows under structures and determine if they are active.

Outside Bird and Bat Inspections

Birds and bats enter buildings for nesting or roosting or when outside conditions become too harsh. Preventing birds and bats from being attracted to or using buildings can be very difficult but such actions are important for preventing accumulations of bird- or bat-associated debris and feces and to keep their ectoparasites from becoming established in buildings. Although bats are beneficial for reducing night-flying insects such as mosquitoes, they should not be allowed to roost inside structures. Provide a bat house for their benefit.

Carefully inspect the eaves, roofs, and other structural building elements for the presence of birds, bats, bird nests, and bird and bat roosting sites. Verify that chimneys have bat-proof caps and roof vents are screened with woven hardware cloth (1/4 in. mesh). Look for and close small (1/4 inch diameter) holes around soffits to keep birds, bats, or other animals out of ceilings and the void spaces between walls. Inspect to be sure that exterior garbage cans are in good condition, kept clean, lids are tight, and disposal practices are appropriate.

Outside Inspection for Large Mammals

The presence of larger vertebrate pests (i.e., skunks, raccoons, rabbits, badgers, foxes, feral dogs and cats, etc.) in or around a structure can allow for various other common pest problems and possible damage. Inspecting buildings for larger animals is easier than for insects or mice because the holes and trails are larger and the animals create more sign.

Carefully inspect building exteriors and perimeters for burrows leading under foundations, large rocks, or tree bases; see that crawlspace openings are tightly closed. Record observations of larger animals and damage to grounds and structures.

Some methods for determining if an animal burrow is active are to: (1) place wadded newspaper in it, (2) sprinkle talc or dust on the ground around the opening, or (3) kick in or collapse the burrow. Look for evidence of activity (newspaper moved, tracks in the dust, or the burrow reopened) on your next visit. Active skunk dens usually have a strong odor associated with them.

Interior Inspections

Conduct thorough inspections of the interior of structures at least twice a year – in early spring (March) and fall (October), usually in conjunction with exterior inspections. Inspect critical sites (displays of organic historic fabric, archive storage, etc.) up to twice a month if necessary. Once insects invade a structure, museum or archival storage area, management can be very difficult, expensive, and require considerable time because small, residual populations are able to survive under even the most sanitary of conditions. Given the opportunity, such latent populations can suddenly explode into major problems.

It is important to find pest infestations as early as possible because most pests are highly adaptable to conditions and very prolific. Inspections that discover the early stages of an insect infestation and concentrate corrective measures on thorough exclusion, increased sanitation, and reducing pest habitat will generally manage most insect problems.

Serious pest problems in one part of a building usually means the entire building will need to have management action because all the rooms usually share an adjoining ceiling and crawlspace as well as pipes, electrical wiring, and ducts. If pests survive in a room with poor exclusion or sanitation, it is possible for them to quickly spread to all other rooms. Thus, pest inspections should also encompass the entire building, especially those containing the historic material or museum.

Use a bright flashlight to examine all portions of the building (all floor, walls, ceilings, and furniture or equipment) for any potential sources of food (crumbs, fabrics, lint, organic artifacts, etc.), water, or harborage (cracks, crevices, clutter, dark corners, etc.) available to pests. Also watch for pests, evidence of pests, and structural deficiencies (holes, cracks or crevices) or cultural practices (sanitation) that could support pests.

Monitor temperature and humidity in structures (use appropriate data loggers) as higher temperatures and humidity increase arthropod metabolisms, resulting in more activity and higher reproduction rates.

Locations often overlooked during inspections include areas inside and under drawers, cabinets, and furniture; attics and store rooms (where rodents or other animals may have food caches), inaccessible wall voids (that may hold dead insect or animal carcasses); and inside electrical equipment and motors (especially computers). Because there are so many different kinds of pests that have different biology and living requirements, museum inspections must be extremely thorough and the inspector must be familiar with the various species and their preferred habitats.

The signs of a pest infestation can include: shed insect skins, feeding debris (or, frass) around or below specimens, hair falling from fur or pelts, mats of fibers, silken tubes or cases, live or dead adults, larvae, or pupae, living or dead insects near windows, damage to or exit or feeding holes

in organic objects (i.e., wood, fabrics, hide, fur, feathers, horn, silk, etc.), infested or damaged food or food packaging, pests captured in pheromone or sticky traps, pests captured in ceiling light fixtures or pests or pest debris found in vacuum bags. A hand lens may be necessary to examine for small insect parts or to find eggs.

Carefully examine window sills and ledges, insides of light fixtures and areas behind or under display cases, baseboards and moldings, picture frames, rug edges, furniture, radiators and areas inside air conditioning and heating ducts, etc.

Monitoring Traps

Even if an inspection has not identified the presence of pests, place light or pheromone traps throughout a building where they will attract and capture flying pests (follow manufacturer's recommendations for placement). Also place sticky insect traps in hidden areas throughout a building, as well as inside specimen cases. Check all the insect traps on each visit (at least every two weeks). Identify all captured pests. Replace sticky traps and re-set rodent traps, as necessary. Record all information on identity, numbers and location of pest presence found in monitoring traps and their surroundings.

Pheromone traps are an excellent means for the early detection of certain kinds of museum pests since the traps only capture pests that are specifically attracted to the given chemical odors (i.e., pheromone). Pheromone traps, however, should not be considered as "control traps". Sticky, light, and electrocuter traps are not selective for species caught and are not principally used for control purposes either. These traps are used to verify the presence of insects, give information as to major areas of infestation or entry, obtain specimens for identification, and determine if insects are coming in from outside, monitor approximate changes in numbers or types present, and evaluate the effectiveness of management measures. Sticky traps (sometimes called “blunder” traps) are used for both inspecting and monitoring and are not selective of the species caught.

Record the direction from which pests enter sticky traps and the location on the trap where pests are captured to help indicate possible focal sources of infestations. One innovative method for using insect sticky traps for difficult-to-catch insects is to place the sticky side of the trap down on 1/16 inch spacers (such as small coins) to keep the trap just barely suspended over the floor. Traps set in this manner often are more effective in capturing crawling insects that seek refuge in small cracks. Insect electrocuter and light traps are useful for detecting flying insects. Some of these traps emit ultraviolet light (black light) that attracts flying insects, particularly flies and moths. The insects attracted to the trap are electrocuted or become stuck on a glue board. These traps, as well as insect sticky traps, must be frequently checked and emptied or replaced or the dead insects can become an attraction for dermestid beetles and other scavengers. Place traps in areas of suspected pest activity, against walls, near doorways, under fixtures and appliances but not directly in air currents, out in the open, or where they will become wet. Pheromone traps, however, sometimes become more effective when placed in air currents (follow the manufacturer's recommendations).

Reposition traps that do not catch pests after a week or two. The number of traps required in a room varies greatly depending on the kinds of pests present and severity and location of infestations. Increase the numbers and locations of traps when infestations can not be found or managed.

Individually number traps and draw their locations on a floor plan diagram of the building or room. Keep careful records of capture information (numbers, locations, species, life stage, etc.), locations where pests were caught and time intervals over which pests were caught. Also record

all findings from inspections, pest reports from residents or employees, track-dusting results, night time surveys with a night-vision scope or red or yellow lights, etc. This information can be very helpful to locate major pest harborage and entrance sites, identifying seasonal risk factors, showing changes in pest numbers over time, providing information on the results of pest management methods, providing information on trap vandalism or unexplained trap losses, noting predation on trapped animals by rodents or other animals, making treatment recommendations, or helping establish new action thresholds.

Pest Harborage

Use a bright flashlight to find and examine all pest harborage in the building. As necessary, inspect cracks or voids with a flushing agent such as compressed air, which forces pests out of hiding and shows the focal points of pest activity.

Sources of Moisture Available to Pests

It is very important to find and remove all possible sources of moisture available to pests. Look for any sources of dampness or wet food (especially, slime, lint, and organic matter in open drain receptacles) that could attract fungus-feeding beetles, flies, mites, psocids, silverfish, and other pests. During inspections, watch for spilled or condensate water around water coolers and fountains, dehumidifiers and humidifiers, water pipes (condensation), potted plants, and aquaria. Check toilets, kitchens or lavatories (sinks), boiler rooms, mop closets, floors, ceilings, crawlspaces, attics for water leaks.

Use a moisture meter to inspect walls and floors for suspected moisture content or to identify leaking pipes. Watch for mold or fungus on walls. If possible, keep the moisture content of wooden structural elements in buildings below 12% to discourage termite, carpenter ant and wood borer activity, and to reduce the incidence of mold.

It is best to not have live, potted plants or fresh flowers (adult dermestids and other museum pests feed on pollen and nectar) in offices, museums, or curatorial areas. If plants must remain inside, assure they are not over-watered and carefully inspect the soil, along the edges of pots, and under supporting catch plates for arthropods, particularly fungus gnats.

Verify that condensation does not form, run off, or puddle under windows in cold weather. In winter, check for residual moisture or puddles of water near boots and overshoes and for water puddles near entryways and in closets.

Check that there are no moisture problems in the crawlspace (if so, increase ventilation or install moisture barriers).

Food Available to Pests

When inspecting buildings containing museum items, be very alert to all possible sources of food available to pests. Check for candy, sugar, fresh fruit, snacks, etc. stored by the staff in office desks, cabinets, or at visitor contact stations (there should be no human foods at all in curatorial areas and museums); empty aluminum cans or food containers destined for recycling (do not store empty aluminum cans indoors before they are moved to recycling stations); fresh flowers or potted plants in offices; spilled food materials or dirty dishes in break rooms; dead insects or rodents on sticky traps; etc. All food kept in the building in employee lounges should be kept in refrigerators or in tightly sealed glass or metal containers. Verify that birdseed, rodent poison, and other animal food materials are not stored in the building housing the museum or curatorial

storage area (if such materials *must* be kept in the building, be sure they are kept in tightly sealed rodent and insect-proof containers). Check to see that lint and all other organic materials are regularly cleaned out of stoves, refrigerator coils, microwave ovens, and other equipment used in the employee break room. Inspect trash cans to see if trash is being removed from the building every night, if the bottoms of can (under plastic liners) are clean, if the lids fit tightly on exterior containers, and if areas outside around exterior trash receptacles are clean. Check to see that interior floors are thoroughly vacuumed every day and that custodians notify supervisors, IPM Coordinator, and museum curator where moisture, pests or evidence of pests, or food scraps are found. Keep garbage cans tightly covered; remove garbage from the building every night; frequently wash garbage cans. Check to see that fabrics in the museum have been dry cleaned to remove pest attracting stains (i.e., sweat, food, etc.) and kill insect larvae and eggs. Woolens should be frequently brushed and cleaned (or, dry cleaned) and hung in the sun to remove larvae and destroy eggs. Rugs and carpeting should be regularly vacuumed.

Importation of Pests

Carefully inspect all boxes, supplies, equipment, wooden pallets, specimens for acquisition, etc. that come into the structure. Verify that all incoming goods are carefully checked for possible pests and, if infested, are rejected or quarantined (tightly sealed in a labeled polyethylene bag kept well separated from collections and supplies until it is determined to be pest-free) or sterilized (deep-freeze, heat, fumigated, or by other means). This activity should be conducted in or near the quarantine area.

Storage Conditions

Verify that all items prone to insect infestation or that could supply harborage to pests (boxes and articles stored on floors) are placed on shelves or platforms (6 inches or more off the floor; the accepted standard for museum storage). This eliminates harborage beneath the items on the floor, moves items up and away from sites of major insect activity, allows for cleaning and inspection of floors, and allows for placement of monitoring traps.

Infested museum items. Verify that all items in the structure or collections showing signs of active pest infestations are immediately removed from display or storage and are isolated and treated. Following removal of infested items, the area surrounding the infestation should be carefully inspected and treated by appropriate means.

Occasional insect invaders. It is important to note that finding outdoor insect pests inside a building (accidental pests) clearly demonstrates the inadequacy of exclusion and should initiate a thorough inspection to find and close the entrance holes. Verify that all doors to the outside have tight-fitting door sweeps and that there are no openings around window and door frames.

INSPECTING FOR RODENTS

Rodents are the most insidious and invasive vertebrates around CAGR structures so more detailed information is provided.

Rodent inspections and monitoring must find and close the points of entry. A Center for Disease Control (CDC) study (Glass, et al) found rodents in rural cabins and mobile homes commonly move from outside habitats into the structure then back outside again. Interior rodent infestations were reduced by more than 90% by simply increasing the standards of construction methods and maintenance. Rodent management will only be effective where inspections uncover and correct structural deficiencies that support rodent infestations, such as: open points of access or

movement into the building or between rooms, careless sanitation and garbage management practices, and inappropriate storage conditions which create harborage. Pre-management inspection and monitoring data can be used as a base-line against which post-treatment results are compared to record the effectiveness of management efforts.

Outside Rodent Inspection and Monitoring

The long-term management of rodents in outside areas (i.e., burrowing rodents around structures, rodents that enter parked vehicles, etc.) can only be accomplished through habitat and ecosystem management which determines and, if possible, removes resources attracting pests and/or effectively excludes the animals from the resources. The ability to identify such conditions requires knowledge of the pests, their biology, abilities, and preferred habitats.

Begin at an identifiable point outside the building and methodically progress around the building to find any evidence of pests or locations where pests could enter the building. Key rodent signs or deficiencies that should be watched for in outdoor inspections are many. Look for fresh burrowing activity, the presence of runways, or damaged plants, etc. Record any structural foundations that are in poor condition, subfloor crawlspace vents and doors, door sweeps, porches, and windows that allow rodents access into buildings. Look for rodent activity around garbage disposal areas. Holes around utility service boxes and pipe or wire chases leading through walls allow rodents access into structures. Be sure structural roofs, chimneys, and roof vents are rodent-proofed with 1/4 in. mesh hardware cloth or similar exclusion device. Note any standing water, leaking pipes/hydrants, or poor grade conditions around buildings. Look for "vegetation ladders" that allow rodents to gain access to upper portions of buildings.

The best methods to monitor population densities of outdoor rodents are through documented visual counts of individuals; counts and locations of active rodent burrows and/or access points into structures; damage to rock or structural walls, foundations, sheds, etc.; and other such observations. Over time, such data will indicate the relative numbers of rodents present in different seasons and in different years. Information obtained from observational study will provide data for effective management approaches.

Monitoring for rodents in outside locations requires:

- regular documented analysis of rodent activity and sign by means of visual observations, trapping and open burrow surveys.
- maintaining weather records (i.e., weather results – not forecasts, precipitation, etc.) as early-warnings for climatic conditions favoring unusual plant growth that influences the occurrence of larger or smaller rodent populations.
- recording the numbers and kinds of dead rodents found. This information acts as an early warning for possible diseases in wild populations. Where feasible, all discovered freshly-dead rodents can be sent to public health agencies for analysis.
- monitoring the storage, transportation, and disposal of garbage and general area sanitation.
- request assistance from the State Department of Health or NPS Public Health officer for monitoring of possible plague-carrying fleas in rodent burrows.

Interior Rodent Inspection and Monitoring

Begin at an identifiable point in one of the rooms and methodically progress along a wall and through all rooms to completely search out all possible points of rodent entry or conditions

supporting their presence. A data sheet for recording inspection data can be used to list such inspection findings.

Sign. The presence of rodents produces a variety of signs that can be used for a subjective determination of the size or occurrence of a population. Signs are often found throughout a building in or around such places as fireplaces and mantles, floors and ceilings, edges of electrical and plumbing traces, hollow walls and structural voids, decorative moldings, wooden and upholstered furniture, inside water heater and furnace cabinets, and in kitchen and bathroom areas. It is always important to consider the physical abilities and behavior of rodents, especially their tendency to seek shelter and warmth behind, under, or in appliances, sink cabinets, drawers, stored goods, wall voids, false ceilings, and other undisturbed areas. Several of the common signs of rodents to look for during an inspection include:

Food Damage: Food packages that rodents have gnawed into, rodent feces or hair in open food containers, food scattered on the floor, etc.

Sounds: Sounds coming from inside walls or under ceilings of rodents gnawing, scratching, squeaking, or running.

Droppings: The number of rodent fecal pellets found relates to the number and type of rodents present and how long they have frequented a location. Periodically vacuuming rodent debris and droppings from an area will allow for information to be developed on relative pest use during an elapsed time interval. Prior to vacuuming, disinfect the droppings and urine in the area to prevent exposure to Hantavirus.

Urine: Rodent urine stains are visible under ultraviolet light (UV) and fluoresce yellowish, bluish-white, or yellowish-white. Since many other items in a building also fluoresce, it is important to be able to recognize stain patterns when using UV light. Urine patterns appear as lines of fine drops or streaks while chemical and food spills tend to be larger, patchy areas or uniformly spread out. Test kits are available to validate the presence of rodent urine.

Rodent Feeding stations: Many rodents carry food to what they consider to be a safe place to eat it, usually in a protected corner. A greater abundance of rodent feces and urine deposits are seen in those areas. Also, remnants of foods (candy wrappers, nut shells, etc.) the animals have carried there are often seen and suggest what food sources should be inspected for rodent damage. Rodent feeding stations are good places to trap rodents.

Smudge marks: Dirt and oil on a rodent's fur leave smudge marks where the animals rub against pipes, beams, and openings. Once the marks are cleaned off the areas, the next monitoring will show if rodents are still using the trails.

Runs/trails: Rodent trails are often found in sheltered areas where rodents feel secure to travel; these appear as dust-free pathways both within and outside of buildings.

Tracks: Rodent footprints and tail drag marks are sometimes seen in outdoor and indoor mud or dusts. Patches of non-toxic tracking powder (chalk, diatomaceous earth [DE] or talc) can be used on floors inside buildings to verify the presence, activity routes, and relative abundance of rodents. Tracking patches have been shown to be up to 150% more effective for monitoring rodent activity than are snap traps.

Odor: Musky rodent odors can be detected when infestations are large and well-established, especially when ventilation is poor.

Gnawing: Rodent gnawing leaves small piles of chips around doors, baseboards, and windows. Gnaw marks may also be found on stored goods and food containers; electrical wire insulation; and as enlarged sides of pipe and wire traces. Fresh gnaw marks are light-colored that darken as they age.

Burrows: Holes and enlarged openings in walls and under foundations are often entrances to rodent burrows.

Nests and food caches: Rodent nests and food caches are found in undisturbed locations in structures including storage areas, computer and water cooler cabinets, crawlspaces, and around refrigerator or freezer motors. Nests are also found outside beneath rocks or boards, in pipes, etc.

Pet reactions: Pet cats and dogs may show unusually strong interest in a specific wall or floor area when rodents are present; this is especially true when rodent invasion is recent.

Use snap traps to monitor for rodent activity. Check the traps daily for dead animals. Place snap traps at each trapping location and place the traps at the floor/wall junction (triggers against the wall), in corners, under furniture, and in other areas where rodents may be active. For general building monitoring, place at least two trap stations in each room. Record the numbers, locations, dates, and species of animals caught on the floor plan diagram.

INTRODUCTION TO CAGR PESTS

Protection of prehistoric architecture, subsurface features, artifacts and all other archeological evidence is essential to fulfill the intent of the enabling legislation that established Casa Grande Ruins National Monument. Birds, mammals, insects, mold, mildew, and wood rot that, under ordinary circumstances may not be considered pests, may be threats to archeological site preservation. Here the adverse effects on the Monument environment from burrowing, feeding, nesting, roosting or other normal, yet benign activities, become a management challenge. Mitigation of these normal activities by native occupants is the goal of this pest management plan.

Bird nesting and roosting provides copious urine and fecal material which is acidic and reacts with the alkaline walls of the earthen architecture, causing damage. Nesting material in the viga sockets of the Great House, cracks, crevices and other areas may create possible degradation. Predators digging into round-tailed ground squirrel burrows further disrupt stratigraphic layers of archeological evidence. Insects breeding in the fecal material occupying the nests provide potential transmission of disease organisms to Monument staff and visitors. Management of the pests and mitigation of adverse effects is the objective.

The following sections introduce the actual pests found at CAGR. Each section details characteristics and recognition of pests, the hazards of infestation, inspection and monitoring information, and management measures. Listed as Appendix I to this pest management plan are pest profiles on each pest found at CAGR, along with others that are potential pests to the Monument grounds.

INTRODUCTION TO MUSEUM PESTS

CHARACTERISTICS AND RECOGNITION

Museum pests are represented by two species of clothes moths and an array of different, although similar-appearing, small, variously colored beetles, which are grouped under the generic name of carpet beetles. These carpet beetles include black and varied carpet beetles, hide beetles, spider beetles, larder beetles, etc. Indian meal moth, cigarette and drugstore beetles, rice and granary weevils, red and confused flour beetles, and saw-toothed grain beetles are also found to attack and damage organic museum artifacts. Carpet beetles are among the most difficult of all insects to manage. Pesticides are rarely effective for very long. Regardless of the treatment used, the best management for museum pests is thorough and very careful inspections, exclusion, good sanitation, and habitat modification.

Textiles infested and damaged by pests are usually wool-based items such as clothing, carpets, and tapestries. However, both carpet beetles and clothes moths feed on a broader diet than just wool, including items containing cotton, silk, hair, mohair, bristles, fur, feathers, and leather, as well as dead insects, pollen, grains, seeds, and many stored foods. Inside, infestations frequently occur when museum pests develop on dead animal carcasses (birds and rodents) or nests located in or adjacent to buildings, on dead insects (wasps, bees, cluster flies, lady beetles, etc.) and molted insect skins, or in spilled foods. Clothing that has food, sweat, or urine stains is especially attractive to clothes moths.

Female moths and carpet beetles lay soft white eggs on materials that will later serve as a larval food source (including lint and organic debris in concealed cracks). Larvae hatch and feed until mature, at which time they may move away from the food source into secluded spots where they pupate. Upon emerging as adults they mate and fly around; the females looking for egg-laying locations. Since larvae and adults often avoid light, finding a random cast skin, larva, pupae, or adult museum pest in a structure may be the only signal of an impending infestation.

Proper identification of pests is a critical part in this low-risk IPM program because it provides information on possible effective management alternatives. However, identification of museum pests is an entire field unto itself. This plan does not attempt to provide enough information for complete or scientific identification of museum pests, which would take volumes of information. Refer to pest profiles for a number of the major pests which might be expected in museums along with very brief sketches of their life histories. Museum curators and IPM Coordinators should refer to taxonomic texts and other sources (universities, reputable researchers, etc.) for pest identification.

INSPECTION AND MONITORING

There is a reason for pest infestation. The intent of inspection is to determine the kind and extent of infestations, how the pest got into the space and what factors contribute to its survival.

Any occurrence of moths or carpet beetles (adults, eggs, larvae, or pupal cases) is ample reason to initiate management measures. Museum pests feed on a wide variety of items, and inspection should be carefully and thoroughly performed in order to identify the food source. Populations can expand rapidly from the presence of only a few adults. Since museum pests are transported into buildings with infested products, management cannot be complete until all infested material is found and removed. This can be a sizeable undertaking, based on the variety of places where museum pests may be found. Inspect the following:

Stored woolen clothing and bedding
Down pillows and comforters
Silk, fur, mohair objects
Wool or silk carpets, rugs and blankets
Stuffed dolls and furniture padding
Upholstered furniture, animal hides and trophies, stuffed animals, light fixtures, dried flower arrangements, pet foods
Floor cracks, baseboards and vents for lint, debris, and hair accumulations
Indian corn decorations and popcorn packing
Spices in metal containers that have been kept for years
Eaves, attics, wall voids, and crawlspaces for wasp and bee nests, bird nests, bat roosts and dead or live animals
Fireplaces, chimneys, and vents for dead animals
Cereal, meal, and flour goods; bird seed or feed
Bean bags or candy that has been hidden away
Old books where insects are attracted to the glue in bindings
Ornamental artwork using foods and grains in printers' boxes, apothecary jars, picture frames and jewelry
Table centerpieces containing nuts, beans, seeds or other food products such as macaroni
Old rodent bait

Other locations where stored-product pests may be found are cork boards and backings; dead animal carcasses in voids, attics, or crawl spaces; objects containing fur, skins, horn, hair, feathers, and bristles; lint in cracks, picture frames, decorations; stored leather goods; old drugs; organic fertilizers and bone meal; garden seeds and bulbs; insect displays and collections; bird, rodent, wasp, bee, and bat nests; and smoked or dried meats.

To inspect carpets, pull back the edges from the tack strip and look under edges. Use sticky traps around walls and make careful visual observations. Insects do not infest the entire rug, only those parts not exposed to light and traffic. Closely examine compressed fibers under rugs and under furniture legs. Also inspect carpet edges under the quarter round.

Monitor pheromone and sticky traps for museum pest infestations at least twice a year (monthly preferred), using a hand lens and flashlight to search for eggs, adults, larvae, granular feces, and cast larval skins. Check window sills, under windows, window runners, behind baseboards, in cracks, crevices, radiators, and air ducts.

Critical Site Pest Sighting Logs

From the pest sighting log, request that the occupants mark on a floor plan of the site where pests have been seen, and then carefully examine those areas.

MANAGEMENT

Major Mistakes in Museum Pest Management Programs

The following are some of the major mistakes made in museum pest management programs:

- Failing to find and manage or remove sources of infestation
- Allowing museum pest infestations from the outside through poor exclusion or importing by infested artifacts, clothing, containers, and contaminated foods

- Failing to periodically monitor for museum pests and allowing infestations to become severe before initiating prevention or management actions

The presence of museum pests generally indicates inadequate sanitation practices; management requires that sources of infestation be found and discarded and the storage area be meticulously cleaned. If the source of infestation is not removed, pest management programs will not be effective.

Physical, Mechanical, and Cultural Measures

Regularly and carefully inspect clothing for insects and evidence of damage; do not import insect eggs or larvae on unprotected or uncleaned articles. Inspect new articles for possible infestation and damage (especially antique upholstered furnishings) before mixing them with articles already in the building. This function should be performed in a quarantine receiving area.

Moths normally only damage seldom-used clothing and blankets; frequently rotate or use woolen fabrics. Once a month, brush hidden areas (pockets, reverse cuffs, collars, etc.) on those garments which are infrequently worn and then shake, brush, comb, beat, and air them out in bright sun. Beating, brushing, and vacuuming dislodge and crush eggs and young larvae. Sunning and dry-cleaning removes both moths and larvae.

Brush or comb fur skins with a fine-toothed comb close to the skin where larvae spin cocoons.

Heat susceptible flour and cereal goods and hold internal temperature at 130ºF for an hour or more to kill most stored-product pests.

Sterilization

Storing fabrics in atmospheres containing more than 50% carbon dioxide or inert gas suffocates insects. Removing the oxygen from a storage area will also kill pests.

Freeze objects (-10ºF) for several days to kill larvae and moths, warm them to (40ºF) to encourage any eggs that survived to hatch, and then freeze again to kill any newly emerged larvae.

Subject infested objects to a temperature of 130ºF or more in a microwave, in a plastic bag placed in the sun, or for extended period of time in temperatures greater than 93ºF. Museum pests have very low resistance to heat. An infested structure can be heated to 160ºF to kill most pests, including drywood termites and mold spores.

HAZARDS OF INFESTATION

Small barbed hairs on larval carpet beetles, when ingested or inhaled, may cause dermatitis and irritations to nasal passages and sinuses. Food containing carpet beetle larvae has sometimes been responsible for enteric irritation in infants, or intestinal disturbances or allergenic conditions (urticaria, conjunctivitis, nausea, respiratory tract irritations) in adults. Further, these insect pests feed upon and damage museum objects.

Although fabric pests are not known to transmit diseases, feeding larvae do considerable damage to organic materials. Clothes moths damage clothing and rugs, as do dermestid beetle larvae and adults.

INTRODUCTION TO PUBLIC HEALTH PESTS

Public health pests are those that have an adverse effect upon human health through the transmission of disease organisms, or through the injection of toxic material into the skin of humans. Many public health pests actually pose a health threat to people; however, some are merely nuisance pests such as cluster flies (*Pollenia rudis* [Fabricius]) and “friendly flies” (*Sarcophaga aldrichi* [Parker]). Other public health pests include cockroaches, fleas, wasps and bees, spiders, ticks,rabid bats, Africanized honey bees and mosquitoes.

CHARACTERISTICS AND RECOGNITION

Flies make up one of the largest groups of insect pests and are carriers and/or transmitters of many health-related diseases. Some species of filth flies and biting flies may be present at CAGR.

Cockroaches may pose health issues because of the habitats they occupy, such as sewers and other poorly cleaned sites. The presence of cockroaches in kitchens or other portions of structures requires management action.

Fleas may be indoor pests, but are also present in outdoor areas: grounds, transition areas and woodlands. There are several species of fleas that may be present in Coolidge that have wild hosts such as fox, coyotes, badgers, skunks, ground squirrels, rats, mice and other rodents. Several flea species can transmit plague, murine typhus and other diseases.

There are only about 50 species of stinging wasps and bees that are troublesome to people. These are generally divided into two groups: the social wasps and bees (including hornets, yellow jackets, umbrella wasps and honey bees); and the solitary wasps and bees which include mud dauber wasps and tarantula hawks. Social wasps and honeybees build nests in and around structures, beneath eaves, on porches, behind blinds, in trees, shrubbery and in the ground. Solitary wasps prey on insects or spiders they paralyze and place, along with eggs, into individual nests. After the eggs hatch, the larvae feed on those paralyzed arthropods until they can emerge from the nest.

Only a few species of spiders live in structures. Since they feed on insects, they are rarely problems in buildings that do not have an insect food source. They are objectionable pests to people fearful of them, even though most are harmless. There are only two spiders considered dangerous to human beings in the United States: the black widow and the brown recluse, which are present at CAGR. Funnel web spiders or grass spiders are common throughout the United States and form webs with a funnel the spider hides in. The web is usually in bushes or grass, but are found in dark rooms inside structures.

Ticks feed on the blood of mammals, birds, reptiles and amphibians. There are two types of ticks: soft and hard. Soft ticks feed on hosts that return periodically to a nest, shelter or cave. Hard ticks are found on pets, wildlife and people.

Mosquitoes are usually incidental pests in and around buildings since their normal breeding habitats are outdoors. Mosquitoes are generally outdoor pests and may invade buildings during the warmer months from March to October. Some mosquitoes that are of concern at CAGR are *Aedes albopictus, Aedes vexans* and *Culex pipiens*.

See the Pest Profiles for more information.

INSPECTION AND MONITORING

Public health pests are usually detected by a thorough inspection of buildings and grounds or from complaints from staff or visitors. Flies, fleas, ticks, wasps or bees, spiders and mosquitoes are quite likely to be complained about by visitors. CAGR can inspect and monitor for these pests, and use signs to suggest personal protection from bites. Monitoring for flies can be done by using sticky fly tapes, Lure Sticks or sticky strings. Inspect ceilings and edges of structural members inside for flies resting at night or fly speck droppings during the day.

Some social wasps will build nests in porches or sheds. Inspect for the early stages of paper nests in the spring, and physically remove nests found with a spatula or knife; then clean the site with soap and water to remove the queen's pheromone which she uses to find the nest. Solitary wasp nests can also be physically removed from structures in the same way. Funnel web spiders can be removed with routine cleaning or a Webster brush can be used. Outdoors these spiders are beneficial.

MANAGEMENT

The most important major management mistake is the tendency to minimize the potential health risks from exposure to the disease organisms transmitted or carried by flies, mice and ticks.

Flies can best be managed by exclusion from buildings with screens on doors and windows. This may not be an option for the historic Structures. Keeping flies from access to food sources can be done by good sanitation practices for waste food material. Personal protection from flies, mosquitoes and ticks can be the wearing of light-colored clothing and the personal application of insect repellents. Garlic Barrier can be sprayed around an area to reduce flying insects for a short time.

Wasp nests can be removed in the spring when only the queen is present before the first brood emerges. Physical removal of the small paper nest can be done with a spatula or pocket knife. Remove the pheromone with soap and water or a spray disinfectant. Mud dauber nests can also be removed before the larvae pupate and the adult solitary wasps emerge. Honey bee swarms may be removed by a professional beekeeper to use the colony for producing honey. Small numbers of bees (not a colony swarm searching for a new site) can be knocked down with soapy water and killed or removed. A full coverage bee suit can provide protection.

INTRODUCTION TO STRUCTURAL PESTS

CHARACTERISTICS AND RECOGNITION

Structural pests are characterized by those organisms that live, eat, bore and/or lay eggs in the materials that make up the structure; and those that take up shelter or forage in structures. The former group includes wood destroying insects (termites, powderpost beetles, other beetles and carpenter ants) and molds and fungi. The second group includes several species of ants, bats, birds, rats, mice and squirrels. Although bats, birds, rats and mice do carry and/or transmit disease organisms to humans and could be included with public health pests, they MUST be excluded from structures. Thus, they are included here with other structural pests.

These various pests can be managed through the application of the basic principles of IPM – thorough inspection and monitoring for conditions conducive to pests as well as the pests themselves, exclusion, sanitation and habitat modification. Structural materials can become the food and shelter for termites, several beetles and fungi, which cause wood to lose its structural strength and its aesthetic appeal. Reconstructed historical structures may require non-historic methods and materials to protect from damage by these pests. Protecting the structure from the presence of water may be the basic concept necessary to manage most structural pests.

Identification of the pests, sometimes by their left-behind signs or behaviors, is very important to management or prevention of damage by the pest(s). Specific identification of all the structural pests may be beyond the scope of this effort, but general information on several major structural pests is provided in the pest profiles. Insect specimens can be identified by your local extension agent or the University of Arizona.

INSPECTION AND MONITORING

A thorough inspection of all wood members of the structure should be done at least twice a year in late spring and early fall. Look for small round or oval holes in the wood and fine powdery wood frass from wood-boring beetles, or coarse wood shavings with insect parts intermingled from carpenter ants. Use a moisture meter to monitor wood moisture as most wood pests need a wood-moisture content of 12% or higher. Carpenter bees prefer to bore entry holes and galleries in outdoor beams or fascia to lay eggs and provisions for next year’s generation.

Ants infest structures in the search for food, shelter and moisture. Ants may form trails or randomly search inside. Outside ants are usually considered to be beneficial; inside they are a nuisance, but also a sign of poor sanitation. Follow trailing ants to find the entry point into the structure to perform exclusion action.

Molds and fungi can live or colonize on most organic substrates that have 12% or more moisture present. A moisture meter is a necessary tool. Many molds and fungi can be detected by a moldy odor or by visual signs of growth or fruiting bodies. The elimination of moisture or a treatment of the substrate may be necessary.

Rodents prefer to run next to vertical surfaces at the floor/wall junction. They leave grease marks from their fur which are visible with a powerful flashlight. Rats and mice tend to dribble urine as they travel these runways and in protected corners where they eat. Use a black light (UV) to detect the fluorescence of rodent urine. Rodents must constantly gnaw on wood or other firm materials to keep their teeth worn down as they constantly grow. Fresh gnawing on wood is light-colored which darkens as it ages. Proper exclusion of rodents is the most effective management method.

Bats in a structure are usually noticed by their droppings beneath roosting areas. At dusk, they can be seen exiting the structure. Birds like to build nests under the protective eaves. Prevention of these pests is best accomplished by exclusion techniques or a 45 - 60º angle on ledges.

Norway and roof rats are notorious for being moved from place to place by shipping. These exotic rodents are common in many urban cities. Exclusion and snap traps are the most effective management practices.

HAZARDS OF INFESTATION

Structural pests occupy areas in buildings that also contain people, thereby placing pests and people in close proximity. Although most of the structural pests do not carry diseases, bats, birds, mice and rats do. Wood-destroying beetles, carpenter ants and molds and fungi can adversely affect the structural strength and aesthetic appearance of wood structures. Structural pests must be managed for safety and aesthetic reasons.

A unique feature of CAGR is the adobe structures, including the Great House, walls and other structural components. The use of a cement encapsulation of the adobe walls and other architectural features would be a nearly impossible effort, and would diminish the historic appeal. As there is evidence of round-tailed ground squirrel entry at the soil/wall junction and burrowing up into the walls, an exclusion approach may be the only means of management. The use of 1/4 inch stainless or galvanized hardware cloth applied at the soil/wall interface may be effective. The presence of the 1/4 inch hardware cloth can be hidden by coating it with mud. Wood beams present in the Great House can be treated with a borate (TimBor or BoraCare) to kill and/or prevent feeding activities by wood borers or termites. A second application can “push” the first application through to the center of the wood.

INTRODUCTION TO ANTS

CHARACTERISTICS AND RECOGNITION

General

Of the 750 different kinds of ants found in almost every North American habitat, only about 30 species cause problems in structures. Because their small size permits ants to enter tiny holes, ant problems may be common. This section will describe methods for managing ants frequently found in kitchens, pantries, and food storage areas. Structure-damaging carpenter ants are covered in Structural Pest Profiles.

Ants are attracted to a wide variety of foods, including other insects, seeds, nectar, meat, grease, sugar, and honeydew (a sweet liquid produced by plant-sucking insects). Some ant species seem to wander randomly while others form trails from the colony to a food source. Most ants bite when disturbed and many species sting.

HAZARDS OF INFESTATION

Regardless of damages, ants are generally considered beneficial. Like spiders, ants kill and eat many insects including flea and fly larvae, and bedbugs. Ants are important in soil aeration and recycling of dead animal and vegetable materials. However, their management in structures is necessary because they contaminate food, damage structures, and some (pharaohs) transmit disease organisms. Several ant species, including pavement ants, are annoying because of their painful stings.

INSPECTION AND MONITORING

The target for exterior inspections is to find and correct breaches (which may be quite small) where ants are entering the structure from outside. The following are offered to assist in interior ant inspections:

- Study ant trails and identify where they are entering the space.
- Inspect behind baseboards, inside heat registers and ducts.
- Carefully inspect foundations and under grass, mulch, rocks, and logs for possible nest sites and trails.

MANAGEMENT

Major mistakes usually made in ant management are:

- Failure to accurately identify the ant so that its biology can be used to manage it.
- Failure to exclude ants through caulking and sealing and removing vegetation "ladders."
- A failure to thoroughly inspect the building, find nests and sterilize or kill the queen or queens.
- Failure to manage contributing conditions such as damp wood, bad sanitation, poor crawl space ventilation.

PREVENTION OF ANT INFESTATIONS

Established ant infestations can be difficult to manage. The best management is good sanitation practices, which eliminates the conditions attracting ants, and exclusion. The following practices are very important to follow:

- Clean up all food particles and frequently sweep, vacuum or mop up all scraps, lint or dead insects.
- Store all food in pest-proof plastic or glass containers.
- Use garbage receptacles with tight-fitting lids and remove the wet garbage every night.
- Trim back (3 feet) vegetation and trees that are next to buildings as these will harbor ants or aphids.
- Eliminate all sources of water for ants.
- Remove all old and decomposing wood debris, shrubs, or tree trunks that could provide nesting possibility for ants; control honey-dew-producing insects with beneficial predator insects.

MANAGEMENT OF ANT INFESTATIONS

Action Thresholds

Because ants readily communicate the location of food and water sources to other members of the colony, it is imperative that ant management begin immediately upon identifying them in the structure. The initial response may be to follow the line of ants and seal the point of entry to the structure. Remove the food attraction. The indoor presence of swarming or winged ants should always suggest the presence of nests indoors. Determine the ant species and possible nest location.

Physical, Mechanical, Cultural Measures

Limiting Entry: The basic Rule of Thumb in ant management is exclusion not eradication. Simply killing worker ants seldom manages a colony and may, indeed, result in colony multiplication. The following exclusions are suggested:

- Caulk all interior and exterior cracks and crevices and install tight fitting door sweeps on exterior doors; ants will stop coming into the structure when the distance from the nest to food becomes too long.
- As an additional precaution, cracks may be treated with an inert dust before caulking.

Physical and Mechanical Measures

- Sponge mop with soapy water or vacuum to remove trailing ants. Soapy water washes away trailing odors and forces ants to find other food sources.

Heat Sterilization

If the affected items can tolerate it, equipment, rooms, and furniture infested with ants can be sterilized by steam cleaning or dry heat (130ºF for 30 minutes).

Pesticide Treatments

Pesticides generally provide only temporary relief from pests in buildings. When chemicals dissipate, ants often reinvade structures. Exterior sanitation should be used in combination with interior sanitation. Treatment should be aimed at destroying the nest or sterilizing the ant queen.

Before any pesticide is applied, it is vital to know the kind of ants present, what they are feeding on, and whether their nests are located indoors. Borate based dusts and baits applied into harborage cracks and crevices of ants and other pests are very effective treatments.

Various types of solid, semi-solid, gel and liquid ant-bait stations are commercially available. Many contain low-risk chemicals including borates, abamectin, or hydramethylnon that are readily taken into the nest and to the queen. Ants feed each other so ant baits must be slow acting as several ants may be fed before the bait is passed through to the queen. These baits are attractive to ants, and help to manage ant populations. Place stations along ant trails where ants quickly find them. However, where sanitation is poor, bait performance will also be poor because of the availability of alternative food sources.

INTRODUCTION TO BIRDS

Birds provide enjoyment and recreation, enhancing the quality of life for those who view, enjoy, study, photograph, or hunt them. Over ten million people enjoy bird-watching as a recreational activity. Birds are protected by laws, regulations, and public opinion. However, birds can become pests when they create health hazards, roost on buildings, contaminate food, or create a nuisance. Pigeons and other birds, for example, cause human health problems when roosting in large numbers, and their droppings can foul buildings and walkways. The acidity of some bird excrement can also degrade the highly alkaline materials used to construct earthen architecture. Whether birds are seen as beneficial or harmful depends on time, location, and activity.

HAZARDS OF INFESTATION

Birds roosting in archeological feature and structural cracks of prehistoric structures, such as the Casa Grande Great House, can jeopardize the integrity of cultural resources. Their movement, within these features, nesting materials, and deposits pose a threat to resource preservation. Large populations of roosting birds may also present risks of disease to people nearby. The most serious health risks are from disease organisms growing in accumulations of bird droppings, feathers, and debris under a roost. If conditions are right, particularly if roosts have been active for years, disease organisms can grow in these rich nutrients. Birds may contaminate food. When parasite-infested birds leave roosts or nests, their parasites may invade buildings and can bite, irritate, or infest people.

Histoplasmosis

This systemic fungal disease (mold) is transmitted to humans by airborne spores from soil contaminated by pigeon and starling droppings (as well as from the droppings of other birds and bats). The soil under a roost usually has to have been enriched by droppings for three years or more for the disease organism (*Histoplasma capsulatum*) to increase to significant levels. Although almost always associated with soil, the fungus, in rare instances, has been found in droppings alone, such as in an attic. Infection is by inhalation of the spores carried by wind, particularly after a roost has been disturbed.

Most infections are mild and produce either no symptoms or a minor flu-like illness. The disease can, on occasion, lead to high fever, blood abnormalities, pneumonia, and even death.

The National Eye Institute (NEI) at National Institutes of Health has reported a potentially blinding eye condition, called ocular histoplasmosis syndrome (OHS). OHS results from infection by *Histoplasma capsulatum.* In this condition, the central part of the retina (the macula, used in straight-ahead vision) becomes inflamed and is damaged as blood vessels grow inside the affected area.

Cryptococcosis

Pigeon droppings appear to be the most important source of the disease fungus, *Cryptococcus neoformans*, in the environment. In general, the fungus is typically found in accumulations of droppings in attics, on ledges, and on other roosting and nesting sites on buildings.

The disease is acquired by inhaling the yeast-like vegetative cells (two to three microns) of the organism. There are two forms of Cryptococcosis that may infect humans. Acne-like skin

eruptions or ulcers characterize the cutaneous form with nodules just under the skin. The generalized form begins with a lung infection, and spreads to other areas of the body, particularly the central nervous system. It can be fatal. Like Histoplasmosis, outbreaks of this disease often occur after building renovation, roost clean-up, or other actions that disturb the old droppings.

Other diseases carried or transmitted by birds affect people to a lesser degree. Psittacosis, pigeon Ornithosis and Toxoplasmosis are normally mild in human beings, although serious illness or death can occur in rare cases. Pigeons, sparrows and many other species of birds have also been implicated in outbreaks of encephalitis.

Ectoparasites

Pigeons, starlings, and house sparrows harbor ectoparasites that can invade buildings. Some of these parasites can bite and irritate occupants. A long list of mites infest pigeons, but the northern fowl mite and chicken mite are usually the main culprits. These pests generally invade buildings from nesting and roosting sites. Other pigeon ectoparasites that may cause problems inside buildings are the pigeon nest bug (a type of bed bug), various species of biting lice, the pigeon tick, and the pigeon fly.

Droppings, feathers, food, and dead birds under a roosting or loafing area can also breed flies, dermestid beetles and other insects that may become major problems in the immediate area. These pests may fly or walk into windows, ventilators, cracks and crevices, and find other means to enter buildings. Structures that house museum specimens and historic artifacts can be invaded by dermestid beetle larvae that leave nesting and roosting sites.

Defacement and Damage to Structures and Equipment

Bird droppings under window sills or structural beams "whitewashing" down a building face, or accumulating on sidewalks and steps are the most obvious problems associated with roosts. Bird droppings can be acidic when in liquid form, further eroding traditional, earthen architecture at archeological sites. Clean-up can be labor-intensive and expensive. Bird droppings are corrosive and will damage automobile finishes, metal trim, electrical equipment, and machinery. Down spouts and vents on buildings also become blocked by droppings, nest materials, and feathers. This accumulation of debris can attract insect pests such as dermestid beetles, spider beetles, and mealworms. The resulting odor impacts visitor enjoyment of the Monument. Movement of birds nesting within structural cracks or archeological features within the Great House can accelerate the erosion of original features and may even cause structural collapse.

Legal Considerations

With very few exceptions, all birds are protected by one or more federal laws and regulations. Although pigeons, starlings, and house sparrows are considered exotic, invasive pest birds, they are not directly protected at the federal level. Monitoring records and observations show the most damaging pest birds are these three. They are the only ones observed to nest in structural cracks and architectural features within the Great House. They are the primary species that need to be addressed in prehistoric sites. Doves are also a problem in the Maintenance complex vehicle bays, but this is not considered as high a priority as preservation of the Great House and may be addressed solely with exclusionary methods. Toxicants or repellents should be applied according to the product label and under the restrictions that apply under the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA).

Non-target birds in the treatment area are protected, and any actions that kill or damage protected birds or their habitats would be a violation of various federal and state regulations. NPS policy and the Arizona State Structural Pesticide Commission further dictate licensing and permitting processes that must be complied with to implement pest control actions that potentially impact birds. Modifying the structure to exclude pest birds from roosting or nesting is not regulated.

When in doubt, contact your State Natural Resources Agency or the United States Fish and Wildlife Service District office in your area for further information.

INSPECTION AND MONITORING

The first step in managing birds is to conduct a detailed and accurate bird survey. Surveys should be conducted early in the morning, midday, and again in the evening to correspond to the different activity periods of birds. The survey should not be limited to information about pest birds; non-target bird activity is just as important in order to minimize risk to these birds. The surveyor should investigate:

- What birds are present?
- How many birds are present?
- Are they residents, migrants, adults, juveniles?
- Are they nesting, feeding, roosting, loafing?
- Where do they eat and drink?
- What is attracting them to the various sites?
- Are the birds causing a health risk?
- Are the birds causing physical damage?
- If dispersed, where would they go?
- Is risk involved to non-targets?
- What are the legal considerations?
- Could there be public relations problems?
- Is exclusion or habitat modification practical?

MANAGEMENT

Habitat Modification

Habitat modification for birds means limiting a bird's food, water, or shelter. Attempting to limit the food or water of pigeons, starlings, and house sparrows may be difficult. Elimination of food and water to local bird populations must be accomplished at sensitive sites. These birds will have a number of feeding and watering sites, often far from roosting and loafing sites. Where people are feeding birds in parks or lunch areas, education can help reduce this source of food. In some cases, people may pay little attention to requests to stop.

The most successful kind of habitat modification is to exclude the birds from their roosting and loafing sites (addressed in the section on exclusion).

Pigeons may be induced to move from an infested site by the persistent destruction of nests and eggs but often attempt to nest again in the same area. Nest destruction is ineffective against sparrows and starlings.

High-pressure streams of water spray are a cost effective method of nest destruction. It destroys the nest, eliminates ectoparasites, cleans droppings and feathers from the nest site, and harasses the roosting birds. However, this method should not be used on adobe buildings because it could permanently damage such buildings. Use high-pressure sprays only where the water will not damage buildings or equipment. Remove all droppings and nest materials from the area. When spraying is not safe, use a ladder or a hook fastened to a long pole to remove the nests. When the nests are within 20 feet of an occupied building, treat the immediate nest area with an insecticide / acaracide to eliminate ectoparasites.

Destroy nests every two weeks during the spring and summer months until the birds move to other nest sites. Nest destruction by any means is not allowed while young are in the nest. Removal of young birds or species protected under the Migratory Species Act may only be done by NPS staff with a permit from Fish and Wildlife Services. If this service is contracted to another federal agency or private contractor/cooperator, that organization must also be operating under a permit from Fish and Wildlife Services.

Exclusion

Some building designs and conditions lend themselves to bird infestation. Flat ledges, openings in water towers and vents, unscreened windows, and other attributes make a building an attractive location for roosting, nesting, and loafing. Modification or repair can exclude birds. Typical solutions include replacing broken windows, adding screens, repairing damaged eaves or ventilation screens, eliminating large crevices, and blocking openings into vents, cooling towers, and roof-top equipment with hardware cloth or similar material. The use of removable, flexible inserts constructed from 1/4 inch galvanized or stainless steel hardware cloth to exclude birds (and bats) from cracks and crevices in the Great House is an excellent approach. It is important that exclusionary devices that are installed in adobe structures are removable, self-supporting, vapor permeable, and may be removed without impacting original features of the building. This approach is also important for adherence to the Secretary of the Interior's Standards for Historic Preservation and Section 106 of the Historic Preservation Act of 1966. Coating 95% of the screen with mud allows for ventilation and makes it almost invisible, and is important for preservation of the ruins.

Exclusion methods also include the use of netting, custom-designed sheet-metal or plastic covers, porcupine wire (Bird Barrier products, for example), electrified wires, and sticky repellents to keep birds from roosting on ledges, roof edges, window sills, building signs, and other surfaces favored by pest birds. Modifying flat ledges by the addition of a 45° angle plastic or metal device eliminates the site for roosting or nesting by birds, and is the most effective approach. Two advantages are that the birds are not killed and the management is comparatively long-lasting.

Netting

Netting is used to block access of birds to large roosting areas in structures. Netting is especially useful in warehouses and around mechanical equipment areas where aesthetics are of minor consideration. It has been used successfully on cooling towers.

Plastic nets are alternatives to metal and fiber nets in bird management. Plastic nets are normally extruded black polypropylene and are made with an ultraviolet inhibitor to reduce UV degradation. Knotted nets are also available. Nets will last from two to five years depending on exposure to sunlight. Use the best quality affordable.

Covers or Ramps

Custom-designed covers for ledges, window air conditioning units, and roof edges are the best technical solution to keep birds from infesting these sites. The cost of this method may deter you from exercising this option on large buildings that have extensive roosting sites. But covers are valid options where limited applications will keep birds off selected sites, and where aesthetics are an important consideration.

The covers usually consist of sheet metal or plastic installed at a 45° angle to prevent the birds from landing. Sometimes plastic inserts are custom-fit into the indentations in order to block off ledges. Plastic or metal 45° angle inserts are now available commercially. These devices become almost invisible when properly installed.

Spikes

Porcupine wire, sharp metal spikes, or any similar "bed of nails" can deter birds from roosting on ledges. Where they can be used, they usually work fairly well. If aesthetics are important, these devices are usually limited to areas where they cannot be easily seen.

If pigeons are likely to drop nest material and other debris on top of the newly installed spikes in an attempt to create a new roosting surface, install metal spikes on potential landing sites above the installation.

Check metal spikes every six months for accumulated debris or nest material. Advise staff to regularly remove falling leaves and other matter that can cover the spikes and reduce their effectiveness. Prune to ensure that no tree branches hang over protected ledges.

Sticky Repellents

Sticky repellents are tacky gels or liquids. The products are designed to be sticky enough to make a bird uncomfortable, but not so sticky that the birds are trapped. After a few attempts, the birds stop trying to land on treated surfaces. The active ingredient is polybutene or isopolybutene (the same substances used in some adhesive bandages) or petroleum naphthenic oils.

Before applying sticky repellents, clean ledges that are covered by bird droppings, feathers, and nest material with a wire brush, paint scraper, high pressure hoses, or by steam cleaning. Ensure that surfaces are clean and dry.

Seal concrete, unpainted wood, brownstone or adobe with silicone or other sealant, paint, or shellac before applying repellent. Sticky repellents will be absorbed into porous materials.

Use a caulking gun to apply repellent. The depth of the bead necessary to repel different species of pest birds is roughly as follows: crows 3/8 inch; pigeons 1/4 inch; starlings 1/8 inch; sparrows 1/16 inch. The pattern of application will depend on the site and personal preference. The caulking gun should be held at an angle of 30-45°.

Place breaks in the bead every few feet to avoid trapping rainwater against the building.

Environmental conditions, particularly dust, make a big difference in the effective life of sticky repellents. In an area with no dust, applications should be expected to remain effective for a year or more.

Precautions should be followed when sticky repellents are used. Be sure migratory or other non-target birds are not harmed. Do not place sticky repellant material where it will become unsightly over time.

The disadvantages of sticky bird repellants are so great that they are not recommended for use in school sites or other urban areas, and may NOT be appropriate for CAGR. Sticky bird repellents, unless appropriately placed, may affect non-target birds and will usually lose their sticky surface with dust, soot and other materials. The sticky material may become ineffective and unsightly over time. It has been shown to be an effective bird repellent in the Maintenance complex vehicle bays where it is under cover.

Spike, glues and other deterrents become ineffective over time and are unsightly.

Remove Nests

Check state and local regulations that may prohibit destroying or disturbing nests containing eggs or young. Information provided to CAGR by USDA-APHIS indicates that unless the bird is covered under the Migratory Bird Act, nests and eggs can be removed. If the species is listed under the Migratory Bird Act, nests can only be removed before eggs are laid. A permit is needed to remove or relocate eggs and birds.

Ultrasonic Sound Devices

Tests by university, government, and private independent researchers have failed to demonstrate any efficacy against birds by any of the ultrasonic devices tested. These devices do not work against most birds because the birds become habituated to the sounds.

Trapping

In many instances, trapping can be an effective supplemental measure. Trapping is especially effective against pigeons. Where a group of birds are roosting or feeding in a confined and isolated area, trapping could be considered a useful tactic. However, caution must be taken not to attract rodents or other pest species to sensitive areas by baiting these traps.

The best time to trap pigeons is in the winter when their natural food is at a minimum. There are many pigeon traps to choose from; which type and size is best is a matter of choice. Most pigeon trapping programs use large walk-in traps. These can be 4 – 6 feet high and designed to be disassembled and moved. Another common type is a low-profile bob-trap that is about 8 inches – 2 feet high. The door or entrance through which pigeons are lured is the principle feature of a trap.

Pest bird trapping was attempted in the Great House in 2005, which resulted in greatly increased numbers of rodents and their damage. Pest bird trapping was abandoned.

Feeding areas are the best trap sites, but are rarely on the same property as the roosting sites. Rooftops that have water from cooling towers or air conditioning units are often good trapping sites in summer. The most difficult part of trapping is motivating birds to feed in a nonfeeding area so that they will follow the bait into the trap.

Remove trapped birds regularly. Trapped birds should be humanely destroyed. Some experts recommend gassing, but many feel it is simpler and more humane to kill the bird by breaking its neck. Since 2006, CAGR has had an agreement with the USDA-APHIS and local wildlife organizations to provide this service. When possible, the removed pest species are used as a food source for local raptor rehabilitation programs.

Avitrol

AVITROL is a poison bait with flock-alarming properties used to manage different kinds of birds. There are different AVITROL baits for each pest bird species. Within 15 minutes of eating a toxic dose of AVITROL, birds flutter erratically and go into convulsions.

AVITROL should only be used by a professional who specializes in vertebrate animal control measures. Before using Avitrol, the IPM Coordinator must obtain written approval from the regional IPM Coordinator.

Risks to Non-targets

Most lethal tactics in bird management pose some risk to non-target birds, as well as other animals. All migratory and game birds are considered non-targets, and are protected by various federal, state, and local regulations, as well as by public opinion. Care must be taken to minimize the threat to non-targets or to use tactics that pose the least risk.

First, identify any non-target birds or animals in the area.
Second, use tactics that are least at risk.
Third, modify tactics to minimize risk.
Fourth, monitor operations to be sure that no non-targets are being adversely affected.

Attract Predatory Species

In 2006, CAGR installed a raptor nesting box at the south boundary of the Monument and under the southwest eave of the Great House ruins shelter. Additional perching poles were installed to existing phone poles that were previously slated for removal just outside of the southwest boundary of the park. Instead, these poles were fitted with perches designed to provide a beneficial habitat for native raptor species. The perches and nesting boxes were designed by Wild Edge Conservation Science, the Bureau of Indian Affairs, and CAGR staff in response to damages caused by nesting bird and rodent populations in the Great House. Observations of raptor species within the park has grown since these measures were installed, but staff are uncertain if that is attributed to increased education among Monument staff reporting raptor sighting, or if local raptor populations are increasing within the perimeter of CAGR.

In 2006, CAGR began raptor flights in Compound A to reduce bird populations. That was a successful deterrent on starling and house finch populations when conducted on a biweekly basis, but not successful with the pigeons. It was halted in 2008 when territorial issues between the resident great horned owls conflicted with the trained raptor from Wild Edge.

Public Relations

People often react more negatively to one dying bird than to accumulated pigeon droppings on sidewalks or potential risks of parasites and disease from bird roosts. Pigeons and sparrows can be seen as pets rather than pests. The public's perception of bird management operations must be considered. All bird management programs should put some effort into avoiding "people problems," particularly when using AVITROL or other toxic techniques.

BIRD DROPPINGS REMOVAL AND CLEAN-UP

Workers removing large quantities of bird droppings should follow these precautions to minimize risk from disease organisms in the droppings:

- Wear a respirator that is labeled to filter particles down to 0.3 microns.
- Wear disposable protective gloves, hat, coveralls, and boots.
- When possible to do so without damaging earthen architecture, wet down the droppings to keep disease spores from becoming airborne, and avoid drying them out.
- Put droppings into sealed plastic garbage bags and wet down the outside of bags.
- Dispose of trash bags. Disposal should be permissible through standard trash pick-up.
- When finished, and while still wearing the respirator, remove the protective clothing and place them in a plastic bag.
- Wash up or shower.

INTRODUCTION TO RODENTS

Rats and mice are occasional structural pests, including the round-tailed ground squirrel, roof rats and native mice. These rodents can cause structural damage as well as posing health risks to Park staff and visitors.

CHARACTERISTICS AND RECOGNITION

Mice are small rodents that have very wide distribution. House mice are found throughout the world, and the deer mice and white-footed mice have populations in North America. The house mouse prefers to live in structures, whereas deer mice and white-footed mice prefer to nest in woodland habitats. The deer mice are known to carry Hantavirus, and will inhabit structures if they are available. These rodents usually have small territories and fast reproduction rates, so populations can build rapidly.

Norway and roof rats are not native to North America; however, they were brought from Europe with the early explorers and colonists. Both exotic rats prefer urban environments, but can easily expand into rural meadows, fields and woodlands. Most large cities have relatively large populations of Norway rats although they are not usually seen. Norway rats have been found to carry Hantavirus in some eastern cities, and also may carry a large number of other human diseases. The roof rat is more often found in suburban areas and also carries many human diseases. Both rats can have large territories if resources are abundant (water, food, harborage). The Norway rat is dominant if the two rats' territories coincide. Norway rats prefer to burrow underground whereas the roof rat prefers to nest up high in trees or attics.

HAZARDS OF INFESTATION

When rodents infest structures, stored food may be consumed and contaminated by urine and fecal droppings, making it unfit for human consumption. Several diseases can be transmitted by rodents or their ectoparasites, such as Salmonellosis, Rickettsial pox, meningitis, Leptospirosis, dermatitis, rat-bite fever, Ray fungus, ringworm and the deadly Hantavirus.

Hantaviruses are a worldwide occurring family of viruses that were first identified as human disease causing agents in the mid-1970's. One of these viruses, recently identified, causes acute and sudden respiratory illness and was responsible for a number of deaths in the Four Corners area of Arizona, Utah, Colorado and New Mexico during the summer of 1993. Now, additional cases of this Hantavirus strain caused a disease called Hantavirus-Associated Respiratory Distress Syndrome (HARDS), and have been confirmed in over a dozen states. Although there is reason to believe individual human resistance varies, records show this Hantavirus is lethal in about 60 to 70% of the clinically confirmed cases.

Hantavirus, naturally found in many rodents, is believed to be primarily carried by the very adaptable and widely distributed deer mice throughout the United States. The Norway rat has also been found to carry Hantavirus. Infected rodents do not show apparent effects of illness and may carry the disease during an entire lifetime, continually shedding virus in urine, saliva and feces. Humans may contract the disease with exposure to infected rodent excreta, especially when the virus is inhaled on contaminated dust particles. However, human transmission may also occur from rodent bites or when dried materials contaminated with rodent excreta are disturbed, directly introduced into broken skin or the eye, or possibly ingested in contaminated food and water.

Before inside rodent elimination work is begun, ventilate closed buildings or areas inside buildings by opening doors and windows for at least 30 minutes. Use an exhaust fan or cross ventilation if possible. Leave the area until the airing-out period is finished. This airing may help remove any aerosolized virus inside the closed-in structure.

INSPECTION AND MONITORING

Rodents may be more active at night and make their presence known by sounds of scrambling, gnawing and squeaks. Such sounds can be more easily pinpointed with the use of an electronic or regular stethoscope. The most easily noticed evidence of rodent activity in structures is fecal droppings. The house mouse will product about 70 droppings per day and the native mice will produce similar numbers. Rats produce fewer droppings. Rodent droppings become quite hard within a few days; fresh ones will be firm. Droppings will be along runways, in protected areas, near food sources and nests. Rodents dribble urine as they travel along runways and in protected areas. Look for many small drops of urine fluorescence using a black light. Rodents also produce greasy smears where dirt and oil from their fur mark pipes, beams and baseboards. Look for footprints and tail marks on dusty surfaces or in mud. Light-colored gnawing on wood corners, enlarged cracks or holes in woodwork, doors, cabinets and baseboards is evidence of recent rodent activity.

MANAGEMENT

Management and prevention of rodents is a three-part process: exclusion (rodent-proofing), sanitation (elimination of all food sources), and population reduction indoors with snap traps. The first two are useful preventive measures. When a rodent population already exists, lethal management is necessary. Otherwise, the reproductive capability of the rodents, and their remarkable ability to find food in almost any habitat, will keep their populations up or increase.

Sanitation

Good sanitation makes it easier to detect signs of infestation since it also increases the effectiveness of baits and traps, which represent the only food supply. However, even the best sanitation may not eliminate mice, since they require very little space to get into the building and small amounts of food to flourish.

Rodent-Proofing

It is a challenge to completely rodent-proof a building, since mice are able to squeeze through an opening a bit larger than 1/4 inch. Seal all holes to limit the movement of rodents into and through a building. Plug holes in foundation walls with 1/4 inch hardware cloth or copper mesh (Stuf-Fit). Caulk and fit doors and windows tightly. Seal holes around pipes, utility lines, and vents, to make it difficult for rodents to move in and out of wall and ceiling voids. This confines them to a smaller area and will make snap traps more effective.

Trapping

Snap Traps

If used correctly, snap traps are very effective in managing rodents. The territory of mice rarely extends further than 30 feet from the nest, and usually is about 10 feet. Rats have larger territories. If rodents are sighted throughout a building it means that there are numerous locations where you will have to set traps. Place snap traps not only wherever you see obvious signs, but look for good trap locations in a three-dimensional sphere about 10 feet in diameter

around those signs. Place traps every 3 – 6 feet in prime mouse habitat, and every 10 – 20 feet in rat infested areas at the floor/wall junction with the trigger against and perpendicular to the wall. Check traps daily.

Rodents can be living above their main food supply in suspended ceilings, attics, inside vertical pipe runs, and on top of walk-in coolers. Or they can be below, in floor voids or crawlspaces. The best trapping sites are those with large numbers of droppings, since that indicates that rodents are spending a lot of time there. Other good sites are along walls, behind objects, and in dark corners, particularly where runways narrow down, funneling rodents into a limited area.

Good baits increase the effectiveness of traps. Peanut butter, bacon, cereal, and nuts are traditional, but another is a cotton ball, which the female rodents like to use for nest material. It should be tied securely to the trigger. Food baits should be fresh to be effective. Mice are attracted to sweet baits, so a gumdrop tied to the bait pan may be effective. Probably the biggest mistake made in rodent trapping is not using enough traps. Use enough to make the trapping campaign short and productive.

Remove killed rodents from the traps. Wear rubber or plastic gloves while handling dead rodents. Place the carcasses in a plastic bag containing a sufficient amount of a general-purpose household disinfectant to thoroughly wet the carcasses. Seal and properly dispose of the bag. Rebait and reset all sprung traps, or discard with the rodent. Before removing the gloves, wash gloved hands in a general household disinfectant and then in soap and water. A hypochlorite solution prepared by mixing three tablespoons of household bleach in one gallon of water may be used in place of a commercial disinfectant. Thoroughly wash hands with soap and water after removing the gloves.

Rat Zapper 2000

Rat Zapper 2000 is an electronic trap that humanely kills rodents. The trap is a battery-powered plastic tunnel that is attractive to rodents, and provides a bait placement inside. When the rodent enters the tunnel for the bait and steps on a sensor, the rodent is given a lethal shock. A blinking red light then alerts you to the dead rodent in the trap. Empty the trap by turning it upside down, allowing the dead rodent to slide out. Remote sensing is also available for multiple traps.

Glue Boards

Glue boards are effective against mice. However, glue boards are not humane and are NOT suggested for use on NPS sites.

Rodenticides

The use of toxic baits and tracking powders is discouraged in occupied structures, museums or historic sites. Rodents are nibblers and may not get a large enough dose to achieve a kill. This leads to bait shyness. Rodents that are killed usually die in hidden areas that may be inaccessible. Dead rodents will have a bad odor for a while, another disadvantage to toxic baits. Dead rodents that are not removed immediately become attractive to blowflies and dermestid beetles that feed upon the carcass. These insects then may become the source of insect infestations in other areas of buildings.

CLEAN-UP OF RODENT CONTAMINATED AREAS

Hantaviruses have lipid envelopes that are susceptible to most disinfectants (e.g., dilute hypochlorite solutions, detergents, ethyl alcohol [70%], or most general purpose household disinfectants), or exposure to strong, direct sunlight.

Areas with evidence of rodent activity (e.g., dead rodents, rodent excreta) should be thoroughly cleaned to reduce the likelihood of exposure to Hantavirus infected materials. Clean-up procedures must be performed in a manner that limits the potential for dirt or dust to become airborne from all potentially contaminated surfaces and goods.

A baseline serum sample, preferably drawn at the time these activities are initiated, should be available for all persons conducting the clean-up of buildings with heavy rodent infestation.

Persons involved in the clean-up should wear coveralls (disposable if possible), rubber boots or disposable shoe covers, rubber or plastic gloves, protective goggles, and an appropriate respiratory protection device, such as a half-mask air-purifying (or negative-pressure) respirator with a high-efficiency particulate air (HEPA) filter or a powered air-purifying respirator (PAPR) with HEPA filters.

Spray dead rodents, rodent nests, droppings, or foods and other items that have been tainted by rodents with a general-purpose household disinfectant. Soak the material thoroughly, and place in a plastic bag. When clean-up is complete (or when the bag is full), seal the bag, then place it into a second plastic bag and seal. Dispose of the bagged material by burning.

After the above items have been removed, mop floors with a solution of water, detergent, and disinfectant. A second mopping or spraying of floors with a general-purpose household disinfectant is optional. To avoid generating potential infectious aerosols, do not vacuum or sweep dry surfaces before mopping. Disinfect countertops, cabinets, drawers and other durable surfaces by washing them with a solution of detergent, water and disinfectant, followed by wiping them down with a general-purpose household disinfectant.

Carpeting and upholstered furniture should be steam cleaned or shampooed. If rodents have nested inside furniture and the nests are not accessible for decontamination, the furniture should be removed and destroyed to avoid reuse. Launder potentially contaminated bedding and clothing with hot water and detergent. Use rubber or plastic gloves when handling the dirty laundry; then wash and disinfect gloves as described earlier. Machine-dry laundry on a high setting or hang it to air dry in the sun.

Personal protective gear should be decontaminated upon removal at the end of the day. If the coveralls are not disposable, they should be laundered on site. If no laundry facilities are available, the coveralls should be immersed in liquid disinfectant until they can be washed.

All potentially infective waste material (including respirator filters) from clean-up operations should be double bagged in appropriate plastic bags. The bagged material should then be labeled as infectious (if it is to be transported) and disposed of in accordance with local requirements for infectious waste.

Workers who develop a febrile or respiratory illness within 45 days of the last potential exposure should immediately seek medical attention and inform the attending physician of the potential occupational risk of Hantavirus infection. The physician should contact local health authorities promptly if Hantavirus-associated illness is suspected. A blood sample should be obtained and forwarded with the baseline serum through the state health department to CDC for Hantavirus antibody testing.

INTRODUCTION TO GROUNDS PESTS

CHARACTERISTICS AND RECOGNITION

Grounds pests can be represented by vertebrates, insects, invasive exotic plants, and bacterial or fungal diseases, all of which may be a concern to the site. The CAGR ruins grounds have become infested by exotic, invasive plants that affect its historic nature, and have insect and vertebrate pests.

INSPECTION AND MONITORING

Inspection is essentially a snapshot in time. It tells you the conditions and pests present at that point in time. Monitoring tells you what has happened over a period of time (overnight, the past week or month) or changes that have occurred over time. Both are essential in managing grounds pests. Inspection and monitoring activities should be an essential part of the implementation plans developed for the Casa Grande Ruins National Monument. Periodic inspection and monitoring will provide feedback on progress toward meeting projected (or professed) management goals.

Inspection for vertebrate pests on the grounds may be dependent upon signs of their presence. Such signs may be burrows, runways, clipped leaves or branches, droppings or damage to trees, cacti or other potential food sources. Actual sighting of vertebrates gives an excellent opportunity to determine species and perhaps the sex of the critter. Monitoring can be done by placing a tracking dust (flour, chalk or diatomaceous earth) in the runways to determine the numbers using the trail. Weighted baits (non-toxic) can be placed to induce feeding overnight, then weighed to determine feeding activity. A more sophisticated (and expensive) approach would be to place a sensor in the runway that counts the animals that pass by the monitor. Monitoring can help with selecting management methods or determining if management is necessary.

Inspection and monitoring for grounds insect pests may be more challenging as they can be very mobile and have very high reproductive capability. Many are very small (microscopic) and many may be cryptic (hide from human presence). It is sometimes easier to look for the results of insect presence or feeding activity on grounds. Many insects feed on turf, either below ground feeding on roots or above-ground feeding on the grass blades or seed. Insect activity on the grounds may be feeding on leaves, fruit, roots or stems. Eggs may be placed in or near fruit. Some insects may damage twigs or branches by laying eggs inside. Insects also feed on trees and shrubs. Inspect fruit, seeds, leaves, twigs and branches for signs of insect feeding or egg sites. Conduct winter inspections for egg masses on twigs by caterpillars (remove them to prevent spring defoliations). Monitoring for insect pests can use pheromone sticky traps for specific insect pests. The pheromone lure is attractive to specific insects (usually males) that get caught in the sticky surface. The glue holds the insect until the trap is monitored and the insect can be identified. Pheromone lures have been developed and marketed for insect pests. Insects Limited (see Vendors) has developed several. The USDA Forest Service has also developed monitoring lures for some pests.

Inspection and monitoring for exotic invasive plants is complicated by needing to know the various growth stages of plants from other countries or regions. Being able to identify an exotic invasive weed in the seedling or rosette stage is important. Inspection requires an extensive botanical knowledge to be able to differentiate the exotic invasive plant from a native plant (that may even be rare or endangered). Many invasive plants develop quickly and are prolific seed producers. Many also reproduce vegetatively by root suckering or other means. Inspection for

weeds is important and should be conducted monthly during the growing season (daily temperatures reach 50ºF or more). Monitoring may involve measuring the infested area and density, rate of growth, seed production and other vegetative measures. Weeds tend to grow where there is bare or disturbed soil, along roads, paths and animal trails.

MANAGEMENT

Vertebrate pest management methods should involve exclusion, sanitation and habitat modification. In landscaped areas, exclusion may be difficult for some situations. Predators on rodents such as owls and hawks can be encouraged by placing hawk roosting stands and owl boxes in various parts of the Monument where rodent activity is observed. Snap traps placed in trap boxes (to avoid non-targets) can be effective.

If through monitoring it is determined that an insect population has grown to the point where remedial action is necessary, the release of an appropriate predator or parasite will reduce the pest insect population to a low level. Some exotic insect pests have escaped without their natural enemies and can develop large damaging populations. Low-risk insecticides may be necessary. Obtain approval from the Regional IPM Coordinator for the purchase and use of any pesticide within the Monument.

Exotic invasive plants must be managed by various means such as hand pulling, pulling saplings with a weed wrench or Talon Claw®, pruning or cut stump and the application of Glyphosate or Triclopyr immediately to the stump. Treating the basal portion of a tree (with no skips) from the ground line up to 24 inches with an oil formulation of Glyphosate or Triclopyr can also be effective. Check with the Exotic Plant Management Team for appropriate species for use of basal treatment. When exotic plants are removed, plant an equivalent desired native plant in its place. Some exotic grasses can be shaded out by staking black plastic over small patches. Areas in full sun can be killed by solarizing the area under two layers of clear plastic. The Exotic Plant Management Team can assist with the management of exotic invasive plants. Two informative websites are http://tncweeds.ucdavis.edu/index.html and http://science.nature.nps.gov/.

HAZARDS OF INFESTATION

Vertebrate pests of grounds and landscape areas can result in degradation of the desired plants through browsing, girdling and feeding on fruit. Populations can expand and reduce the vigor of the desired plants. Some vertebrates also carry diseases hazardous to humans, or harbor insects (ticks or fleas) that also feed on humans and transmit disease.

Insects feed and damage landscaped areas and reduce plant vigor, transmit diseases that have adverse effects on turf and native vegetation.

Invasive exotic plants have infested the grounds and other areas of the Monument, changing its native aspects. Pests interfere with the Monument objectives, changing the historic scene and increasing the costs of management.

INTRODUCTION TO INVASIVE EXOTIC PLANT PESTS

Invasive exotic plants may be the most troublesome and expensive pest issue in the Monument. Exotic plants can be numerous, cover large acreage and produce many seeds that are dispersed by birds and other animals. Many exotic plants reproduce vegetatively as well. Some high priority exotic plants may need to be removed (and replaced with desired native plants) and herbicides applied to reduce resprouting. See Pest Profiles.

PEST SPECIES THAT ARE ACTIVELY MANAGED AT CAGR

STARLINGS *(Sturnus vulgaris L.)*

European starlings were introduced into the United States in 1890 and rapidly expanded throughout North America. They are considered an exotic, invasive species.

Habits of Starlings

Starlings nest in holes or cavities, and on buildings and other structures. Starlings average two broods per year with four to seven young per brood. Both parents build the nest, incubate the eggs, and feed the young. The young birds leave the nest at about three weeks old.

Starlings form large flocks and migrate to cities as weather cools, forming large roost sites.

Starling *Sturnus vulgaris L.*

Droppings damage buildings and build up to such levels that they become a human health hazard. Starlings have been responsible for outbreaks of a number of diseases.

Management Concerns and Action Thresholds

Is this species native to CAGR? – No

IPM Zone #1 - Public and Administrative Buildings

This species has a high potential for resource damage because they nest in the structural cracks and archeological features of prehistoric architecture. Installation of exclusionary devices will prevent this species from damaging architecture. Nests and eggs from this species are removed from architectural structures when found. Additional preventive measures include trained raptor flights and removal of specific pest animals by APHIS.

IPM Zone #2 – Residential Areas

Damage to personal property within the residence areas may trigger installation of similar exclusionary devices on their personal property. However, residents are not authorized to install any exclusionary devices that are not on their personal property without prior IPM Team review and approval.

IPM Zone #3 – Front Country Exhibits and Sites

Damage to prehistoric archeological resources will trigger treatment in the form of excrement removal or installation of the archeologist approved exclusionary devices that are included in this plan. Nests and eggs from this species are removed from architectural structures when found. Additional preventive measures include trained raptor flights and removal of specific pest animals by APHIS.

IPM Zone #4 – Back Country Archeological Sites

No treatment is authorized for this species within management zone #4 without prior IPM Team review and approval.

IPM Zone #5 – Back Country Natural Landscape
No treatment is authorized for this species within management zone #5 without prior IPM Team review and approval.

IPM Zone #6 – Roadside Maintenance
No treatment is authorized for this species within management zone #6 without prior IPM Team review and approval.

HOUSE FINCH *(Carpodacus mexicanus)*

House Finch

The house finch is a medium-sized finch of the Rosefinch genus. Adults have a long, square-tipped brown tail and are a brown or dull brown color across the back with some shading into deep grey on the wing feathers. Breast and belly feathers may be streaked; the flanks usually are. In most cases, adult males' heads, necks and shoulders are reddish. This color sometimes extends to the stomach and down the back, between the wings. Male coloration varies in intensity with the seasons and is derived from the berries and fruits in its diet. The colors range from pale straw yellow through bright orange to deep, intense red. Adult females have brown upperparts and streaked under parts. Their song is a rapid, cheery warble or a variety of chirps.

RANGE AND HABITAT

These birds are mainly permanent residents; some eastern birds migrate south. Their breeding habitat is urban and suburban areas, as well as various semi-open areas in the west from southern Canada to northern Florida, and the Mexican state of Oaxaca. Originally only a resident of Mexico and the southwestern United States, they were introduced to eastern North American in the 1940s.

FEEDING

House finches normally forage on the ground or in vegetation. They primarily eat grains, seeds and berries, being voracious consumers of weed seeds such as nettle and dandelion. Incidental small insects such as aphids are included in their diet. The house finch is known to damage orchard fruit and consume commercially grown grain, but is generally not considered a significant pest; rather an annoyance.

BREEDING

Nests are made in cavities, including openings in structures, hanging plants and other cup shaped outdoor decorations. Nests abandoned by other birds may be used. Nests may be reused for subsequent broods or in following years. The nest is build by the female, sometimes in as little as two days. It is well made of twigs and debris, forming a cup shape, usually 6 to 9 feet above the ground.

During courtship, the male will touch bills with the female. He may then present the female with choice bits of food. The male also feeds the female during the breeding and incubation of both eggs and young.

The female lays clutches of eggs from February through August, two or more broods per year with 2 to 6 eggs per brood, most commonly 4 or 5. The actual egg laying usually takes place in the morning, at the rate of one egg per day. The eggs are a pale bluish green with few black spots, and a smooth, somewhat glossy surface. In response to mite infestation, the mother finch may lay one gender of egg first, which increases the changes of the young finch's survival. The female incubates the eggs for 12 to 14 days. Shortly after hatching, she removes the empty egg shells from the nest. The young are pink with closed eye and tufts of fluffy down at hatching. The female always feeds the young, and the male usually joins in. The young are silent for the first 7 or 8 days, and subsequently start peeping during feedings. Initially the mother carries fecal sacs out of the nest, but when the young become older, she no longer carries away the sacs, allowing droppings to accumulate around the edge of the nest. Before flying, the young

often climb into adjacent plants, and usually fledge at about 11 to 19 days after hatching. Dandelion seeds are among the preferred seeds fed to the young.

House finches are one of the few birds that are aggressive enough to keep house sparrows out of their birdhouse and evict them.

PARASITES
The house finch may be infected with a number of parasites, including *Plasmodium relictum* and *Mycoplasma gallisepticum*, which caused the population of house finches in eastern North America to crash during the 1990s.

The mite *Pellonyssus reedi* is often found on house finch nestlings, particularly for nests later in the season.

The brown-headed cowbird, a brood parasite, will lay its eggs in house finch nests, although the diet house finches feed their young is inadequate for the young cowbirds, which rarely survive.

Management Concerns and Action Thresholds

Is this species native to CAGR? – Yes

IPM Zone #1 - Public and Administrative Buildings
This species has a high potential for resource damage because they nest in the structural cracks and archeological features of prehistoric architecture. Installation of exclusionary devices will prevent this species from damaging architecture. Nests and eggs from this species are removed from architectural structures when found. Additional preventive measures include trained raptor flights and removal of specific pest animals by APHIS.

IPM Zone #2 – Residential Areas
Damage to personal property within the residence areas may trigger installation of similar exclusionary devices on their personal property. However, residents are not authorized to install any exclusionary devices that are not on their personal property without prior IPM Team review and approval.

IPM Zone #3 – Front Country Exhibits and Sites
Damage to prehistoric archeological resources will trigger treatment in the form of excrement removal or installation of the archeologist approved exclusionary devices that are included in this plan. Nests and eggs from this species are removed from architectural structures when found. Additional preventive measures include trained raptor flights and removal of specific pest animals by APHIS.

IPM Zone #4 – Back Country Archeological Sites
No treatment is authorized for this species within management zone #4 without prior IPM Team review and approval.

IPM Zone #5 – Back Country Natural Landscape
No treatment is authorized for this species within management zone #5 without prior IPM Team review and approval.

IPM Zone #6 – Roadside Maintenance
No treatment is authorized for this species within management zone #6 without prior IPM Team review and approval.

HOUSE SPARROWS *(Passer domesticus)*

House Sparrow Male & Female, *Passer domesticus (Linnaeus)*

The house sparrow, also called the English sparrow, was introduced into the United States in the 1850's, and has spread throughout the continental United States except in heavy forests, mountains and deserts. It prefers human-altered habitats in cities and around farm buildings and houses.

The house sparrow is a brown, chunky bird 5 – 6 inches long. The male has a distinctive black bib, white cheeks, a chestnut mantle around a grey crown, and chestnut upper wing covers. The female and young birds have a grey breast, buff-colored eye stripe, and a streaked back.

HABITS

House sparrows average three broods per season with four to seven eggs per brood. Breeding can occur in any month, though it is most common from March through August. Eggs are incubated for about two weeks, and the young stay in the nest another two weeks.

Nests are bulky and roofed over, and located in trees and shrubs, on building ledges, in signs, on light fixtures, and under bridges.

Sparrows are aggressive social birds, often out-competing native species. They have no recognized migration patterns, and will stay in an area as long as food and nest sites are available. Young birds, however, move out of an area to establish new territories. Sparrows are tolerant of human activity, and will not hesitate to set up housekeeping in high traffic areas. House sparrows prefer to feed on grain. They will also feed on fruits, seeds, and garbage.

House sparrows can be pests in many situations. Droppings and feathers make unsanitary and smelly wastes. Sparrows can also become a pest when they nest inside a structure. The birds cause damage by pecking at rigid foam insulation in buildings. Sparrows transmit a number of diseases, internal parasites, and ectoparasites. They are thought to be a major reservoir of St. Louis encephalitis.

<u>Management Concerns and Action Thresholds</u>

Is this species native to CAGR? – No

<u>IPM Zone #1</u> - Public and Administrative Buildings

This species has a high potential for resource damage because they nest in the structural cracks and archeological features of prehistoric architecture. Installation of exclusionary devices will prevent this species from damaging architecture. Nests and eggs from this species are removed from architectural structures when found. Additional preventive measures include trained raptor flights and removal of specific pest animals by APHIS.

<u>IPM Zone #2</u> – Residential Areas

Damage to personal property within the residence areas may trigger installation of similar exclusionary devices on their personal property. However, residents are not authorized to install

any exclusionary devices that are not on their personal property without prior IPM Team review and approval.

IPM Zone #3 – Front Country Exhibits and Sites
Damage to prehistoric archeological resources will trigger treatment in the form of excrement removal or installation of the archeologist approved exclusionary devices that are included in this plan. Nests and eggs from this species are removed from architectural structures when found. Additional preventive measures include trained raptor flights and removal of specific pest animals by APHIS.

IPM Zone #4 – Back Country Archeological Sites
No treatment is authorized for this species within management zone #4 without prior IPM Team review and approval.

IPM Zone #5 – Back Country Natural Landscape
No treatment is authorized for this species within management zone #5 without prior IPM Team review and approval.

IPM Zone #6 – Roadside Maintenance
No treatment is authorized for this species within management zone #6 without prior IPM Team review and approval.

INCA DOVE *(Scardafella inca)*


Inca Dove

The Inca dove is a small New World dove belonging to the genus *Columbina*. It ranges from the southwestern United States and Mexico through Central America to Costa Rica; the Inca dove only lives on the Pacific side of Central America. Despite being named after the Inca Empire, this species does not occur in any of the lands that constituted that region. Inca doves are common to abundant within their range and they are expanding their range north and south.

Inca doves reach a length of 6.5 to 8.25 inches and weigh 1.6 oz. They are slender with a grey-brown body covered in feathers that resemble a scaled pattern. The tail is long and square, edged with white feathers that may flare out in flight. In flight, the underwing is reddish like other ground doves, and on takeoff, the wings produce a distinctive, quiet rattling noise.

This is a terrestrial species which occurs in flocks in open areas, including scrub and cultivation. It will feed in urban areas, eating grass seeds and taking advantage of the ready availability of water from agricultural and suburban irrigation. The song, a forceful cooing rendered variously as “cowl-coo” or “poo-pup,” may be given from a tree, wire or other open, high perch.

During winter, they roost in communal huddles in a pyramid formation that helps them conserve heat. These pyramids can contain up to 12 birds.

The flimsy twig nest is built 3 to 24 feet high in a tree, often a thorny species, and two white eggs are the normal clutch.

Management Concerns and Action Thresholds

Is this species native to CAGR? – Yes

IPM Zone #1 - Public and Administrative Buildings
This species has a high potential for resource damage because they nest in the structural cracks and archeological features of prehistoric architecture. Installation of exclusionary devices will prevent this species from damaging architecture. Since this species is protected under the Migratory Bird Act, a permit is required to remove eggs and baby birds from architectural structures. Additional preventive measures include trained raptor flights and removal of specific pest animals by APHIS.

IPM Zone #2 – Residential Areas
Damage to personal property within the residence areas may trigger installation of similar exclusionary devices on their personal property. However, residents are not authorized to install any exclusionary devices that are not on their personal property without prior IPM Team review and approval.

IPM Zone #3 – Front Country Exhibits and Sites
Damage to prehistoric archeological resources will trigger treatment in the form of excrement removal or installation of the archeologist approved exclusionary devices that are included in this plan. A permit is required to remove eggs and baby birds from architectural structures. Additional preventive measures include trained raptor flights and removal of specific pest animals by APHIS.

IPM Zone #4 – Back Country Archeological Sites
No treatment is authorized for this species within management zone #4 without prior IPM Team review and approval.

IPM Zone #5 – Back Country Natural Landscape
No treatment is authorized for this species within management zone #5 without prior IPM Team review and approval.

IPM Zone #6 – Roadside Maintenance
No treatment is authorized for this species within management zone #6 without prior IPM Team review and approval.

MOURNING DOVE *(Zenaida macroura)*


Mourning Dove

The mourning dove is a member of the dove family *Columbidae*. The bird is also called the American mourning dove or rain dove, and was formerly known as the Carolina pigeon or Carolina turtledove. It is one of the most abundant and widespread of all North American birds. It is also the leading game bird with up to 70 million birds shot annually in the U.S., both for sport and for meat. Its ability to sustain such pressure stems from its prolific breeding; in warm areas, one pair may raise up to six broods a year. Its plaintive woo-oo-oo-oo call gives the bird its name. The wings can make an unusual whistling sound upon take-off and landing, and the bird is a strong flier, capable of speeds up to 55 mph.

Mourning doves are light grey and brown, slender, medium sized (about 12 inches in length), and generally muted in color. Males and females are similar in appearance. The species is generally monogamous, with two young per brood. Both parents incubate and care for the young. The clutch size is almost always two eggs. Mourning doves eat almost exclusively seeds and forage on the ground for their food. The young, however, are crop milk by their parents.

There are five subspecies of mourning dove. The ranges of most of the subspecies overlap a little, with three in the United States or Canada. The western subspecies is found in western North America and parts of Mexico, and has a large range of nearly 6.8 million square miles. They occupy a wide variety of open and semi-open habitats, such as urban areas, farms, prairie, grassland and lightly wooded areas, avoiding swamps and thick forest. The species has adapted well to areas altered by humans, and commonly nests in trees in cities or near farmsteads. Migration is usually during the day, in flocks, and at low altitudes. However, not all birds migrate.

Mourning doves can be afflicted with several different parasites and diseases, including tapeworms, nematodes, mites and lice. The mouth-dwelling parasite, *Trichomonas gallinae*, is particularly severe. While a mourning dove will sometimes host it without symptoms, it will often cause yellowish growth in the mouth and esophagus that will eventually starve the host to death. Avian pox is a common, insect-vectored disease.

<u>Management Concerns and Action Thresholds</u>

Is this species native to CAGR? – Yes

<u>IPM Zone #1</u> - Public and Administrative Buildings
This species has a high potential for resource damage because they nest in the structural cracks and archeological features of prehistoric architecture. Installation of exclusionary devices will prevent this species from damaging architecture. Since this species is protected under the Migratory Bird Act, a permit is required to remove eggs and baby birds from architectural structures. Additional preventive measures include trained raptor flights and removal of specific pest animals by APHIS.

<u>IPM Zone #2</u> – Residential Areas
Damage to personal property within the residence areas may trigger installation of similar exclusionary devices on their personal property. However, residents are not authorized to install

any exclusionary devices that are not on their personal property without prior IPM Team review and approval.

IPM Zone #3 – Front Country Exhibits and Sites
Damage to prehistoric archeological resources will trigger treatment in the form of excrement removal or installation of the archeologist approved exclusionary devices that are included in this plan. A permit is required to remove eggs and baby birds from architectural structures. Additional preventive measures include trained raptor flights and removal of specific pest animals by APHIS.

IPM Zone #4 – Back Country Archeological Sites
No treatment is authorized for this species within management zone #4 without prior IPM Team review and approval.

IPM Zone #5 – Back Country Natural Landscape
No treatment is authorized for this species within management zone #5 without prior IPM Team review and approval.

IPM Zone #6 – Roadside Maintenance
No treatment is authorized for this species within management zone #6 without prior IPM Team review and approval.

ROCK DOVE *(Columba livia)*

The domestic pigeon, *Columba livia*, developed from the rock doves of Europe and Asia where they nested in caves, holes, and under overhanging rocks on cliffs. They have adapted to window ledges, roofs, eaves, steeples, and other portions of structures.

Domestic or Rock Pigeon

Habits of Pigeons

Primarily seed or grain eaters, in urban areas pigeons feed on garbage, spilled grains, insects, food left by outdoor diners and food provided by bird lovers. Pigeons commonly feed, roost, and loaf together whenever possible. Feeding, roosting, and loafing sites are usually separate areas. Roosting sites are used for nesting, congregating at night, and shelter in bad weather. Loafing sites will be close to the roosting sites used by inactive birds during the day. Feeding sites may be several miles away from the nesting location. When pigeons are not feeding or mating, most of their day is spent cooing, preening, and sun bathing. Sun bathing is most common in the morning of cool days.

Pigeons prefer flat, smooth surfaces on which to feed, roost and nest.

Male pigeons are sexually mature at three to four months old, females at six months. After pairing and mating, a nest is built by the mated pair. Nests are usually located in protected openings in or on buildings.

One or two eggs are laid eight to 12 days after mating and are incubated for 18 days before hatching. Young pigeons are full grown in less than a month, and are fledged at 37 days.

Pigeons mate year around and live from three to 15 years. Fecal material from pigeons is very acidic and may damage structures. Pigeon nests harbor mites, clothes moths, dermestid beetles, and other insects that feed on the feces, feathers and other organic material. When the nest is abandoned by the birds, these nest inhabitants may find their way into the structure in search of food and habitat.

Management Concerns and Action Thresholds

Is this species native to CAGR? – No

IPM Zone #1 - Public and Administrative Buildings
This species has a high potential for resource damage because they nest in the structural cracks and archeological features of prehistoric architecture. Installation of exclusionary devices will prevent this species from damaging architecture. Nests and eggs from this species are removed from architectural structures when found. Additional preventive measures include trained raptor flights and removal of specific pest animals by APHIS.

IPM Zone #2 – Residential Areas
Damage to personal property within the residence areas may trigger installation of similar exclusionary devices on their personal property. However, residents are not authorized to install any exclusionary devices that are not on their personal property without prior IPM Team review and approval.

IPM Zone #3 – Front Country Exhibits and Sites
Damage to prehistoric archeological resources will trigger treatment in the form of excrement removal or installation of the archeologist approved exclusionary devices that are included in this plan. Nests and eggs from this species are removed from architectural structures when found. Additional preventive measures include trained raptor flights and removal of specific pest animals by APHIS.

IPM Zone #4 – Back Country Archeological Sites
No treatment is authorized for this species within management zone #4 without prior IPM Team review and approval.

IPM Zone #5 – Back Country Natural Landscape
No treatment is authorized for this species within management zone #5 without prior IPM Team review and approval.

IPM Zone #6 – Roadside Maintenance
No treatment is authorized for this species within management zone #6 without prior IPM Team review and approval.

WHITE-WINGED DOVE *(Zenaida asiatica)*

White-winged Dove

The white-winged dove is a dove whose native range extends from the southwestern United States through Mexico and the Caribbean. Most populations of these doves are migratory, wintering in Mexico and Central America. The dove inhabits scrub, woodlands, desert and cultivated areas. It builds a flimsy stick nest in a tree and lays two cream-colored to white, unmarked eggs. Its flight is fast and direct, with the regular beats and occasional sharp flick of the wings that are characteristic of pigeons in general.

White-winged doves are large, chunky pigeons about 10 inches long. They are brownish-grey above and grey below, with a bold white wing patch that appears as a brilliant white crescent in flight and is also visible at rest. Adults have a patch of blue, featherless skin around each eye and a long, dark mark on the lower face. Their eyes, legs and feet are red.

Both sexes are similar, but juveniles are greyer than adults. They have no blue eye ring and their legs and feet are brownish pink.

Doves feed on a variety of seeds, grains and fruits. They migrate into the Sonoran desert to breed during the hottest time of the year because they feed on pollen and nectar, and later on the fruits and seeds of the Saguaro cactus. This species can be an agricultural pest, descending on grain crops in large flocks. It is also a popular game bird in areas of high population.

Management Concerns and Action Thresholds

Is this species native to CAGR? – Yes

IPM Zone #1 - Public and Administrative Buildings
This species has a high potential for resource damage because they nest in the structural cracks and archeological features of prehistoric architecture. Installation of exclusionary devices will prevent this species from damaging architecture. Since this species is protected under the Migratory Bird Act, a permit is required to remove eggs and baby birds from architectural structures. Additional preventive measures include trained raptor flights and removal of specific pest animals by APHIS.

IPM Zone #2 – Residential Areas
Damage to personal property within the residence areas may trigger installation of similar exclusionary devices on their personal property. However, residents are not authorized to install any exclusionary devices that are not on their personal property without prior IPM Team review and approval.

IPM Zone #3 – Front Country Exhibits and Sites
Damage to prehistoric archeological resources will trigger treatment in the form of excrement removal or installation of the archeologist approved exclusionary devices that are included in this plan. A permit is required to remove eggs and baby birds from architectural structures. Additional preventive measures include trained raptor flights and removal of specific pest animals by APHIS.

IPM Zone #4 – Back Country Archeological Sites
No treatment is authorized for this species within management zone #4 without prior IPM Team review and approval.

IPM Zone #5 – Back Country Natural Landscape
No treatment is authorized for this species within management zone #5 without prior IPM Team review and approval.

IPM Zone #6 – Roadside Maintenance
No treatment is authorized for this species within management zone #6 without prior IPM Team review and approval.

BURROWING OWL *(Athene cunicularia)*

Burrowing Owl

The burrowing owl is a small, ground-dwelling owl with a round head, no ear tufts, and white eyebrows. It is sandy colored on the head, back and under parts of the wings; and white to cream with barring on the breast and belly. Females are usually darker than the males. They are approximately 8.5 to 11 inches long with a wingspan of 20 to 24 inches, and they weigh 6 to 8 oz.

Burrowing owls feed on a wide variety of prey, changing food habits as location and time of year determine availability. Their diet consists mainly of beetles and grasshoppers. Small mammals such as mice, rats, gophers and ground squirrels are also important food sources. Other prey can include reptiles and amphibians, scorpions, young rabbits, bats and birds. Unlike other owls, burrowing owls also eat fruits and seeds.

Burrowing owls are fairly easy to see as they are often active in daylight and can be bold and approachable. They are generally active at dusk and dawn and are often seen perched on one foot on a mound or fence post.

These owls are found in open, dry grasslands, agricultural and range lands, and desert habitats often associated with burrowing animals such as ground squirrels, prairie dogs and badgers.

The nesting season begins in late March or April. Burrowing owls are usually monogamous. They generally nest in abandoned burrows dug by mammals and often line their nest with an assortment of dry materials. Adults usually return to the same or nearby area each year. They are able to live for at least nine years in the wild; however, are often killed by vehicles while crossing roads. Natural enemies include larger owls, hawks, falcons, badgers, skunks, ferrets, snakes, and domestic cats and dogs.

Burrowing owls are present in North America. They occur in all states west of the Mississippi Valley and extend south into Mexico, Central and South America; and breed south through the western and Midwestern states. Birds from the northern part of the U.S. and Canada are migratory. Burrowing owls are listed as endangered, threatened, or a species of special concern in most states and provinces where they occur. It is also listed as a species of national concern.

<u>Management Concerns and Action Thresholds</u>

Is this species native to CAGR? – Yes

<u>IPM Zone #1</u> - Public and Administrative Buildings
This species has potential to prevent resource damage because they hunt other pest species. However, burrowing owls move artifacts from their original context, and enlarge burrows to breed their young. They are a species of concern for Arizona but are quite abundant at CAGR. No treatment is authorized for this species within management zone #1 without prior IPM Team review and approval.

<u>IPM Zone #2</u> – Residential Areas
Damage to personal property within the residence areas may trigger installation of similar exclusionary devices on their personal property. However, residents are not authorized to install

any exclusionary devices that are not on their personal property without prior IPM Team review and approval.

IPM Zone #3 – Front Country Exhibits and Sites
Damage to prehistoric archeological resources will trigger treatment in the form of excrement removal or installation of the archeologist approved exclusionary devices that are included in this plan, or relocation of nesting birds. A permit is required to remove eggs and baby birds from architectural structures. No treatment is authorized for this species within management zone #3 without prior IPM Team review and approval..

IPM Zone #4 – Back Country Archeological Sites
No treatment is authorized for this species within management zone #4 without prior IPM Team review and approval.

IPM Zone #5 – Back Country Natural Landscape
No treatment is authorized for this species within management zone #5 without prior IPM Team review and approval.

IPM Zone #6 – Roadside Maintenance
No treatment is authorized for this species within management zone #6 without prior IPM Team review and approval.

GREAT HORNED OWL *(Bubo virginianus)*

Great Horned Owl

The great horned owl is a large owl native to the Americas. It is an adaptable bird with a vast range and is the most widely distributed true owl in the Americas. Females are larger than males. Individual owls range in length from 18 – 27 inches and have a wingspan of 40 – 60 inches. An average adult is 22 inches long and weighs about 3 pounds. Adults have large ear tufts, a red, brown or grey face and a white patch on the throat. The ear tufts are not actually ears, but tufts of feathers. The under parts are light with brown barring; the upper parts are mottled brown. The legs and feet are covered in feathers up to the talons.

The breeding habitat of the great horned owl extends from sub-arctic North America through much of Central and South America. Within their habitat, they can take up residence in trees that include deciduous, coniferous and mixed forests, rain forests, prairie, mountains, deserts, tundra, rocky coasts, swamp forests and some urban areas. Eggs, nestlings and fledglings can be preyed on by foxes, coyotes or cats. There are almost no predators of adults, but they can be killed in confrontations with eagles, snowy owls or other great horned owls. It is not considered a globally threatened species.

An owl's hearing is as good as or better than its sight. They have better depth perception than humans. These birds hunt at night by waiting on a high perch and swooping down on prey. Prey is varied and is predominantly small to medium-sized animals such as rabbits, rats, squirrels, mice, bats, etc. It is a natural predator of porcupines and skunks, and of other birds up to the size of snowy owls. Great horned owls have 500 pounds of crushing power in their talons.

Great horned owls are some of the earliest breeding birds in North America, breeding in late January or early February. They often take over a nest used by some other large bird; however may use cavities in trees and snags, cliffs, deserted buildings and artificial platforms. There are usually two eggs per clutch. Young owls move onto nearby branches at six weeks and start to fly about a week later. Most do not separate from their parents until right before they start to reproduce for the next clutch (December).

<u>Management Concerns and Action Thresholds</u>

Is this species native to CAGR? – Yes

<u>IPM Zone #1</u> - Public and Administrative Buildings
This species has potential to prevent resource damage because they hunt rodent species that cause more damage to architectural structures than the owls do. However, owls may impact earthen architecture with their nesting practices and excrement. A breeding pair of Great Horned Owls currently nests in the Great House shelter. Thus, installation of exclusionary devices will prevent this species from damaging architecture. Since this species is protected under the Migratory Bird Act, a permit is required to relocate eggs and baby birds from architectural structures to nesting boxes. No treatment is authorized for this species within management zone #1 without prior IPM Team review and approval.

<u>IPM Zone #2</u> – Residential Areas
No treatment is authorized for this species within management zone #2 without prior IPM Team review and approval.

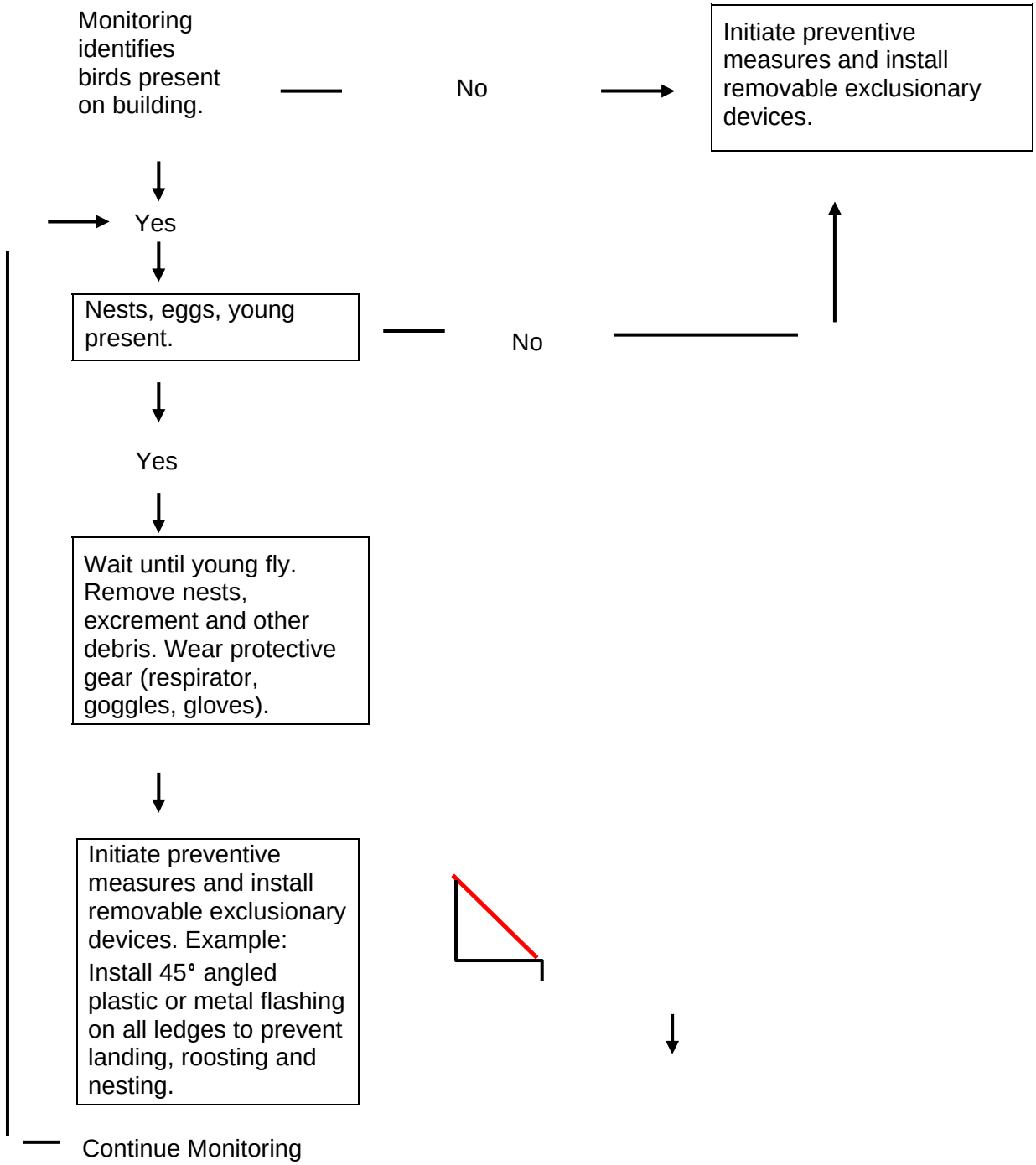
IPM Zone #3 – Front Country Exhibits and Sites
Damage to prehistoric archeological resources will trigger treatment in the form of excrement removal, installation of the archeologist approved exclusionary devices that are included in this plan, or relocation of nesting birds to nesting boxes. A permit is required to remove eggs and baby birds from architectural structures. Preventive measures include the installation and relocation of Great Horned Owls to nesting boxes when their chosen nest locations damage other resources. Trained raptor flights must take the presence of Great Horned Owls into consideration. While trained raptor flights have proven successful in dispelling small birds from the Great House, care should be taken not to also dispel Great Horned Owls that naturally manage rodent pests.

IPM Zone #4 – Back Country Archeological Sites
No treatment is authorized for this species within management zone #4 without prior IPM Team review and approval.

IPM Zone #5 – Back Country Natural Landscape
No treatment is authorized for this species within management zone #5 without prior IPM Team review and approval.

IPM Zone #6 – Roadside Maintenance
No treatment is authorized for this species within management zone #6 without prior IPM Team review and approval.

BIRDS


Monitoring identifies birds present on building.
No
Initiate preventive measures and install removable exclusionary devices.
Yes
Nests, eggs, young present.
No
Yes
Wait until young fly. Remove nests, excrement and other debris. Wear protective gear (respirator, goggles, gloves).
Initiate preventive measures and install removable exclusionary devices. Example:
Install 45° angled plastic or metal flashing on all ledges to prevent landing, roosting and nesting.
Continue Monitoring

LITTLE BROWN BAT (*Myotis lucifugus)* (LeConte),

Little brown bat is actually a benefit to the Park except for roosting in historic structures. Adults are about 3 1/8 – 3 5/8 inch long, including the tail, with a wingspread of 8 11/16 – 10 5/8 inches. They weigh 1/8 – 1/2 oz. Little brown bats are found from middle Alaska through southern Canada, and in the United States except Florida, Texas and southern California.

Little Brown Bat

Little brown bats form nursery colonies in the spring. They feed on flying insects, especially flies and moths. They alternate feeding flights with rest periods to digest the catch. In the north, most little brown bats will migrate south where they hibernate from September/October through March/April in mines and caves in the eastern U.S.

If bats have left the cracks, crevices or other voids of the Monument structures in winter (and there are no big brown bats hibernating there), thorough exclusion of the openings at the Monument can be accomplished. Otherwise, after mid-August when young are flying, close all exit/entry holes (over 1/4 inch) except two exits. When bats have adjusted to those two exits, install bat valves or seal the last two holes after all bats have left for evening foraging. Providing a proper bat house before the exclusion will allow the bats to remain in the area to feed on flying insects.

Management Concerns and Action Thresholds

Is this species native to CAGR? – Yes

IPM Zone #1 - Public and Administrative Buildings
This species has a moderate potential for resource damage because they nest in the structural cracks and archeological features of prehistoric architecture and deposit guano on architecture. They also pose a potential threat to human health and safety because the bat population at CAGR has tested positive for rabies. Installation of exclusionary devices will prevent this species from damaging architecture. Guano can be removed from architectural structures with approval from a staff archeologist. Additional preventive measures include the installation of bat boxes to redirect nesting areas and removal of specific pest animals by APHIS.

Zone #2 – Residential Areas
No treatment is authorized for this species within management zone #2 without prior IPM Team review and approval.

IPM Zone #3 – Front Country Exhibits and Sites
Damage to prehistoric archeological resources will trigger treatment in the form of excrement removal, removal of diseased animals by APHIS or trained staff, and installation of the archeologist approved exclusionary devices that are included in this plan. Additional preventive measures include the installation of bat boxes.

IPM Zone #4 – Back Country Archeological Sites
No treatment is authorized for this species within management zone #4 without prior IPM Team review and approval.

IPM Zone #5 – Back Country Natural Landscape
No treatment is authorized for this species within management zone #5 without prior IPM Team review and approval.

BAT HOUSES

North American bats are invaluable natural resources. As primary predators of night-flying insects, bats play a vital role in maintaining the balance of nature. A single little brown bat can catch hundreds of mosquitoes in an hour. Bats that frequent bat houses eat insects that could damage crops, such as cucumber and June beetles, stink bugs, leafhoppers and corn worm moths. Most likely to inhabit bat houses are the little brown bats, big brown bats, eastern pipistrelle and the eastern long-eared bat.

Providing bat houses can help build the populations of many valuable bat species. Providing houses furnishes places for bats to roost, hibernate and raise young, in addition to natural sites that may not be available or desirable.

Bats find houses by sight. If a house is in the proper location, meets the requirements and is needed, the bats will move in on their own.

Bat houses should be hung at least 15 feet above the ground – the higher, the better. Research shows that they are more successful if they have at least 8 hours of sun. The morning sun is most important. Bat houses should face the south or southeast. In southern parts of the country, the boxes can be painted latex water base white if there is too much direct sun. Bat houses mounted 20 feet away from trees are inhabited twice as quickly as those in wooded areas.

There are many designs and sizes of bat house plans available on the internet and in books. Several sources are listed below:

www.eparks.org/wildlife_protection/wildlife_facts/bats/bat_houses

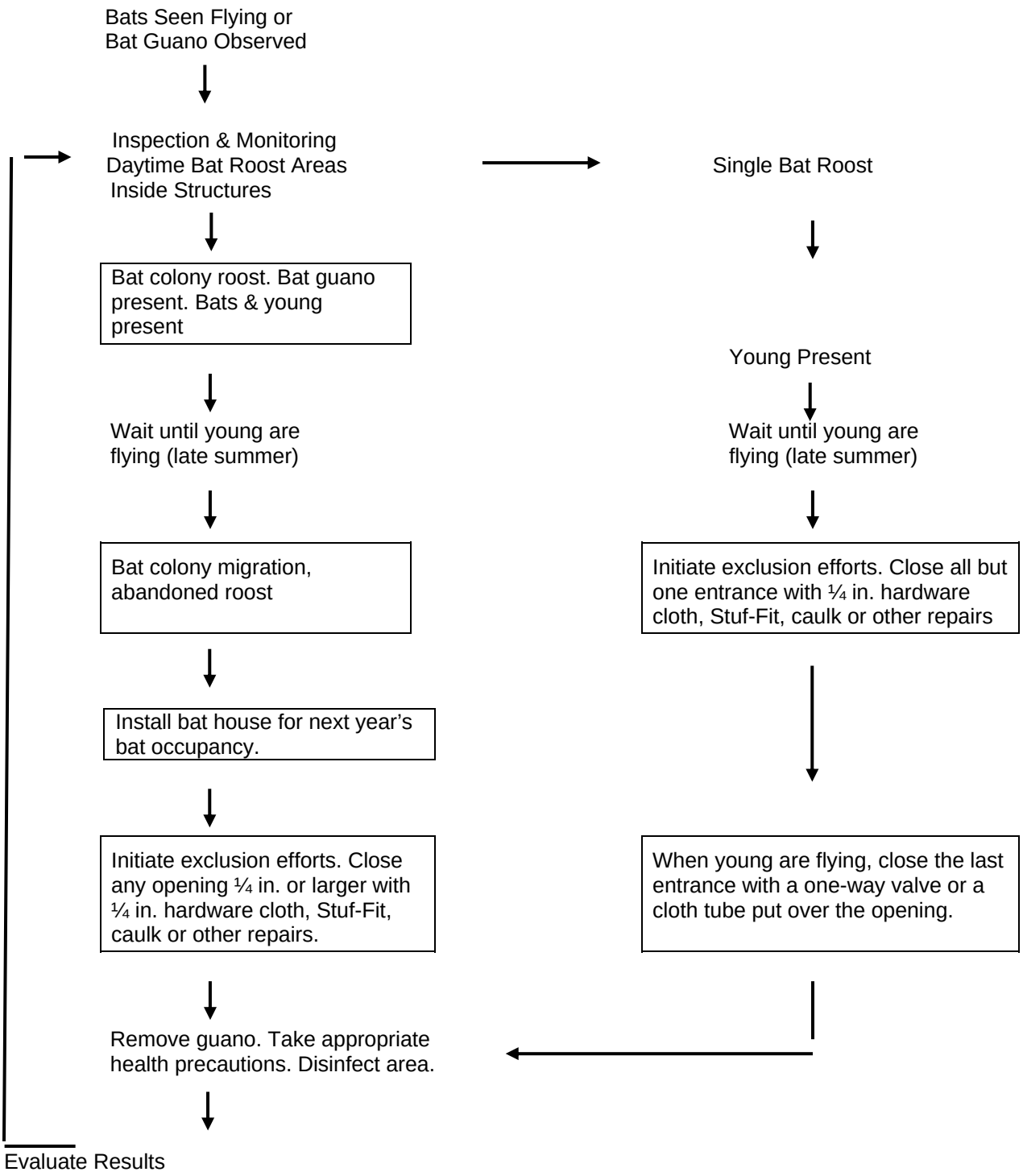
www.shopatron.com/product/part_number=1254/567.0.25796.0

www.wbu.com/education/bats.html

Bat Conservation International

Bats Unlimited

BATS


Bats Seen Flying or
Bat Guano Observed
Inspection & Monitoring
Daytime Bat Roost Areas
Inside Structures
Single Bat Roost
Bat colony roost. Bat guano present. Bats & young present
Young Present
Wait until young are flying (late summer)
Wait until young are flying (late summer)
Bat colony migration, abandoned roost
Initiate exclusion efforts. Close all but one entrance with ¼ in. hardware cloth, Stuf-Fit, caulk or other repairs
Install bat house for next year's bat occupancy.
Initiate exclusion efforts. Close any opening ¼ in. or larger with ¼ in. hardware cloth, Stuf-Fit, caulk or other repairs.
When young are flying, close the last entrance with a one-way valve or a cloth tube put over the opening.
Remove guano. Take appropriate health precautions. Disinfect area.
Evaluate Results

BLACK-TAILED JACKRABBIT *(Lepus californicus)*

Black-tailed Jackrabbit

The black-tailed jackrabbit, also known as the desert hare, is a common hare of the western United States and Mexico where it is found at elevations from sea level up to 10,000 feet.

Like other jackrabbits, the black tail has distinctive long ears and the long, powerful rear legs characteristic of hares. Reaching a length of about two feet, and a weight of from three to six pounds, the black-tailed jackrabbit is the third largest North American hare. The dorsal fur is dark buff peppered with black, and its undersides and the insides of its legs are creamy white. The ears are black-tipped on the outer surface.

The jackrabbit is a natural occupant of the desert, prairie and chaparral communities. It may be seen during the day although it is primarily nocturnal. Diet includes cactus, sagebrush, mesquite, juniper berries, grasses and crop plants such as clover and alfalfa. The hare needs very little water as its needs are met from its food. Jackrabbits do not use burrows, but rest during the day in shallow scrapes dug into the soil under the cover of vegetation. In winter, such beds are located in vegetation that offers protection from the chilling winds.

Although they are solitary animals, they forage and rest in groups. Breeding can occur year-round in southern regions of the range. A healthy doe may produce four to five litters per year with one to eight per litter. The gestation period is 41 – 47 days. The young are precocious and active shortly after birth. They grow rapidly and reach adult size in about 7 or 8 months.

Black-tailed jackrabbits rely on their acute hearing and speed to elude predators. They can reach speeds of 40 – 45 mph and can leap 19 feet in a single bound. Jackrabbits will thump the ground with their hind legs as an alarm signal as they sprint away from danger. Natural predators include hawks and eagles, as well as coyotes, foxes, bobcats, badgers and weasels.

<u>Management Concerns and Action Thresholds</u>

Is this species native to CAGR? – Yes

<u>IPM Zone #1</u> - Public and Administrative Buildings
Evidence or observation of one or more within the buildings will trigger immediate treatment in the form of exclusionary devices, capture and relocation to the exterior of the building, etc.

<u>Zone #2</u> – Residential Areas
Damage to personal property within the residences may trigger immediate treatment by the resident by installing exclusionary devices, but damage to property outside of the housing unit will trigger IPM Team review.

<u>IPM Zone #3</u> – Front Country Exhibits and Sites
Damage to archeological resources and/or damage to plants within the maintained landscape within zone #3 will trigger treatment. Treatment to archeological resources or historic structures may be in the form of encapsulation patching and repair, filling in burrows with sterile soil, and installation of the archeologist approved exclusionary devices that are included in this plan. Treatments for the maintained landscapes include animal repellents such as caging of young plants, and the use of biodegradable deterrents (chili powder, plant sprays, blood meal, etc.).

Interdisciplinary IPM Team review will also be triggered if more than 20 rabbit holes are recorded within a 10 x 10 meter survey unit anywhere within this management zone.

IPM Zone #4 – Back Country Archeological Sites
Damage to archeological resources and/or presence of 40 or more rodent burrows within a 10 x 10 meter survey unit will trigger IPM Team review to determine appropriate, archeological approved treatments.

IPM Zone #5 – Back Country Natural Landscape
No treatment is authorized for this species within management zone #5 without prior IPM Team review and approval.

IPM Zone #6 – Roadside Maintenance
No treatment is authorized for this species within management zone #6 without prior IPM Team review and approval.

DESERT COTTONTAIL *(Sylvilagus auduboni)*

Desert Cottontail

Cottontails are named after their tail, which is shaped like a cottony ball. The desert portion of their common name arises from their distribution across the arid lands of the American southwest and plains states. Desert cottontails occur in a wide variety of habitats, including dry desert-like grasslands and shrub lands, riparian areas and pinyon-juniper forests. They may occur in the same areas as the black-tailed jackrabbit, and are found up to 6,500 feet in elevation.

The desert cottontail is light colored, tan to grey, with a yellow tinge. The underside of the body is whitish. The length of a cottontail is 13 – 17 inches long; ears average 3 – 4 inches long; and the average weight is 2 – 3 pounds. Females are larger than the males.

Hind feet are large and average 3 inches long. When the rabbit takes short hops, its tracks look like the number “7,” with the 2 hind feet planted first, then the 2 front feet set behind.

The desert cottontail is born in a nest lined with grass and fur which the mother pulls from her belly. The nest is located in a depression, abandoned badger or ground squirrel burrow, or beneath a shrub.

A female may bear young year round or up to eight months of the year. She may bear 20 to 30 young in 4 to 5 litters. A normal litter has 2 to 6 young, which are born blind, furless and unable to care for themselves. The mother returns to the den site to feed her young. The young are weaned at 2 weeks old, and they leave the nest area 3 weeks after birth.

Cottontails may be seen at any time during the day. They may rest in the shade of shrubs, in burrows or thickets. In the hot months of the summer, they conserve moisture and energy by avoiding activity during the day.

Desert cottontails are herbivores and they eat a wide variety of plants, including grasses, forbs, shrubs and even cacti; however, 90% of their diet is grass. Cottontails will forage on domestic crops, even the bark of fruit trees.

When alarmed, a cottontail can run up to 20 miles per hour in a zigzag pattern to escape predators.

<u>Management Concerns and Action Thresholds</u>

Is this species native to CAGR? – Yes

<u>IPM Zone #1</u> - Public and Administrative Buildings
Evidence or observation of one or more within the buildings will trigger immediate treatment in the form of exclusionary devices, capture and relocation to the exterior of the building, etc.

<u>Zone #2</u> – Residential Areas
Damage to personal property within the residences may trigger immediate treatment by the resident by installing exclusionary devices, but damage to property outside of the housing unit will trigger IPM Team review.

IPM Zone #3 – Front Country Exhibits and Sites
Damage to archeological resources and/or damage to plants within the maintained landscape within zone #3 will trigger treatment. Treatment to archeological resources or historic structures may be in the form of encapsulation patching and repair, filling in burrows with sterile soil, and installation of the archeologist approved exclusionary devices that are included in this plan. Treatments for the maintained landscapes include animal repellents such as caging of young plants, and the use of biodegradable deterrents (chili powder, plant sprays, blood meal, etc.). Interdisciplinary IPM Team review will also be triggered if more than 20 rabbit holes are recorded within a 10 x 10 meter survey unit anywhere within this management zone.

IPM Zone #4 – Back Country Archeological Sites
Damage to archeological resources and/or presence of 40 or more rodent burrows within a 10 x 10 meter survey unit will trigger IPM Team review to determine appropriate, archeological approved treatments.

IPM Zone #5 – Back Country Natural Landscape
No treatment is authorized for this species within management zone #5 without prior IPM Team review and approval.

IPM Zone #6 – Roadside Maintenance
No treatment is authorized for this species within management zone #6 without prior IPM Team review and approval.

COYOTE *(Canis latrans)*

Coyote

The coyote, also known as the prairie wolf, is a species of canine found throughout North and Central America, ranging from Panama in the south, north through Mexico, the United States, Canada and into Alaska. The coyote evolved in North America alongside the Dire Wolf. Unlike the wolf, the coyote's range has expanded in the wake of human civilization and readily reproduces in metropolitan areas. The name "coyote" is from Mexican Spanish, derived from the Nahuati word *coyotl*. Its scientific name, *Canis latrans*, means "barking dog."

The color of the coyote's pelt varies from grayish brown to yellowish grey on the upper parts, while the throat and belly tend to have a buff or white color. The forelegs, sides of the head, muzzle and feet are reddish brown. The black-tipped tail has a scent gland located on its dorsal base. Coyotes shed once a year, beginning in May with light hair loss, ending in July after heavy shedding. Mountain dwelling coyotes tend to be dark furred while desert coyotes tend to be more yellowish in color.

Although coyotes have been observed to travel in large groups, they primarily hunt in pairs. Typical packs consist of six closely related adults, yearlings and young. Coyotes reach their growth in the first year. They are generally nocturnal but can occasionally be seen during the daylight hours. Coyotes are capable of digging their own burrows, though they often appropriate the burrows of American badgers. In areas where wolves have been exterminated, coyotes flourish. They have been known to live a maximum of 10 years in the wild.

Coyotes will sometimes mate with domestic dogs, usually in areas where coyotes are plentiful and the breeding season is extended because of the warm weather. The resulting hybrids maintain the coyote's predatory nature, along with the dog's lack of timidity toward humans, making them a more serious threat to livestock than pure-blooded animals.

Coyotes are omnivores that primarily eat small mammals such as cottontails, ground squirrels and mice, though they will also eat birds, snakes, lizards, deer, javelina and livestock, as well as large insects and other large invertebrates. Packs of coyotes can bring down prey as large as adult elk. Fruits and vegetables are a significant part of the coyote's diet in the autumn and winter months.

The grey wolf is a significant predator of coyotes whenever their ranges overlap. Cougars and bears sometimes kill coyotes, although coyotes have an instinctive fear of cougars, and bears and coyotes often compete for a kill.

Coyotes have a beneficial impact on the Monument in that they help keep the rodent and small mammal populations managed. Coyotes dig dens in mounds on Monument grounds, however, disrupt the remains of the prehistoric and historic civilizations and need to be discouraged. They are also a human health and safety concern because they can carry diseases and/or parasites. They have also been known to attack humans.

<u>Management Concerns and Action Thresholds</u>

Is this species native to CAGR? – Yes

IPM Zone #1 - Public and Administrative Buildings
Evidence or observation of one or more within the buildings will trigger immediate treatment in the form of exclusionary devices, capture and relocation to the exterior of the building, etc.

Zone #2 – Residential Areas
Damage to personal property within the residences may trigger immediate treatment by the resident by installing exclusionary devices, but damage to property outside of the housing unit will trigger IPM Team review.

IPM Zone #3 – Front Country Exhibits and Sites
Damage to archeological resources and/or damage to plants within the maintained landscape within zone #3 will trigger treatment. Treatment to archeological resources or historic structures may be in the form of encapsulation patching and repair, filling in burrows with sterile soil, and installation of the archeologist approved exclusionary devices that are included in this plan. Coyotes will be deterred from burrowing within this zone by human activity (scent and noise) and infilling of inactive burrows. Exclusionary devices that are approved for the maintained landscapes include the use of biodegradable deterrents (chili powder, plant sprays, blood meal, etc.). Interdisciplinary IPM Team review will also be triggered if any coyote burrows are observed within this management zone. APHIS will remove coyotes that pose a safety hazard to staff or visitors.

IPM Zone #4 – Back Country Archeological Sites
Coyote dens that are located within archeological sites will be monitored to ensure that the den is vacant; then it will be infilled with sterile soil. Any damage to archeological sites will trigger IPM Team review to determine appropriate archeologist approved treatments.

IPM Zone #5 – Back Country Natural Landscape
No treatment is authorized for this species within management zone #5 without prior IPM Team review and approval.

IPM Zone #6 – Roadside Maintenance
No treatment is authorized for this species within management zone #6 without prior IPM Team review and approval.

FERAL DOGS *(Canis familiaris)*

Feral Dog

In appearance, most feral dogs are difficult to distinguish from domestic dogs. It is noted that German shepherds, Doberman pinschers and collies are breeds that often become feral. The primary feature that distinguishes feral from domestic dogs is the degree of reliance or dependence on humans. Feral dogs survive and reproduce independently of human assistance. They differ markedly in their response to people: feral dogs show highly aggressive behavior, growling, barking and attempting to bite. Since many feral dogs have been pursued, their aggressive behavior toward humans is not surprising.

Feral dogs are active during dawn, dusk and at night like other wild canids. They often travel in packs like coyotes or wolves. The tracks left by a pack of feral dogs vary in size depending on the size of the dog, and are not consistent like the tracks of a pack of coyotes.

Feral dogs are the most widespread of the wild canids, and occur in all of the 50 states and the Americas. Home ranges of feral dogs vary greatly in size and are influenced by the availability of food. Dog packs that are primarily dependent on garbage may remain in the immediate vicinity of a landfill, while other packs that depend on livestock or wild game may forage over an area of 50 square miles or more.

Feral dogs may become skilled at hunting in groups for small game such as rabbits and ground squirrels. They commonly kill house cats, and may kill or injurer domestic dogs. In areas where people have not hunted and trapped feral dogs, the dogs may not have developed fear of humans and may then attack people, especially children.

State and local laws concerning feral and free-ranging dogs vary considerably, but most states have some regulations. State agencies or agriculture departments are usually responsible for managing feral dogs in rural areas. CAGR maintains a cooperative agreement with APHIS for trapping and removal of feral dogs.

DAMAGE PREVENTION AND CONTROL METHODS

<u>Exclusion</u>
Protect Monument grounds from feral and domestic dogs with well-maintained net fences. Horizontal spacing of the mesh should be less than 6 inches; vertical spacing should be less than 4 inches. Barbed wire at ground level or a buried wire apron will discourage dogs from digging under the fence. The fence should be about 6 feet high to hinder animals from jumping over.

Fencing is one of the most beneficial investments in dealing with predator damage if practicality warrants its use. However, while installation of such fences would effectively deter feral dogs from entering CAGR, they will also limit the mobility of many other native and non-pest animals. Limiting the mobility of non-pest individuals and other native species could exacerbate an island effect and eventually pose a threat to ecosystem health. Thus, these measures will not be used to manage feral dogs at CAGR.

<u>Frightening</u>
Several visual and auditory devices (yard lights, effigies, loud music) have been used to frighten coyotes, and are likely to be effective with feral dogs. A device called the Electronic Guard has

been effective in reducing coyote predation. This device consists of a combination of strobe lights and sirens that periodically activate during the night. Similar results could reasonably be anticipated with feral dogs; however, these devices may not be suitable for use on Monument grounds.

Repellents
Methyl monyl ketone, mostly in granular form or in liquid sprays, is widely used to prevent urination or defecation by dogs in specific areas. Several other chemicals are registered for repelling dogs, including anise oil, Bitrex, capsaicin, d-limonene, dried blood, essential oils, naphthalene, nicotine, Ropel, Thiram, Thymol and tobacco dust. These chemicals may be useful in keeping feral dogs from establishing scent stations or relieving themselves on selected sites.

Several states own their own registrations for using M-44 cyanide baits. Consult state and local regulations with respect to M-44 use. In all instances, M-44s can only be used by certified applicators.

Cultural Considerations
The long-term solution to most problems caused by unconfined dogs, including feral dogs, is responsible dog ownership and effective local dog management programs. Many depredation problems can be solved by confining dogs to kennels or to the owner's property. Dog breeding must be controlled. Unwanted dogs should be placed for adoption or destroyed rather than abandoned, since the latter leads to the formation of free-living, feral populations.

Management Concerns and Action Thresholds

Is this species native to CAGR? – No

IPM Zone #1 - Public and Administrative Buildings
Evidence or observation of one or more within the buildings will trigger immediate treatment in the form of exclusionary devices, capture and relocation to the exterior of the building, etc.

Zone #2 – Residential Areas
Damage to personal property within the residences may trigger immediate treatment by the resident by installing exclusionary devices, but damage to property outside of the housing unit will trigger IPM Team review.

IPM Zone #3 – Front Country Exhibits and Sites
Observation of feral dogs will trigger capture by APHIS or park staff and removal by Pinal County Animal Control.

IPM Zone #4 – Back Country Archeological Sites
Observation of feral dogs will trigger capture by APHIS or park staff and removal by Pinal County Animal Control.

IPM Zone #5 – Back Country Natural Landscape
Observation of feral dogs will trigger capture by APHIS or park staff and removal by Pinal County Animal Control.

IPM Zone #6 – Roadside Maintenance
No treatment is authorized for this species within management zone #6 without prior IPM Team review and approval.

KIT FOX *(Vulpes macrotis)*

Kit Fox

The kit fox is the smallest of the American foxes and are beautifully adapted to life in the desert. Their pale coloring makes them nearly invisible against a background of light-colored desert soils. They are primarily nocturnal, although they may occasionally be seen during the day. The kit fox usually emerges from its den shortly after sunset for hunting which occurs sporadically throughout the night. The diet of these foxes includes small mammals, particularly rodents, insects, small birds, lizards, amphibians and fish.

Kit foxes live alone in their underground dens for half the year. In winter, male and females pair up, mate and begin preparing the den for the coming family. The den is used year after year, and they haul out debris each year and dig new entrances.

Foxes have a beneficial impact on the Monument in that they help keep the rodent and small mammal populations managed. Foxes dig dens in mounds on Monument grounds; however, and disrupt the remains of the prehistoric and historic civilizations and need to be discouraged. They are also a human health and safety concern because they can carry diseases and/or parasites.

Management Concerns and Action Thresholds

Is this species native to CAGR? – Yes

IPM Zone #1 - Public and Administrative Buildings
Evidence or observation of one or more within the buildings will trigger immediate treatment in the form of exclusionary devices, capture and relocation to the exterior of the building, etc.

Zone #2 – Residential Areas
Damage to personal property within the residences may trigger immediate treatment by the resident by installing exclusionary devices, but damage to property outside of the housing unit will trigger IPM Team review.

IPM Zone #3 – Front Country Exhibits and Sites
Damage to archeological resources within the maintained landscape of zone #3 will trigger treatment. Treatment to archeological resources or historic structures may be in the form of encapsulation patching and repair, filling in burrows with sterile soil, and installation of the archeologist approved exclusionary devices that are included in this plan. Interdisciplinary IPM Team review will also be triggered if any fox burrows are observed within this management zone. APHIS will remove foxes that pose a safety hazard to staff or visitors.

IPM Zone #4 – Back Country Archeological Sites
Fox dens that are located within archeological sites will be monitored to ensure that the den is vacant; then it will be infilled with sterile soil. Any damage to archeological sites will trigger IPM Team review to determine appropriate archeologist approved treatments.

IPM Zone #5 – Back Country Natural Landscape
No treatment is authorized for this species within management zone #5 without prior IPM Team review and approval.

IPM Zone #6 – Roadside Maintenance
No treatment is authorized for this species within management zone #6 without prior IPM Team review and approval.

COMMON GREY FOX *(Urocyon cinereoargenteus)*

Grey Fox

The grey fox can be found from Ontario, Canada throughout the southwestern United States down to South America. It prefers wooded and brushy areas where most of the rainfall is in the winter. Its den sites are made in rock formations, hollow logs and trees, burrows and brush piles. The dens are often lined with grass and leaves.

The grey fox is medium sized with grey upperparts, reddish-brown legs, tawny sides and light-colored throat, cheeks and belly. It is a solitary hunter, is omnivorous and its food varies with season and availability. Its diet consists of berries, nuts, birds, insects, rabbits and other rodents. The grey fox has few predators besides man. Hawks, eagles, owls, bobcats and dogs will kill and eat the pups.

The grey fox is the only member of the dog family that can climb trees, and does this to escape its enemies. It climbs by grabbing the trunk with its forepaws and scrambling up with the long claws on its hind feet. It will also sit in trees to ambush prey.

Grey foxes are nocturnal and go back to their dens during the day. They are very territorial and mark their boundaries with urine. The grey fox does not migrate.

Management Concerns and Action Thresholds

Is this species native to CAGR? – Yes

IPM Zone #1 - Public and Administrative Buildings
Evidence or observation of one or more within the buildings will trigger immediate treatment in the form of exclusionary devices, capture and relocation to the exterior of the building, etc.

Zone #2 – Residential Areas
Damage to personal property within the residences may trigger immediate treatment by the resident by installing exclusionary devices, but damage to property outside of the housing unit will trigger IPM Team review.

IPM Zone #3 – Front Country Exhibits and Sites
Damage to archeological resources within the maintained landscape of zone #3 will trigger treatment. Treatment to archeological resources or historic structures may be in the form of encapsulation patching and repair, filling in burrows with sterile soil, and installation of the archeologist approved exclusionary devices that are included in this plan. Interdisciplinary IPM Team review will also be triggered if any fox burrows are observed within this management zone. APHIS will remove foxes that pose a safety hazard to staff or visitors.

IPM Zone #4 – Back Country Archeological Sites
Fox dens that are located within archeological sites will be monitored to ensure that the den is vacant; then it will be infilled with sterile soil. Any damage to archeological sites will trigger IPM Team review to determine appropriate archeologist approved treatments.

IPM Zone #5 – Back Country Natural Landscape
No treatment is authorized for this species within management zone #5 without prior IPM Team review and approval.

IPM Zone #6 – Roadside Maintenance
No treatment is authorized for this species within management zone #6 without prior IPM Team review and approval.

HOUSE MOUSE (*Mus musculus*)

House Mouse *Mus musculus*

The house mouse easily adapts to living with people. It thrives in a wide range of climatic conditions in a great variety of habitats, feeding on most human food, and reproducing at a remarkable rate. House mice subsist throughout the United States, and are found in most areas of human habitation. They are also found living in the wild. They are common inhabitants of grassy fields, and a problem in residences and structures. Not only does the house mouse destroy food and cause damage to structures and personal possessions, it also has the potential to transmit diseases and parasites to people and domestic animals.

CHARACTERISTICS AND RECOGNITION

The house mouse is a delicate, agile little rodent. Adult weights vary by region and usually range from 1/2 – 1 ounce. Adult house mice vary in color from light brown to dark gray, but most often are a dusky gray or medium brown over most of their bodies, except the belly, which may be a slightly lighter shade of their general color but never white. The mouse has moderately large ears for its body size. The tail is nearly hairless and about as long as the body and head combined (2 1/2 – 4 inches). The feet are small in proportion to its body, and the eyes are also relatively small.

Under optimum conditions, house mice breed year round. Out-of-doors, house mice may tend toward seasonal breeding, peaking in the spring and fall. Environmental conditions, such as the availability and quality of food, can influence the frequency of pregnancy, litter size, and survival. Females may produce as many as ten litters of five young in each litter in a year. At very high densities, however, reproduction may nearly cease despite the presence of excess food and cover.

Newborn mice are quite undeveloped, weighing between .02 – .03 ounce and are nearly hairless. Their eyes and ears are closed, but within two weeks the body is covered with hair and the eyes and ears are open. At about three weeks, the young begin short trips away from the nest and begin taking solid food.

While mice primarily are active at night, some day activity occurs. Movements of house mice are largely determined by temperature, food, and hiding places. Home ranges of mice tend to be smallest where living conditions are good. Mice tend to travel over their entire territory daily, investigating each change or new object that may be placed there. They are very aggressive. They show no fear of new objects. They dart from place to place, covering the same route over and over again. This behavior can be used to advantage in management programs. Disturbing the environment at the beginning of a program by moving boxes, shelves, pallets, and other objects can improve the effectiveness of traps. Mice will investigate the changed territory thoroughly.

Mice have relatively poor vision, and are also color blind. They rely heavily on smell, taste, touch, and hearing. Mice use their keen sense of smell to locate food and to recognize other individuals, especially those of the opposite sex. Taste perception in mice is also good. Mice use their acute hearing to detect and escape danger. An important sensory factor for mice is

touch. Mice use long, sensitive whiskers near the nose and guard hairs on the body as tactile sensors to enable them to travel in the dark, pressing against walls and boxes, scurrying through burrows.

It is a challenge to mouse-proof a building or manage mice without understanding their physical capabilities. For their size they are excellent jumpers. They can jump against a wall or flat vertical surface, using it as a spring board to gain additional height. They can run up almost any vertical surface including wood, brick walls, metal girders, pipes, weathered sheet metal, wire mesh, and cables without difficulty if the surface is rough. They can run horizontally along insulated electrical wires, small ropes, and the like, with ease. They can squeeze through openings slightly more than 1/4 inch. They are quick to explore any physical change in their environment.

House mice prefer cereals over other items, although they feed on a wide variety of foods. Mice satisfy much of their water need with moisture in their food, but they drink if water is readily available. Mice have two main feeding periods, at dusk and just before dawn, and they are nibblers, feeding twenty or more times during evening rounds. In any territory there will be one or two feeding sites, dark and protected, where mice eat more than at other places.

Mice are territorial and seldom travel more than thirty feet from their nest. When food is nearby, mice may restrict their activity to a few feet. Males average slightly larger ranges than do the females. House mice may nest in any dark, sheltered location, in nests approximately 4 inches in diameter and constructed of fibrous, shredded materials such as paper, cloth, burlap, insulation, or cotton, which generally look like a loosely woven ball. Outdoors, house mice sometimes dig and nest in small burrows.

HAZARDS OF INFESTATION

When mice infest stored food, the greatest loss is not what mice eat, but what is thrown out because of real or suspected contamination. Mice also damage personal property and structures by gnawing, including electrical wiring in buildings. House mice frequently take up residence in electrical appliances and end up chewing into the power supply.

House mice and their parasites are implicated in the transmission of a number of diseases. Salmonellosis can be spread when some foods are contaminated with infected rodent feces. Mice are probably more responsible than rats for the spread of this disease. *Rickettsia akari* is the causal agent of Rickettsialpox, a disease causing a rash similar to chickenpox. Rickettsialpox is transmitted from mouse to mouse, then to people by the bite of the house-mouse mite. Lymphocytic Choriomeningitis is a virus infection of house mice that may be transmitted to people (mainly to children) through contaminated food or dust. The mouse can also be a major carrier of Leptospirosis (Weil's disease). Rat-bite fever can be transmitted by house mice, as can ray fungus, *Actinomyces muris*. Certain tapeworms are spread in house-mouse droppings, and ringworm, a skin fungus disease, can be carried to human beings by mice or contracted indirectly from mice through cats. Tularemia has also been linked to house mice.

INSPECTION AND MONITORING

Sounds are common at night where large numbers of mice are present. Listen for squeaks, scrambling, and sounds of gnawing. An electronic stethoscope is useful.

Mouse droppings are frequently the first evidence that mice are infesting. Large cockroaches, bats, and other species of mice such as deer mice (*Peromyscus* sp.) and meadow mice (*Microtus* sp.), may produce droppings similar to those of house mice. Look along runways, by food, near shelters, and in other places mice may frequent. House mice occasionally make small mounds known as "urinating pillars." These consist of a combination of grease, urine, and dirt, and may become quite conspicuous. Look for many small drops of urine using a black light, since urine stains will fluoresce under ultraviolet light.

Like rats, mice produce greasy smears where dirt and oil from their fur mark pipes and beams. Recent gnawing damage on wood is light in color and will turn darker with age. Look for enlarged cracks beneath doors and small tooth marks. Such evidence frequently helps to distinguish between mice and rats. Look for wood chips with the consistency of coarse sawdust around baseboards, doors, basement windows and frames, and kitchen cabinets.

Management Concerns and Action Thresholds

Is this species native to CAGR? – No

IPM Zone #1 - Public and Administrative Buildings
Evidence or observation of one or more within the buildings will trigger immediate treatment in the form of snap trapping and installation of exclusionary devices.

Zone #2 – Residential Areas
Damage to personal property within the residences may trigger immediate treatment by the resident in the form of snap trapping and installation of exclusionary devices (or park staff if the housing unit is unoccupied).

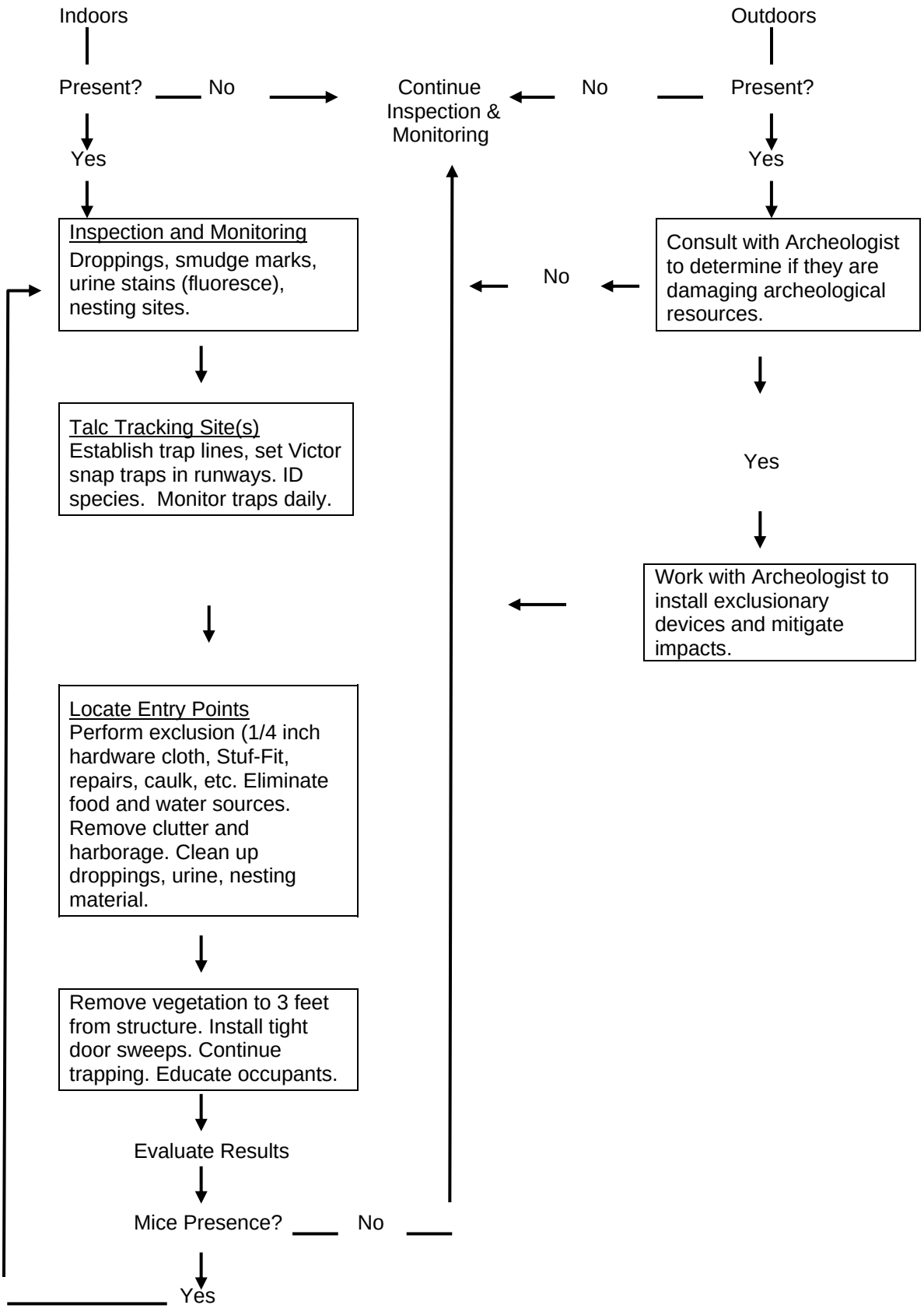
IPM Zone #3 – Front Country Exhibits and Sites
Damage to archeological resources within zone #3 will trigger treatment in the form of encapsulation patching and repair, snap trapping, and installation of the archeologist approved exclusionary devices that are included in this plan.

IPM Zone #4 – Back Country Archeological Sites
Damage to archeological resources will trigger immediate treatment in the form of snap trapping and installation of exclusionary devices.

IPM Zone #5 – Back Country Natural Landscape
No treatment is authorized for this species within management zone #5 without prior IPM Team review and approval.

IPM Zone #6 – Roadside Maintenance
No treatment is authorized for this species within management zone #6 without prior IPM Team review and approval.

HOUSE MICE


Indoors
Present?
No
Yes
Inspection and Monitoring
Droppings, smudge marks, urine stains (fluoresce), nesting sites.
Talc Tracking Site(s)
Establish trap lines, set Victor snap traps in runways. ID species. Monitor traps daily.
Locate Entry Points
Perform exclusion (1/4 inch hardware cloth, Stuf-Fit, repairs, caulk, etc. Eliminate food and water sources. Remove clutter and harborage. Clean up droppings, urine, nesting material.
Remove vegetation to 3 feet from structure. Install tight door sweeps. Continue trapping. Educate occupants.
Evaluate Results
Mice Presence?
No
Yes
Continue Inspection & Monitoring
Outdoors
Present?
No
Yes
Consult with Archeologist to determine if they are damaging archeological resources.
No
Yes
Work with Archeologist to install exclusionary devices and mitigate impacts.

DEER MOUSE (*Peromyscus maniculatus* [Wagner])

Deer Mouse

The native deer mouse is the rodent in the United States that most commonly carries the Hantavirus, and is implicated in most of the cases of human infection by this strain. The deer mouse is also the most likely native rodent to be found in or near buildings. Deer mice often invade homes and structures that are closed for the season. If outside populations are large, structures may have numerous *Peronyscus sp.* present, which may result in substantial amounts of saliva, urine and droppings with the Hantavirus aerosolized into the interior air and in dust. The opportunity for human exposure is great when the structure is reopened for use.

CHARACTERISTICS AND RECOGNITION

Appearance

The deer mouse is the most widely distributed and the most variable member of the genus. Color ranges from pale grayish buff to deep reddish brown. The tail is always sharply bicolored, dark above and white below. Head and body are 2 4/5 – 4 inches long and the tail is 2 – 5 inches. The deer mouse weighs only 2/3 – 1 1/4 ounces. The eyes and ears are moderate size and prominent and the tail is covered with short fur.

Habitat and Habits

The deer mouse is versatile and occupies nearly every dry land habitat within its range from forests to grassland and a mixture. With the exceptions of Virginia, North and South Carolina, Georgia, Florida, Alabama, Mississippi and Louisiana, the deer mouse can be found throughout the continental United States (including part of Alaska) and Canada. In the east, deer mice are found from the Hudson Bay south to Pennsylvania and the southern Appalachians. They build a large globular nest in burrows in the ground, in trees and stumps, and buildings. The deer mouse feeds on seeds, nuts, acorns, berries, small fruits, and adult and larval insects, and can carry food in a cheek pouch to be stored in its nest. The home range is one-half to three acres or more. A summer population of 10 to 15 per acre is high, although they may congregate in winter. They rarely live more than two years in the wild. Females may show territorial behavior in the breeding season, which may vary with latitude, normally February to November. There may be two to four litters per year with one to eight naked and blind young (usually three to five) per litter. Gestation period is 21 – 27 days. Deer mice are nocturnal, feeding mostly at dusk and dawn. They are excellent climbers and fast runners.

INSPECTION AND MONITORING

Droppings

Observing droppings indoors where native mice have tunneled, fed and nested are telltale signs of their presence. Outdoors runways in grassy areas may be observed, and droppings may also be present. Fresh mouse droppings are dark and shiny, then turn dull and gray as they age. Large numbers of droppings in a small area indicate a feeding or resting site. Droppings and urine will also be found in the nest.

Runways

Outdoors runways may be distinct as grass is clipped and the trail may show. Inside the runways that are being used will show as dust free areas, usually next to walls or other objects.

Tracks

Outdoors in soft soil or dirt areas look for tracks and tail marks in the dust. Deer mice (and others) have large hind feet with five toes and small front feet with four toes. Indoors a non-toxic tracking patch (talc) 6 x 10 inches and 1/16 inch deep can be placed on the floor to determine activity. Place several patches in the area near possible food sources, or other critical areas.

Visual Sightings

If possible, make observations at night as most *Peromyscus* are nocturnal. Use a powerful flashlight or spotlight to check storage spaces or other food or harborage sources. Disturbed mice will rapidly run to shelter.

PEST MANAGEMENT MEASURES

Management of native mice consists of preventive measures such as exclusion, sanitation, habitat modification, and population reduction with snap traps.

Exclusion

If you keep them out, they can't get in! Exclusion may be the most important aspect of native mouse management. All holes, cracks, crevices or other openings larger than 1/8 inch must be filled, covered or otherwise blocked to keep mice out.

As the native rodents can gnaw through wood or other soft substances, burrow into soil, and are good climbers, keeping the structure in good repair is important. Use hard material such as metal flashing, concrete and 1/8 inch hardware cloth for exclusion. Doors and windows should also close tightly.

Sanitation

Keep food and water in clean, tightly closed containers that are resistant to rodent attack. Removal of clutter and debris will also deter rodent activity. If rodents are suspected or observed inside the structure, very strict procedures need to be followed.

Habitat Modification

Another preventive or remedial measure that can be taken outdoors to reduce the opportunity for rodent/human exposure is to remove brush, weeds and other materials from around structures to reduce protected hiding places for rodents. Modifying protective cover makes native rodents more susceptible to predation by hawks, owls and other natural predators. A gravel barrier 4 – 6 inches deep and 3 feet wide next to the structure reduces rodent intrusion.

Trapping

Because of the risk of exposure to the Hantavirus, if native rodents are dwelling inside structures, lethal force in the form of snap traps is recommended. Do not use live traps. Do not use rodenticides or other toxic means for rodents inside structures. Baits that may be used in the snap traps are seeds such as conifer seed, chunky peanut butter, sunflower seed, oats, or cotton balls (plain or with vanilla flavor). Traps should be placed in observed runways or near resting and feeding sites. Check traps daily. Wear rubber or plastic gloves when handling killed mice. Remove dead mice and treat with a disinfectant to kill Hantavirus.

Management Concerns and Action Thresholds

Is this species native to CAGR? – No

IPM Zone #1 - Public and Administrative Buildings
Evidence or observation of one or more within the buildings will trigger immediate treatment in the form of snap trapping and installation of exclusionary devices. While dear mice are a native species within Arizona, CAGR is located at the southern edge of their range and no deer mouse observations have been recorded at CAGR. However, deer mice have been known to carry diseases such as Hantavirus. Thus, any evidence of this species within staff offices, residences or public areas must be addressed immediately.

Zone #2 – Residential Areas
Damage to personal property within the residences may trigger immediate treatment by the resident in the form of snap trapping and installation of exclusionary devices (or park staff if the housing unit is unoccupied).

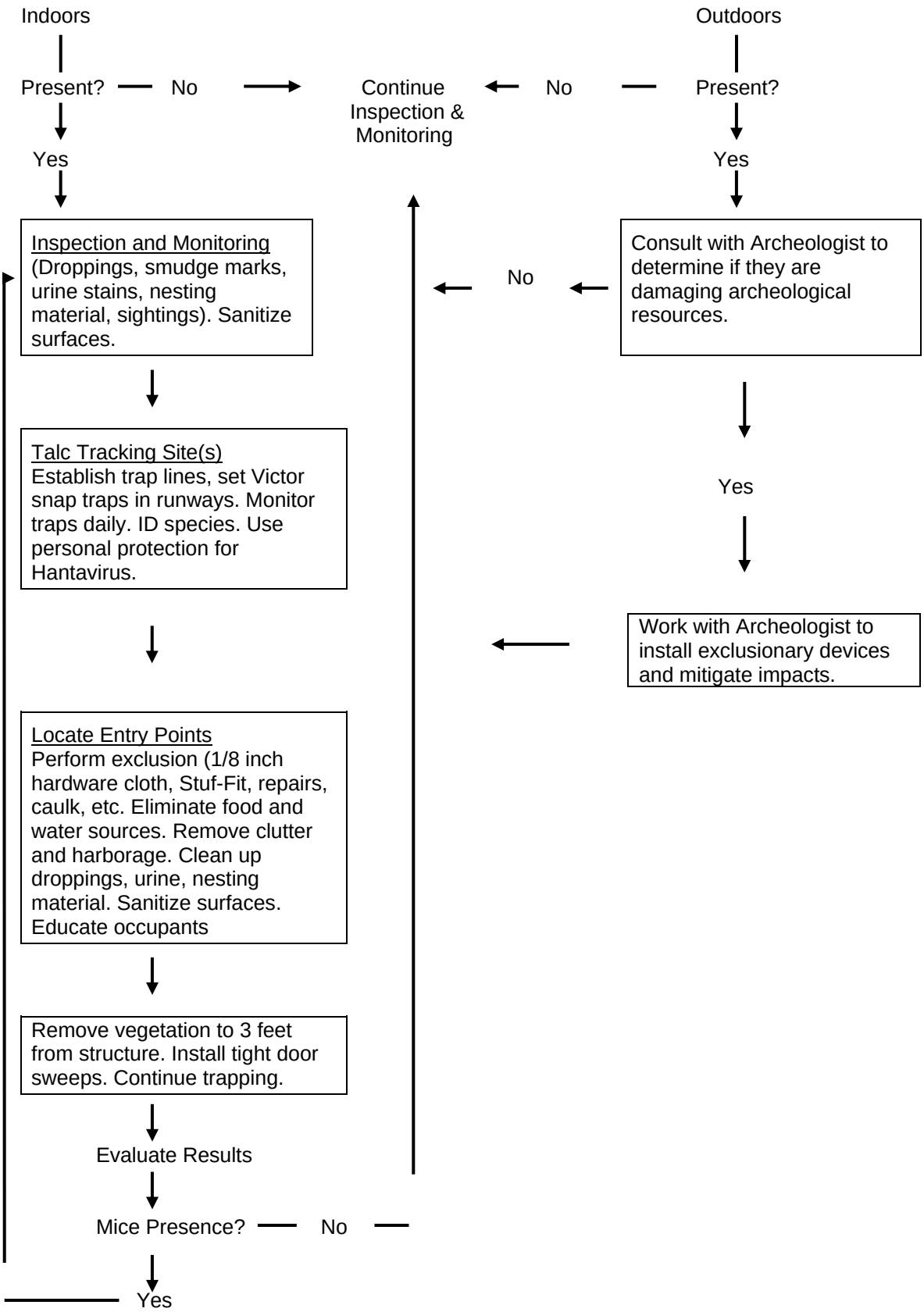
IPM Zone #3 – Front Country Exhibits and Sites
Damage to archeological resources within zone #3 will trigger treatment in the form of encapsulation patching and repair, snap trapping, and installation of the archeologist approved exclusionary devices that are included in this plan.

IPM Zone #4 – Back Country Archeological Sites
Damage to archeological resources will trigger immediate treatment in the form of snap trapping and installation of exclusionary devices.

IPM Zone #5 – Back Country Natural Landscape
No treatment is authorized for this species within management zone #5 without prior IPM Team review and approval.

IPM Zone #6 – Roadside Maintenance
No treatment is authorized for this species within management zone #6 without prior IPM Team review and approval.

DEER MICE


Indoors
Present?
No
Continue Inspection & Monitoring
No
Outdoors
Present?
Yes
Yes
Inspection and Monitoring (Droppings, smudge marks, urine stains, nesting material, sightings). Sanitize surfaces.
No
Consult with Archeologist to determine if they are damaging archeological resources.
Talc Tracking Site(s) Establish trap lines, set Victor snap traps in runways. Monitor traps daily. ID species. Use personal protection for Hantavirus.
Yes
Work with Archeologist to install exclusionary devices and mitigate impacts.
Locate Entry Points Perform exclusion (1/8 inch hardware cloth, Stuf-Fit, repairs, caulk, etc. Eliminate food and water sources. Remove clutter and harborage. Clean up droppings, urine, nesting material. Sanitize surfaces. Educate occupants
Remove vegetation to 3 feet from structure. Install tight door sweeps. Continue trapping.
Evaluate Results
Mice Presence?
No
Yes

NORWAY RAT *(Rattus norvegicus)* and ROOF RAT (*Rattus rattus)*

CHARACTERISTICS AND RECOGNITION

Rats have caused more human suffering and economic damage than any other vertebrate pest. It is estimated that rats destroy 20% of the world's food supply every year, by feeding on or contaminating it. Rats have adapted to nearly all human environments. They live in granaries, fields, city sewers, attics, basements, street trees, on roofs, and food storage areas.

Rats can leap 3 feet straight up and 4 feet horizontally. They can scramble up the outside of a pipe 3 inch in diameter, climb inside pipes of 1 1/2 – 4 inches in diameter, and walk between buildings on telephone or power lines. Rats can swim through a half mile of open water, tread water for up to three days, swim against a strong current in a sewer line, and dive through a sewer trap to pop up inside a toilet. They can fall more than 50 feet and survive.

Rats gnaw constantly to wear down their teeth which continue to grow, and their teeth are extremely hard. They commonly chew through building materials such as concrete block, aluminum siding, sun-dried adobe brick, wall board, wooden cabinets, lead sheathing, asphalt paving, and plastic or lead pipes. An adult rat can compress its body and squeeze through a 1/2 inch opening.

Rats are very wary. Hundreds may be nesting in a city block, in underground burrows, in sewers, on roofs, inside buildings, and few people in the area will realize it. Their populations may be excessive.

Successful long-term rat management is not simple. The key is to manage the environment of rat populations, not individual rats. Rat management requires an integrated approach that includes non-lethal tools such as careful inspection, upgraded sanitation, and rat-proofing structures to exclude rat entry. Lethal methods may also combine the use of low-risk measures such as snap traps or Rat Zappers.

HAZARDS OF INFESTATION

Rats as Disease Carriers

Rats are responsible for the spread of many diseases. Sometimes they transmit the disease directly, by contaminating food with their urine or feces. At other times they transmit disease indirectly; for example, fleas may first bite an infected rat, then a person. Following are some typical diseases associated with rats.

<u>Plague</u>
The "Great Plague" of London killed half of the city's population. The "Black Death" of Europe lasted 50 years in the 14th Century and killed 25 million people. In the first quarter of this century, an estimated 11 million people died in Asia from plague. The disease is transmitted to human beings primarily by the oriental rat flea. The flea bites an infected rat and then, while feeding on people, inoculates them with the bacteria that cause disease.

Although no major urban outbreak of plague has occurred since 1924, this is not a disease of the past. A reservoir of plague exists in some populations of wild rodents in several western states, and human beings contacting these rodents could contract the disease. As suburbia expands into undeveloped areas, wild rodents can transmit the disease to urban rats. There is a concern that an outbreak of urban plague could occur in the United States.

Rat-Bite Fever

Rats bite thousands of people each year; most bites occur in inner cities. In some cases victims, particularly infants and bed-confined elderly, are bitten in the face while sleeping. Those who are bitten may develop rat-bite fever from the bacteria carried on the teeth and gums of rats. Although the disease is similar to flu, it can be fatal. It is of particular risk to infants.

Salmonella Food Poisoning

Rats frequent sewers, rotting garbage, cesspools, and similar sites where salmonella bacteria thrive. Rats can infest stored food or leave bacteria on dishes, silverware, or food-preparation surfaces, and thus transmit Salmonella food poisoning to people.

Leptospirosis or Weil's disease

This disease is seldom fatal to people. The disease organisms are spread from rat urine to water or food, and affect people through mucous membranes, minute cuts, and abrasions of the skin.

KINDS OF RATS

In the United States, the two typical species of rats are the Norway rat (*Rattus norvegicus)* and the roof rat (*Rattus rattus*). The Norway rat is also called the brown rat, house rat, sewer rat, and wharf rat. The Norway rat is considered the most common in the U.S. and is found in every state. The roof rat, also called the black rat, ship rat, and Alexandrine rat, is found primarily in coastal areas including California, Washington, Oregon, the Southeast and Middle Atlantic States, and the Gulf States.

The two species look similar, but there are noticeable differences. In general:

Norway Rat (*Rattus norvegicus)*

A Norway rat looks sturdier than the roof rat; the roof rat is sleeker.

A mature Norway rat is 25% longer than a roof rat, and weighs twice as much.

A Norway rat's tail is shorter than the length of its head and body combined; a roof rat's tail is longer than its head and body.

A Norway rat's ears are small and covered with short hairs; a roof rat's ears are large and nearly hairless.

A Norway rat's snout is blunt; the roof rat's snout is pointed.

Roof Rat *(Rattus rattus)*

HABITS OF RATS

The knowledge of the life history, habitat, food requirements, patterns of behavior, range, and other factors is essential to the management of rat infestations. Since Norway and roof rats have similar habits, these discussions apply to either species.

Roof Rat Climbing A Wall

Life Cycle

A mature female rat can give birth to about twenty young in a year (four to six at a time), if she lives that long. The average life span of a rat in the field is less than one year, although females live longer than males.

The young are born in a nest. They are hairless, and their eyes and ears are closed. Within two weeks their eyes and ears open, they become furry and rat-like, and they begin exploring the nest area. In the third week they begin to eat solid food, and imitate their mother in foraging, escaping, and watching for danger.

If the mother rat has become wary of rodenticides or traps, many of her young will learn to avoid them. This learning experience can make management difficult in sites where long-term rodent-baiting programs have been unsuccessful in the past.

Young are totally weaned at four or five weeks old, when they weigh about 1 1/2 oz., and at the age of three months, the young are independent of their mother. They will mate and continue the cycle in the same location, or will migrate to a new area.

Social Behavior

Rats live in colonies with well-defined territories that they mark with urine and glandular secretions. The colony has a complex social hierarchy with a dominant male leader and a "pecking order" of subordinate males and ranking females. The strongest and most dominant animals occupy the best nest and resting sites, and feed at their leisure. Weaker, subordinate rats are pushed out to less favorable sites, or forced out of the territory completely.

Rats are aggressive, and social conflicts are most common at feeding sites, prime resting areas, and territorial boundaries. Females fiercely defend their nest and young from other rats.

Roof Rat *(Rattus rattus)*

Rat Senses

Vision, Touch, Taste, Balance

Rats have poor vision. They are nearly color blind, and react to shapes and movement rather than identifying objects by sight. 30 – 45 feet is the limit of their vision, and their eyes are adapted to dim light. Other senses, however, compensate for poor vision. They use their sensitive noses to locate food, follow pathways, tell whether another rat is friend or foe, and identify new objects in their territory. They use long whiskers and guard hairs to "touch" their way through dark burrows, pipe chases, wall voids, and other runways. Their ears detect faint sounds that signal danger. Rats can taste certain chemicals at a parts-per-million concentration.

This explains why rats often reject baits or avoid traps that have been contaminated with insecticides. Rats have an excellent sense of balance which allows them to walk on wires and always land on their feet in a fall.

Fear of New Objects (Neophobia)

Rats are wary of anything new that appears in their territory. A bait station, a trap, or a block of wood will be avoided for a few days until the rats become familiar with the new object. Even then, they approach cautiously. This fear of new objects can make baiting and trapping difficult. Rats will avoid poison bait when it is first placed. Later, they may nibble warily. If the poison bait makes them ill, but doesn't kill them, they will subsequently avoid similar baits or stations.

Food and Water

Rats need about one ounce of food daily. Norway and roof rats prefer different types of food. Norway rats prefer protein-based foods such as meat, fish, insects, pet food, nuts, and grain. Household garbage is ideal food for Norway rats. Roof rats prefer plant materials such as fruits, nuts, seeds, berries, vegetables, and tree bark. They occasionally feed on garbage and meats. Both rat species will feed on non-preferred food if nothing else is available.

Rats may hide or hoard food in hidden areas. This food may or may not be eaten when other food supplies run short. Hoarding food is important for three reasons. First, rats may be moving toxic bait into areas where perhaps the label does not permit its use. Second, rats may be hoarding poison bait while feeding on their regular food. In this case, a baiting program becomes ineffective. Third, hidden food may become a focal point for insect infestations.

Rats need water every day. The amount varies, depending on the moisture content of their food, but is usually around 1/2 – 1 fl ounces. Rats prefer to nest where water is available.

Range

Rats usually begin foraging after dark. Most of their food gathering occurs between dusk and midnight, but short bursts of restlessness and activity can occur anytime, day or night. Rats commonly travel 100 – 150 feet from their nest looking for food and water and patrolling their territory. It is not unusual for a colony that nests outdoors to forage inside a building (100 feet) away.

Nests

Outdoors, Norway rats usually nest in burrows dug into the ground. The burrows are shallow (less than 18 inches) and usually short (less than 3 feet), with a central nest. Extra "bolt holes" are used for emergency escapes. They are hidden under grass or boards or lightly plugged with

dirt. Burrow openings are 2 – 4 inches in diameter. Indoors, Norway rats nest inside walls, in the space between floors and ceilings, underneath equipment, between and under pallets, and in crawlspaces, storage rooms, and any cluttered area that is normally unoccupied. Norways prefer to nest in the lower floors of a building.

Roof rats commonly nest above ground, in trees, particularly untrimmed palm trees, and in piles of wood or debris, vine-covered fences, and stacked lumber. Overgrown landscaping is also a prime nesting area. Roof rats will sometimes nest in burrows if above-ground sites are limited and Norway rats are not nesting in the area. Indoors, roof rats prefer to nest in the upper levels of a building in the attic and ceiling voids, near the roof line. But at times, they also nest in the lower levels of a building.

Both species also nest in sewers and storm drains, and highly unusual nest sites and can have several "hotel" nest sites in an area. A rat may spend a week in its home base and then move for a day or two into a secondary "hotel" nest site. Norway rats have been shown, on occasion, to have a home range of up to twenty acres when these secondary nest sites were included in calculations.

INSPECTION AND MONITORING

There are many signs of a rat infestation which can assist the inspector in identifying where rats are feeding and nesting, their patterns of movement, the size of the population, and the extent of infestation. This helps to influence what management measures to use, where and how to use them, and how much effort is needed to manage the population.

Signs of Rats

An inspection using a powerful flashlight after dark is the best way to see live rats. Dead rats are signs of either a current or past infestation. Dried carcasses and skeletons may indicate an old infestation. Fresh carcasses may indicate a recent poison baiting. If rats are seen during the day, the rat population is probably high.

Sounds

Squeaks and fighting noises in a building, clawing, scrambling, or gnawing sounds in walls may indicate the presence of rats. Use a stethoscope or electronic listening device to help pinpoint such noises.

Droppings

A rat may produce 50 droppings daily. Roof-rat droppings are generally smaller (1/2 inch) than the Norway rat's (3/4 inch). The highest number of droppings will be found in locations where rats rest or feed. Determine if a rat population is active by removing old droppings, and then reinspect a few days to a week later for new droppings.

Look at the appearance of droppings to determine if rats are present. Fresh rat droppings are black, glisten and look wet, and have the consistency of putty. After a few days the droppings become dry, hard, and appear dull. After a few weeks, droppings become gray, dusty, and crumble easily. Note that sometimes old droppings moistened by rain may look like new droppings; however, if crushed, they will crumble.

Urine

Both wet and dry urine stains will glow blue-white under an ultraviolet light (black light). Use portable ultraviolet light, as used in the food industry, to identify rat urine on food and other items. Other substances besides rat urine also glow, which can be confusing, so proper use of this inspection method, takes practice.

Grease Marks

Oil and dirt rub off of a rat's coat as it runs along walls. Grease marks build up in frequented runways. Look for grease marks along wall and floor junctions, and at pipes, ceiling joists, and sill plates, where rats swing around obstacles. Grease marks are also found at regularly used openings in walls, floors, and ceilings. Fresh grease marks along baseboards are waxy.

Runways

Outdoors, rats constantly travel the same route. Their runways appear as beaten paths on the ground. Look for such paths next to walls, along fences, and under bushes and buildings. Indoor runways of rats may appear as well-polished trails which are free of dust.

Tracks

A rat's footprint is about 3/4 inch long, and may show four or five toes. Rats may also leave a "tail drag" line in the middle of their tracks. Look in dust or soft moist soil. Place a tracking patch in suspected rat areas to show footprints. A tracking patch is a light dusting of an inert material such as clay, talc (unscented baby powder), or powdered limestone. Don't use flour, which may attract insect pests. A good patch size is 12 x 4 inches. Apply patches in suspected runways and near grease marks. When inspecting tracking patches, shine a flashlight at an angle that causes the tracks to cast a distinct shadow. Note that a tracking patch is not the same as a toxic tracking powder. Tracking powders are diluted rodenticides in dust form. Tracking patches use nontoxic dust. Do not use a toxic tracking powder to make a tracking patch.

Gnawing Damage

A rat's incisor teeth grow at a rate of about 5 inches per year. Rats keep their teeth worn down by continuously working them against each other and by gnawing on hard surfaces. Look for gnawing damage on floor joists, ceiling joists, door corners, kitchen cabinets, and around pipes in floors and walls as evidence of rat infestation. Gnawed holes may be 2 inches or more in diameter.

Nest Sites

Roof rats often nest or store food in the attics of buildings. Their nests may also be found in trimmed dense vegetation.

Burrows

Outdoors, rat burrows may be found singly or in groups along foundation walls, under slabs and dumpster pads, in overgrown weedy areas, beneath debris, and in embankments. Look for a burrow opening that is free of dirt, leaves, and debris. The openings may be covered with smooth, hard-packed soil. Look for rub marks at the opening, and soil pushed out in a fan-shaped pattern.

Fill the opening with a small amount of wadded-up newspaper or a few leaves and cover it with loose soil. Or, just kick in the open entrance to close it. If the rats are still using the burrow, they will reopen and clear the hole overnight. This is a good monitoring method to identify active burrows.

Pet Excitement

Cats and dogs may excitedly probe an area of floor or wall where rats are present, especially if the rats have recently invaded.

Odor

Heavy infestations have a distinctive odor which can be identified with practice. The odor of rats can be distinguished from the odor of mice.

Estimating Rat Numbers

It's not easy to tell how many rats are infesting a site. Rat signs, however, may categorize the population as low, medium, or high. In rat-free or low infestation conditions, no signs are seen. In the case of medium infestation, old droppings and gnawing can be observed and one or more rats are seen at night. No rats are seen during the day. When there is a high infestation, fresh droppings, tracks, and gnawings are common. Three or more rats are seen at night, and rats may be seen in the daytime as well.

MANAGEMENT

Most successful rat management programs use a combination of tools and procedures to reduce and eliminate a rat population. The methods combine habitat alteration and population reduction. Some of the tools, such as trapping, are lethal to the rat. Some tools are not. Rat-proofing by making building repairs or increasing the frequency of garbage pickup are examples of non-lethal management methods.

Sanitation

Rats may ignore bait since it can't compete with the rats' regular food. Reducing rats’ normal food supply encourages them to move to some other territory. This can be accomplished by closing or repairing open or damaged dumpsters and garbage containers, cleaning up food spills promptly, and not allowing food to be left out overnight.

Eliminate Hiding Places

Outdoors, remove plant ground covers such as ivy to 3 feet from buildings. Remove high grass, weeds, wood piles, and construction debris that permit rats to live and hide adjacent to a building. Indoors, eliminate clutter in buildings and rarely-used rooms, basements, storage rooms, equipment rooms. Organize storage areas to remove clutter.

Rat-Proofing (exclusion)

The most successful long-term form of rat management is to build them out. Rat-proofing is an exclusion technique that makes it impossible for rats to get into a building.

Building Exterior

Seal cracks and holes in building foundations and exterior walls. Block openings around water and sewer pipes, electric lines, air vents, and telephone wires. Install 1/4 inch steel wire screen or hardware cloth on ventilation openings. Caulk and seal doors with door sweeps to ensure a tight fit, especially between door and floor threshold. Fit windows and screens tightly. Caulk and close openings on upper floors and the roof. Inspect under siding and repair damaged soffits. Repair breaks in the foundation below ground level.

Building Interior

Seal spaces inside hollow block voids or behind wallboard. Repair broken blocks and holes around pipes. Repair holes or stuff them with copper Stuf-Fit. Cover floor drains with sturdy metal grates secured firmly in place.

Trapping

Trapping for rodents is a widely used, low-risk method of rodent management. Trapping offers great usefulness and versatility in the form of snap or guillotine traps where toxicants cannot or should not be used. The snap trap is an effective method of killing rats when used correctly, and is advised for use inside structures. It has several advantages: there is less non target risk than from a toxicant bait; the pest manager knows instantly whether or not the trap has been successful; and trapping allows disposal of the carcass to eliminate hidden odor problems. Carcass disposal also eliminates the possibility of secondary infestation by blowflies and dermestid beetles that would feed on it. Traps should be strategically placed in sufficient number, otherwise rats will avoid them. Place bait on the unset trap for a few days until the bait is taken, then bait and set the trap.

Physical Condition of Traps

A trap physically incapable of holding a rodent should never be set out. Staples holding the spring should be firm; the trap jaw should be square and fit inside the trap base. The trigger mechanism should operate smoothly at the slightest touch. Use properly sized traps for the species to be managed: mousetraps for mice; rat traps for roof and Norway rats. The trap base should not be warped or the trap will rock when stepped on. If necessary, working parts should be lightly oiled with mineral or other inorganic oil, not machine oil. Traps should be kept away from pesticides or other strong odors that might be repellent to the rodents. Don't clean a trap bloodied by a catch, since the odors enhance its acceptance. A shiny new trap increases the possibility of rejection in response to the "new object avoidance" instinct. For some situations, the best traps are those with enlarged bait pans (triggers) set for a light touch.

Enlarged Bait Pans

Some traps may need enlarged bait pans. Commercial traps with expanded bait pans are available, but the old style traps can easily be adapted with wire screen or light metal cut from metal cans or hardware cloth. The enlarged bait pan should be trimmed so that it is 1/4 inch smaller than the trap jaw wire and securely fastened to the standard bait pan.

Placement of Traps

Traps with enlarged bait pans, if properly placed in runways, do not need to be baited, but baiting adds to their effectiveness. Smear peanut butter in the center of the bait pan, sprinkle oats lightly across the pan, or tie a nutmeat or dried fruit piece to the center of the pan. Meat, like sausage, bacon, or peanut butter is attractive to Norway rats, while fresh or dried fruit will draw roof rats. Cotton balls also are attractive to females of both rat species. Traps must be placed in the rodents' regular active runways, as indicated by the presence of feces, smears, or tracks.

Place light tracking patches of talc or other odorless, innocuous fine-particled material to find where the rodents are most active and place traps there. All traps should be set perpendicular to and across the runway so that the bait pan is in the runway, and against the wall or other vertical surface. Make narrow runways to force the animals to cross over the trap pan. Put traps in concealed places where rodents are more apt to be found rather than in places the trapper can easily reach. Trap the area heavily, every 10 – 12 feet. Map the locations so traps can be more easily recovered later or by someone else if necessary. Move traps to other areas after two weeks (the first area can be retrapped after a lapse of several weeks).

Adhere to good public relations practices, and pick up trapped animals as soon as possible (at least daily). In areas used frequently by the public, use trap stations to cover trapped animals in snap traps. This also protects them from accidental tripping by maintenance personnel. Don't place traps above food or food handling areas or in areas where pets or children can reach, as rat traps can break their small bones.

Leaving the traps unset for a few days may increase the catch by reducing the chance that wary rats will trip the traps without capture. Set traps with bait, if food for rats is in short supply and without bait if they have enough. When runways are located on rafters and pipes, set expanded trigger traps directly across them, fastening them securely to pipes with wire or hose clamps, and to rafters with nails. Use enough traps. Set five or ten traps in an active corner of a space. Set three traps in a row so that a rat, leaping over the first, will be caught in the second or third. If unsure about sites of activity, set traps along possible runways spaced ten to twelve feet apart.

Camouflage traps when only a few rats remain and are difficult to capture. Set traps in a shallow pan of meal, sawdust, or grain. In stubborn cases, expose food in shallow pans until the rats readily feed on it. Then add a buried trap. Inspect traps frequently to remove dead rodents and change old bait.

The Victor Snap Trap is the oldest trap and is still one of the most effective ways to humanely kill rats.

Victor Rat Trap

Rat Zapper 2000

The Rat Zapper 2000 is an electronic trap that humanely kills rats and mice. The trap is a battery-powered plastic tunnel that is attractive to rodents and provides a bait placement inside. When the rodent enters the tunnel for the bait and steps on a sensor plate, the rodent is given a lethal shock. Empty the trap by turning it upside down, allowing the dead rodent to slide out. A blinking red light alerts you to the dead rodent in the trap. Remote sensing is also available for multiple traps.


Rat Zapper

Glue Boards

Glue boards are not humane for trapping rodents and must NOT be used on NPS sites. However, it should be noted that glue traps are acceptable for trapping and monitoring insects within enclosed buildings.

Rodenticides

A rodenticide is a pesticide designed to kill rodents. Rodenticides are NOT recommended for the management of rats or mice in NPS sites or other public areas. However, rodenticide use has been approved to manage animal populations in specific cases. These cases are reviewed on an individual basis and must be approved by the Chief of Resource Management, the IPM Coordinator, Biological Science Specialist, and the CAGR Superintendent. NO pesticides may be applied without prior approval and issuance of an NPS Pesticide Use Permit.

Management Concerns and Action Thresholds - NORWAY RAT *(Rattus norvegicus)*

Is this species native to CAGR? – No

IPM Zone #1 - Public and Administrative Buildings
Evidence or observation of one or more within the buildings will trigger immediate treatment in the form of snap trapping and installation of exclusionary devices.

Zone #2 – Residential Areas
Damage to personal property within the residences may trigger immediate treatment by the resident in the form of snap trapping and installation of exclusionary devices (or park staff if the housing unit is unoccupied).

IPM Zone #3 – Front Country Exhibits and Sites
Damage to archeological resources within zone #3 will trigger treatment in the form of encapsulation patching and repair, snap trapping, and installation of the archeologist approved exclusionary devices that are included in this plan.

IPM Zone #4 – Back Country Archeological Sites
Damage to archeological resources will trigger immediate treatment in the form of snap trapping and installation of exclusionary devices.

IPM Zone #5 – Back Country Natural Landscape
No treatment is authorized for this species within management zone #5 without prior IPM Team review and approval.

IPM Zone #6 – Roadside Maintenance
No treatment is authorized for this species within management zone #6 without prior IPM Team review and approval.

Management Concerns and Action Thresholds – ROOF RAT *(Rattus rattus)*

Is this species native to CAGR? – No

IPM Zone #1 - Public and Administrative Buildings
Evidence or observation of one or more within the buildings will trigger immediate treatment in the form of snap trapping and installation of exclusionary devices. This pest species has a history of nesting in records storage areas, ventilation ducts and air conditioning units. Thus, special care must be taken to promptly remove animals from traps and not to treat roof rats with pesticides. Only snap traps and exclusionary devices are authorized in zone #1 without prior IPM Team review and approval.

Zone #2 – Residential Areas
Damage to personal property within the residences may trigger immediate treatment by the resident in the form of snap trapping and installation of exclusionary devices (or park staff if the housing unit is unoccupied).

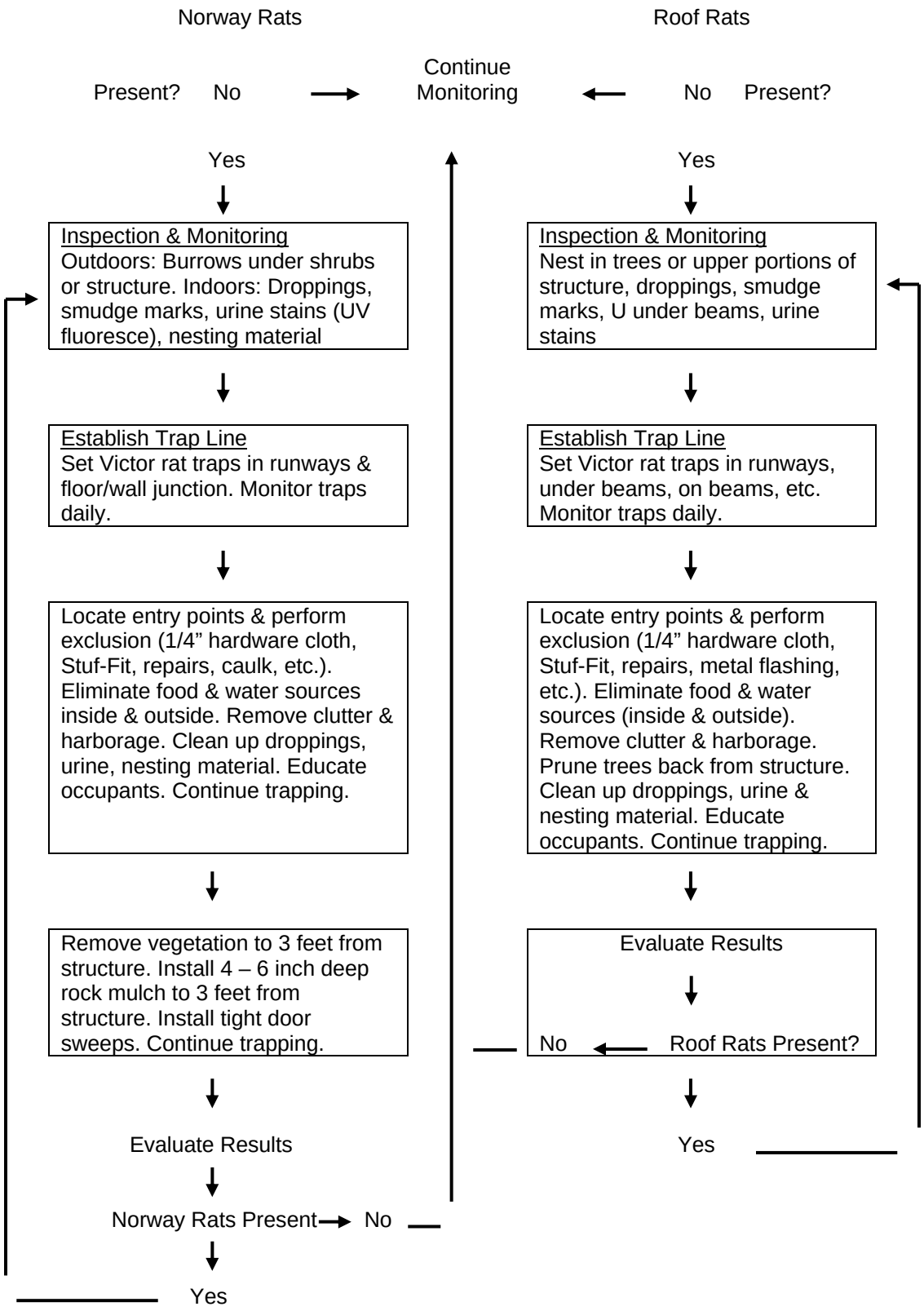
IPM Zone #3 – Front Country Exhibits and Sites
Damage to archeological resources within zone #3 will trigger treatment in the form of encapsulation patching and repair, snap trapping, and installation of the archeologist approved exclusionary devices that are included in this plan.

IPM Zone #4 – Back Country Archeological Sites
Damage to archeological resources will trigger immediate treatment in the form of snap trapping and installation of exclusionary devices.

IPM Zone #5 – Back Country Natural Landscape
No treatment is authorized for this species within management zone #5 without prior IPM Team review and approval.

IPM Zone #6 – Roadside Maintenance
No treatment is authorized for this species within management zone #6 without prior IPM Team review and approval.

RATS


Norway Rats
Roof Rats
Present? No
Continue Monitoring
No Present?
Yes
Yes
Inspection & Monitoring
Outdoors: Burrows under shrubs or structure. Indoors: Droppings, smudge marks, urine stains (UV fluoresce), nesting material
Inspection & Monitoring
Nest in trees or upper portions of structure, droppings, smudge marks, U under beams, urine stains
Establish Trap Line
Set Victor rat traps in runways & floor/wall junction. Monitor traps daily.
Establish Trap Line
Set Victor rat traps in runways, under beams, on beams, etc. Monitor traps daily.
Locate entry points & perform exclusion (1/4" hardware cloth, Stuf-Fit, repairs, caulk, etc.). Eliminate food & water sources inside & outside. Remove clutter & harborage. Clean up droppings, urine, nesting material. Educate occupants. Continue trapping.
Locate entry points & perform exclusion (1/4" hardware cloth, Stuf-Fit, repairs, metal flashing, etc.). Eliminate food & water sources (inside & outside). Remove clutter & harborage. Prune trees back from structure. Clean up droppings, urine & nesting material. Educate occupants. Continue trapping.
Remove vegetation to 3 feet from structure. Install 4 – 6 inch deep rock mulch to 3 feet from structure. Install tight door sweeps. Continue trapping.
Evaluate Results
No
Roof Rats Present?
Evaluate Results
Yes
Norway Rats Present
No
Yes

ROUND-TAILED GROUND SQUIRRELS *(Spermophilus tereticaudus)*

Round-tailed Ground Squirrel

Round-tailed ground squirrels (RTGS) are native rodents usually found below 3,200 feet elevation. Their range includes southern Arizona, Nevada, southeastern California and northern Mexico. This rodent is typically found in low, flat areas devoid of vegetation except for creosote bush, mesquite, bursage and palo verde. RTGS are 5 to 6 inches long with small ears and a sparsely haired, curved tail which is about an inch shorter than the body. They do not have stripes or spots on their bodies, and are uniformly pink to reddish-brown in color. RTGS occur throughout Casa Grande Ruins National Monument and become undesirable pests when they locate their colonies near park structures, picnic grounds or archeological ruins.

RTGS dig their own burrows which may be a foot or more deep and 4 to 5 feet long. They will also move into abandoned burrows. The burrows are mainly located in open areas where quick escape is possible should a predator approach. Although RTGS are gregarious, they do not share burrows. Their activity patterns are dependent on temperature and weather, and are most active during summer heat from about 8 AM to Noon, and again from late afternoon until dusk. An individual squirrel may forage for approximately 200 yards.

RTGS hibernate beginning in September and October, but never become completely dormant. A few animals can usually be seen above ground every month of the year on warm days. They are primarily vegetarians during most of the year and eat leaves, flowers, bark and pods of mesquite, and fruits of creosote bush and chinchweed. They will climb into bushes and trees in search of seeds and vegetation, but they do not store food. Their water requirements are generally met by their habit of eating succulent foods.

Breeding occurs from February through March and litters which average about 6 are born in March and April. The young spend their first month in the burrow; then emerge from burrows in late April to May. They disperse to find their own burrows in June. This is important as it establishes when the young emerge and establishes when population control could be most effective.

Young RTGS become sexually mature in slightly less than a year. Survival rate for young squirrels is about 33% from one year to the next, and less than 1% of the adults survive beyond 4 years. Predators include coyotes, foxes, badgers, raptors, thrashers, coachwhip snakes, rattlesnakes, gopher snakes, Gila monsters and bobcats.

POTENTIAL DAMAGE AND HEALTH CONCERNS

Burrows and tunnels in areas where visitors are allowed post the risk of turned or broken ankles and/or falls which pose a liability risk. Squirrel colonies are located near the Great House, the picnic area, the ball court, and in the administrative and maintenance areas. RTGS burrows damage historical artifacts, ornamental plants, increase rates of erosion and attract predators which enlarge rodent burrows trying to catch prey. RTGS, like other rodents, may harbor a number of parasites such as fleas and can transmit diseases to humans such as plague and salmonellosis.

ACTION THRESHOLDS

RTGS can rapidly increase in number and management is justified with the presence of structural damage or possible health concerns for Monument staff and visitors. Action thresholds for RTGS around archeological structures and other areas to be protected will be determined by CAGR staff based on population levels and threat to structures and artifacts.

INSPECTION AND MONITORING

All persons doing rodent inspection and monitoring should wear approved personal protective equipment for personal safety. Reports should document needed repairs on inspection forms and list any evidence which supports pests.

Inspect and monitor to determine the amount and kind of damage caused by RTGS. Also note and eliminate any conditions which supply harborage, food or water to support populations. Monitor weather conditions to recognize when conditions will likely support increased plant growth and increase rodent numbers.

Monitor rodent populations and numbers of active rodent burrows. Maintain data on the number of animals in specific areas, both prior to and following management measures. Keep all abandoned burrows closed, including those made by other species. Keep records of rodent activity in regard to season and time of day. Record numbers, kinds and locations of dead animals which could indicate the presence of disease.

NON-CHEMICAL MANAGEMENT

No single management method is available for burrowing rodents. Animals will continually move in from surrounding areas. Management methods which can significantly reduce damage include:

Exclusion
Fill in or seal all holes, pathways or accesses into buildings with ¼ inch hardware cloth and 1 inch gravel, 4 inches deep. Remove access to archeological resources by infilling and patching deteriorated encapsulation materials under the guidance and approval of the Chief of Natural Resources and an Archeologist. All treatments within known archeological sites MUST BE in compliance with the National Historic Preservation Act.

Habitat Modification
Modify the habitat to reduce or eliminate harborage, water and food. Remove weeds and other plant growth from areas around RTGS colonies. Cover infested ground near structures or critical artifact sites with ¼ inch hardware cloth and 1 inch gravel, 4 inches deep to prevent RTGS burrowing. This also reduces hazards to visitors from stepping into burrows.

Use rodent-proof garbage cans and collect garbage at the close of business daily. Inform visitors not to feed rodents and to clean up all food scraps and trash from the picnic area. Install “Do Not Feed Animals” signs and issue tickets to those persons who do so.

Repair leaking water faucets, pipes or drip irrigation to reduce or eliminate sources of water.

Predation

The Monument should continue to protect the occurrence of native predators which are an important part of the natural ecosystem. Provide and maintain nesting platforms for hawks and owls to increase predator populations.

Behavioral Controls

RTGS react to the presence of predators by escaping into their burrows. If barriers are placed near their burrows so they cannot determine if predators are present, they are likely to move burrows to safer ground. Continue to move barriers toward an acceptable area. Place sight barriers so that moved burrows are not impacting artifacts or structures. Fill in abandoned burrows and cover with ¼ inch hardware cloth and 1 inch gravel, 4 inches deep.

Population Reduction

Where damage exceeds action thresholds, the preferred methods of population reduction for RTGS in problem areas will be by rat-sized, snap traps which are protected to prevent injury to non-target animals; by box-type, and by shooting.

RTGS are easy to trap; however, trapping can be difficult during spring when animals are feeding on green vegetation. Use celery or peanut butter to bait the Victor-brand rat traps. Set traps near or over burrow entrances and bait with celery, cereals, nuts, raisins or other foods attractive to RTGS. Continue trapping at burrows until all animals are thought to have been removed. When traps no longer catch animals, place wadded paper, leaves, etc. in burrows and revisit the sites for a few days to verify that animals are no longer using the burrows.

When all animals have been removed, close the burrow with soil and rocks and smooth over the surface of the ground. Continue to monitor the area for a few weeks to be sure new animals have not reopened old burrows. If burrows are reopened, trap the animals again and seal the burrow entrance as before, but finish by covering the hole with a 3 foot square piece of ¼ inch hardware cloth and cover it with soil and gravel.

DO NOT live capture RTGS.

Shooting RTGS with a small caliber rifle or air gun is an effective, direct management tool where permitted, and the numbers of animals to be removed is not excessive. However, RTGS may become gun shy.

Concentrate all rodent management efforts only on active burrows and continue to trap RTGS until their impact on resources is greatly reduced.

Repellents

There are no good repellents for ground squirrels; however, some reports indicate that animals have been repelled, for at least short periods of time, with commercial coyote or fox urine, which is available from trapping supply outlets. Care must be taken not to apply canine urine in areas where additional territorial marking by wild canine species could pose a threat to resource protection.

CHEMICAL MANAGEMENT

Where physical or mechanical methods of RTGS management are proven through monitoring and evaluation to not be effective and needs for control remain, NPS approval will be sought for appropriate poisons to use in outdoor locations or unoccupied buildings. One of these poisons might be cholecalciferol, which is registered under a Special Local Needs Permit for ground

squirrels. Another pesticide that has been found to be effective at managing RTGS is Zinc Phosphide. Additional research is being conducted on the efficacy of immunocontraceptives. However, it should be noted that any pesticide use must be reviewed on a case-by-case basis and approved by the Chief of Resource Management, the IPM Coordinator, Biological Science Specialist, and the CAGR Superintendent. NO pesticides may be applied without prior approval and issuance of an NPS Pesticide Use Permit.

Portions of this section were taken from a paper done by Karen Munroe, University of Arizona, Tucson, Arizona.

Management Concerns and Action Thresholds

Is this species native to CAGR? – Yes

IPM Zone #1 - Public and Administrative Buildings
Evidence or observation of one or more within the buildings will trigger immediate treatment in the form of snap trapping and installation of exclusionary devices.

Zone #2 – Residential Areas
Damage to personal property within the residences may trigger immediate treatment by the resident in the form of snap trapping and installation of exclusionary devices (or park staff if the housing unit is unoccupied), but damage to property outside of the housing unit will trigger IPM Team review.

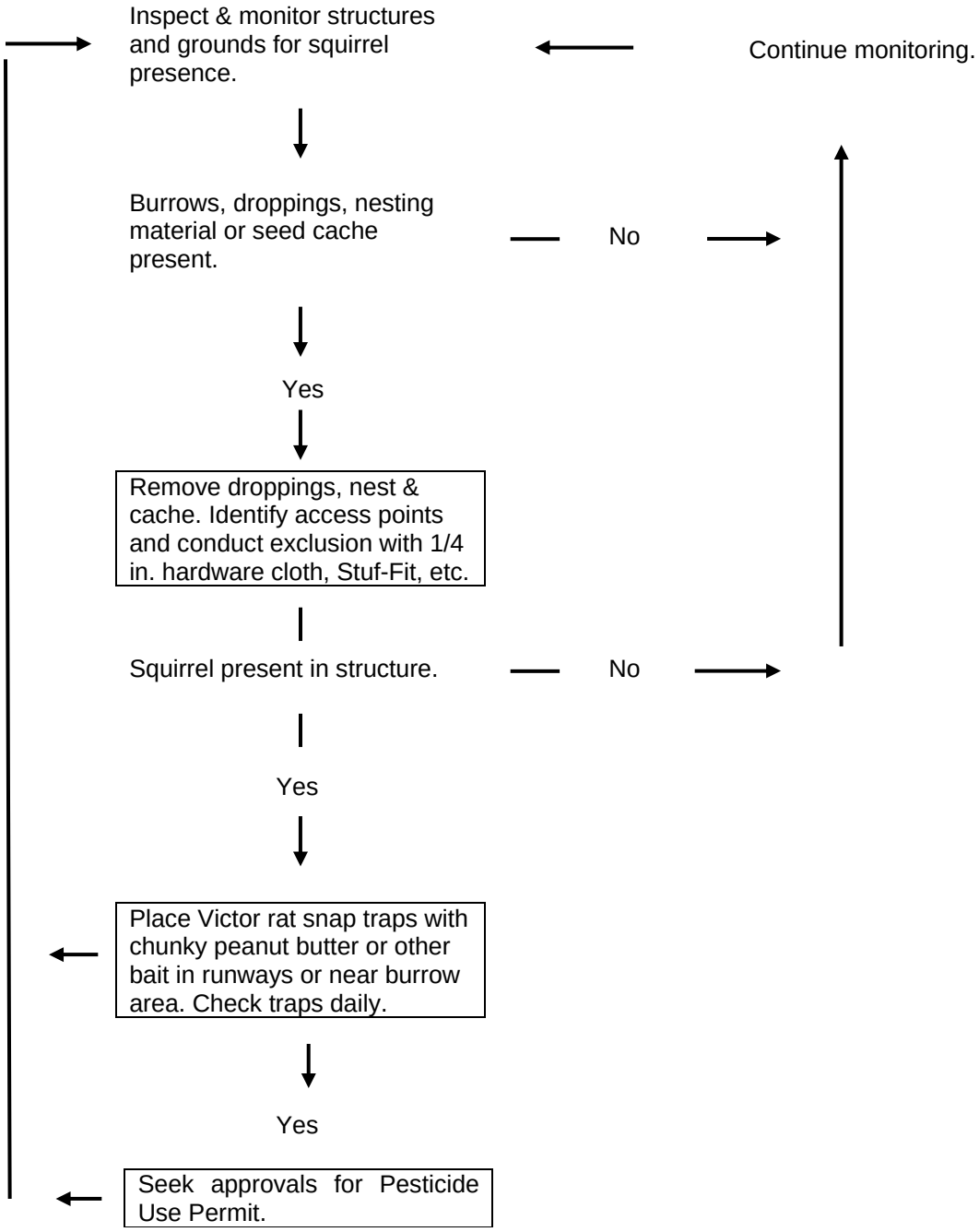
IPM Zone #3 – Front Country Exhibits and Sites
Damage to archeological resources within zone #3 will trigger treatment in the form of encapsulation patching and repair, filling in burrows with sterile soil, and installation of the archeologist approved exclusionary devices that are included in this plan. Interdisciplinary IPM Team review will also be triggered if more than 20 rodent holes are recorded within a 10 x 10 meter survey unit anywhere within this management zone.

IPM Zone #4 – Back Country Archeological Sites
Damage to archeological resources and/or the presence of 40 or more rodent burrows within a 10 x 10 meter survey unit will trigger IPM Team review to determine appropriate, archeologist approved treatment such as Zinc Phosphide, etc.

IPM Zone #5 – Back Country Natural Landscape
Property damage would trigger IPM Team review to determine appropriate, archeologist approved treatment.

IPM Zone #6 – Roadside Maintenance
No treatment is authorized for this species within management zone #6 without prior IPM Team review and approval.

ROUND-TAILED GROUND SQUIRREL



WESTERN COACHWHIP SNAKE *(Masticophis flagellum testaceus* [Say])

Coachwhips range throughout the southern United States from coast to coast, and in the northern half of Mexico; mainly open hillsides, dry sand, prairie, oak and pine woodlands, grassy areas, dunes and scrub.


Western Coachwhip Snake

Coachwhips are thin bodied snakes with small heads with large eyes that have round pupils. They vary greatly in color, but most reflect a camouflage for their natural habitat. Most are typically a shade of light brown with darker brown flecking, but some specimens frequently have some red in their coloration. Coachwhip scales are patterned almost so that at a glance, the snake looks as if it were braided.

In the U.S., coachwhips reproduce once per year. Mating occurs in the spring and females lay a clutch of 4 – 16 eggs in June or July. The young hatch from the granular-surfaced eggs in 6 – 11 weeks.

Coachwhips are a diurnal snake and actively hunt and eat lizards, small birds, rodents, small turtles, bird eggs, insects and other snakes – including rattlesnakes. It will eat several small rodents during one feeding, and feeds approximately every 5 days.

They tend to be high strung and often bolt at the first sign of a potential threat. They are extremely fast moving snakes. They are curious with good eyesight, and are sometimes seen raising their heads above the level of the grass or rocks to see what is around them. They use scent trailing as well as vision to seek out prey. When confronted by a potential enemy, they will normally flee. If this is not feasible, they will coil up, hissing loudly and vibrating the tail. They may strike repeatedly.

This species can grow to be one of the largest snakes in the United States. It is a very active animal and does not do well in captivity.

Management Concerns and Action Thresholds

Is this species native to CAGR? – Yes

IPM Zone #1 - Public and Administrative Buildings
Evidence or observation of one or more snakes within the buildings that constitute this zone will trigger immediate treatment in the form of animal relocation and installation of exclusionary devices.

Zone #2 – Residential Areas
Evidence or observation of one or more snakes within the residences may trigger immediate treatment by the resident in the form of animal relocation and the installation of exclusionary devices; but no treatments will be permitted outside of the housing unit without prior IPM Team review.

IPM Zone #3 – Front Country Exhibits and Sites
Observation of one or more snakes within this zone will trigger immediate animal relocation to non-public areas and installation of exclusionary devices. Damage to archeological resources within zone #3 will trigger treatment in the form of encapsulation patching and repair, filling in

burrows with sterile soil, and installation of the archeologist approved exclusionary devices that are included in this plan.

IPM Zone #4 – Back Country Archeological Sites
Damage to archeological resources will trigger IPM Team review to determine appropriate, archeologist approved treatment. It should be noted and weighed accordingly by the IPM Team that snakes serve as an effective predatory manager of rodent species which cause the most damage to archeological sites.

IPM Zone #5 – Back Country Natural Landscape
No treatment is authorized for this species within management zone #5 without prior IPM Team review and approval.

IPM Zone #6 – Roadside Maintenance
No treatment is authorized for this species within management zone #6 without prior IPM Team review and approval.

MOHAVE RATTLESNAKE *(Crotalus scutulatus)*

The Mohave rattlesnake is a venomous pit viper species found in the deserts of the southwestern United States and central Mexico. It is perhaps best known for its potent venom. This species grows to an average of 39 – 53 inches in length.


Mohave Rattlesnake

The color varies from shades of brown to pale green, depending on the surroundings. The green hue found among Mohave rattlesnakes has led to them being known as “Mojave greens” in some areas. It has a dark diamond pattern along its back. The white bands on the tail tend to be wider than the black. This viper also has enlarged scales on the top of the head between the supraoculars and the light post-ocular stripe which passes behind the corner of the mouth.

Common names include Mohave rattlesnake, Mojave green, Mojave diamond rattlesnake, Mojave rattlesnake, desert diamond back. Mojave rattler and scutulated rattlesnake.

The Mohave is found in the southwestern United States in southern California, southern Nevada, extreme southwestern Utah, most of Arizona, southern New Mexico and western Teas. It also ranges southward through much of Mexico. The Mohave is found in deserts and other areas with xeric vegetation. Primarily a snake of high desert or lower mountain slopes, they are often found near scrub brush such as mesquite and creosote, but may also reside in lowland areas of sparse vegetation, among cacti, Joshua tree forests, or grassy plains. They tend to avoid densely vegetated and rocky areas, preferring open arid habitats.

Mohaves are most active from April to September. They hibernate alone or in small groups during the winter. As ambush predators, they eat mostly small rodents and lizards. Females bear live young, from 2 to 17 (average about 8) per clutch, from July through September. Although they have a reputation for being aggressive toward people, such behavior is not described in the scientific literature. Like other rattlesnakes, they will defend themselves vigorously when disturbed.

<u>Management Concerns and Action Thresholds</u>

Is this species native to CAGR? – Yes

<u>IPM Zone #1</u> - Public and Administrative Buildings
Evidence or observation of one or more snakes within the buildings that constitute this zone will trigger immediate treatment in the form of animal relocation and installation of exclusionary devices.

<u>Zone #2</u> – Residential Areas
Evidence or observation of one or more snakes within the residences may trigger immediate treatment by the resident in the form of animal relocation and the installation of exclusionary devices; but no treatments will be permitted outside of the housing unit without prior IPM Team review.

IPM Zone #3 – Front Country Exhibits and Sites
Observation of one or more snakes within this zone will trigger immediate animal relocation to non-public areas and installation of exclusionary devices. Damage to archeological resources within zone #3 will trigger treatment in the form of encapsulation patching and repair, filling in burrows with sterile soil, and installation of the archeologist approved exclusionary devices that are included in this plan.

IPM Zone #4 – Back Country Archeological Sites
Damage to archeological resources will trigger IPM Team review to determine appropriate, archeologist approved treatment. It should be noted and weighed accordingly by the IPM Team that snakes serve as an effective predatory manager of rodent species which cause the most damage to archeological sites.

IPM Zone #5 – Back Country Natural Landscape
No treatment is authorized for this species within management zone #5 without prior IPM Team review and approval.

IPM Zone #6 – Roadside Maintenance
No treatment is authorized for this species within management zone #6 without prior IPM Team review and approval.

WESTERN DIAMONDBACK RATTLESNAKE *(Crotalus atrox)*

Western Diamondback Rattlesnake

Atrox is a venomous pit viper species found in the United States (from central Arkansas to southeastern California) and Mexico. It is likely responsible for the majority of snakebite fatalities in northern Mexico and the second greatest number in the United States.

Adults commonly grow to 4 feet in length. Specimens over 5 feet are infrequently encountered, while those over 6 feet are very rare. The maximum reported length considered to be reliable is just over 7 feet. Males become much larger than females, although this difference in size does not occur until after they have reached sexual maturity. The color pattern generally consists of a dusty looking grey-brown ground color, but it may also be pinkish-brown, brick red, yellowish, pinkish or chalky white. This ground color is overlaid dorsally with a series of body blotches that are dark grey-brown to brown in color. The first of these may be a pair of short stripes that extend backward to eventually merge. Most are a distinctive diamond shape. The tail has 2 – 8 black bands separated by interspaces that are ash white or pale grey.

The diamondback is found in areas ranging from flat coastal plains to steep rocky canyons and hillsides. It is associated with many different types of vegetation, including desert, sandy creosote areas, mesquite grassland, desert scrub and pine–oak forests.

The life expectancy is more than 20 years, but is typically shorter because of hunting and human expansion. They are solitary outside of mating season, and are one of the more aggressive rattlesnake species found in North America because they rarely back away from confrontation. When threatened, they usually coil and rattle to warn aggressors. There is suspicion that rattlesnakes living around human population centers do not rattle as often because it leads to the snake's discovery and destruction.

In the winter, they hibernate in caves or burrows, sometimes with many other species of snakes. They are poor climbers. Although adults have no natural predators, hawks, eagles and other snakes have been known to prey on young or adolescents. These snakes are usually inactive between late October and early March, although they can occasionally be seen sunning themselves on warm winter days.

Mating occurs in the spring and the females give birth to as many as 25 young, which may be as long as 12 inches in length. The young are fully capable of delivering a venomous bite from the moment they are born. The young only stay with the mother for a few hours before they set off on their own to hunt and find shelter, thus the mortality rate is very high.

Prey consists of small rodents, rabbits, birds and lizards, although large specimens are capable of swallowing adult cottontail rabbits. They hunt (or ambush prey) at night or in the early morning. These snakes can go for up to 2 years without food in the wild. In turn, it is preyed upon by a variety of larger mammals and birds, such as coyotes, foxes and hawks. It is primarily a nocturnal animal, hunting for its prey on warm summer nights. It is, however, seasonally diurnal, moving between hunting sites during the day during the cooler spring and fall months.

Management Concerns and Action Thresholds

Is this species native to CAGR? – Yes

IPM Zone #1 - Public and Administrative Buildings
Evidence or observation of one or more snakes within the buildings that constitute this zone will trigger immediate treatment in the form of animal relocation and installation of exclusionary devices.

Zone #2 – Residential Areas
Evidence or observation of one or more snakes within the residences may trigger immediate treatment by the resident in the form of animal relocation and the installation of exclusionary devices; but no treatments will be permitted outside of the housing unit without prior IPM Team review.

IPM Zone #3 – Front Country Exhibits and Sites
Observation of one or more snakes within this zone will trigger immediate animal relocation to non-public areas and installation of exclusionary devices. Damage to archeological resources within zone #3 will trigger treatment in the form of encapsulation patching and repair, filling in burrows with sterile soil, and installation of the archeologist approved exclusionary devices that are included in this plan.

IPM Zone #4 – Back Country Archeological Sites
Damage to archeological resources will trigger IPM Team review to determine appropriate, archeologist approved treatment. It should be noted and weighed accordingly by the IPM Team that snakes serve as an effective predatory manager of rodent species which cause the most damage to archeological sites.

IPM Zone #5 – Back Country Natural Landscape
No treatment is authorized for this species within management zone #5 without prior IPM Team review and approval.

IPM Zone #6 – Roadside Maintenance
No treatment is authorized for this species within management zone #6 without prior IPM Team review and approval.

OTHER IPM RELEVANT SPECIES AT CAGR

BARN OWL *(Tyto alba)*

Barn Owl

The barn owl is the most widely distributed species of owl, and one of the most widespread of all birds. It is also referred to as the common barn owl, to distinguish it from other species in the barn owl family. The barn owl is found almost anywhere in the world outside polar and desert regions.

The barn owl is a pale, long-winged, long-legged owl with a short square tail. Depending on subspecies, it measures 9 – 17 inches in overall length with a wingspan of 2 – 3.5 feet. Tail shape is a way of distinguishing the barn owl from tree owls when seen in flight, as are the wavering motions and the open, dangling, feathered legs. The light face with its peculiar shape and the black eyes give the flying bird an odd and startling appearance, like a flat mask with oversized black eyes, and the ridge of feathers above the bill resembling a nose. Its head and under parts are a mixture of buff and grey. The barn owl does not hoot; it produces a *shree* scream which is ear-shattering at close range. It can hiss like a snake, and when captured or cornered, throws itself on its back and flails with sharp, taloned feet.

The barn owl prefers open country but prefers to hunt along the edges of woods. It hunts by flying low and slowly, hovering over spots that conceal prey. This owl feeds primarily on small vertebrates, primarily rodents (one or more per night); and a pair of barn owls and their young can eat more than 1,000 rodents per year. Their diet is supplemented with birds, katydids, Jerusalem crickets, true crickets, bats and toads. Because of their high metabolism, barn owls consume more rodents than possibly any other creature. This makes the barn owl one of the most valuable wildlife animals.

Typical nest sites include tree stumps and crevices, but barn owls will also nest in attics, vacant buildings, wells, chimneys, hunting blinds and similar locations. Predators of the barn owl include opossums and raccoons, as well as hawks, eagles and other owls such as the great horned owl. Some also fall victim to large snakes; however, the biggest threat are humans and their pets.

Barn owls are common throughout most of their range and are not considered globally threatened. However, severe declines from DDT poisoning in the mid-20th century and rodenticides in the late 10th century have affected some populations. In the United States, barn owls are listed as an endangered species in seven Midwestern states.

WESTERN KINGBIRD *(Tyrannus verticalis)*

Western Kingbird

Adult kingbirds are grey-olive on the upper parts with a grey head and a dark line through the eyes. The under parts are light becoming light orange-yellow on the lower breast and belly. They have a long, black tail with white outer feathers.

Kingbirds are 8 – 9 inches long with a wingspan of 15 – 16 inches, and weigh 1.3 – 1.6 ounces.

Their breeding habitat is open areas in western North America. The breeding range has been expanding eastward for the last 100 years. They make a sturdy cup nest in a tree or shrub, sometimes on top of a pole or other man-made structure. The eggs are creamy white with dark spots concentrated around the large end of the egg. A clutch is usually two to seven eggs. The name “kingbird” is derived from their take-charge behavior. They are a conspicuous and aggressive bird in open country. The kingbird aggressively defends its territory, even against much larger birds such as hawks.

Kingbirds migrate in flocks to Florida and the pacific coast of southern Mexico and Central America.

They wait on an open perch and fly out to catch insects in flight, sometimes hovering and then dropping to catch food on the ground. They also eat berries. Birds capture most prey by aerial hawking from an elevated perch; however, they also capture insects on the ground and off vegetation.

The kingbird’s song is a squeaky chatter. The call is a sharp, loud *whit*.

GILA WOODPECKER (*Melanerpes uropygialis*)

Woodpeckers are classified as non-game migration birds and are protected under the Migratory Bird Treaty Act.

Gila Woodpecker

There may be several species of woodpeckers that may be present at CAGR. Woodpeckers are considered beneficial as they feed on insects, usually wood-boring, or insects found on tree trunks and branches. A prominent resident at CAGR includes the Gila woodpecker. They are 8 – 10 inches long, and both male and female have a brown face, black and white zebra striped back, and white wing patches that are visible during flight. Adult males have a red cap of feathers on the top of their head. They have a stout, pointed beak and very strong head and neck muscles so they are able to withstand the shock of pecking into trees and other materials.

Gila woodpeckers are a native species that can be found in southeast California, southwest Nevada, southern Arizona, southwest New Mexico and south into central Mexico. They are permanent Sonoran Desert dwellers and are found in all of its habitats.

Gila woodpeckers eat mainly insects, but they will also eat cactus fruits, mistletoe berries and other seasonal fruits. They have adapted to human populations by learning to hang onto backyard hummingbird feeders and lick up the sugary water. They have also been known to steal dog food from backyard porches.

Woodpeckers nest in cavities that they excavate with their long beak, often in saguaro cactus. The inside of a cactus provides a safe, cool place for the woodpeckers to raise their young. Typically, woodpeckers lay 3 – 4 white eggs from early April to late May.

Predators of the Gila woodpecker can include bobcats, coyotes, hawks, snakes and foxes. They are not currently threatened in the wild.

WOODPECKER DAMAGE

Woodpeckers cause damage to wood structures (and trees) by drilling holes in the wood (cedar and redwood preferred), and synthetic stucco siding and eaves; and can be an annoyance when hammering or “drumming” on the structures. The “drumming” is done by male woodpeckers to attract mates and delineate or defend their territory. Woodpeckers also damage wood in their search for larvae of wood-boring insects and carpenter bee larvae. They also excavate nesting and roosting sites in trees and wood structures.

Deter the drilling into wood for nesting by covering the hole (when it is just started, if possible) with aluminum flashing or can lids and painting it to match the siding. This may alter the visual attractiveness of the hole. Quality oil-based paint on the wood can deter the carpenter bees from boring galleries to deposit eggs and provisions for offspring. Providing woodpecker nest boxes may also provide habitat that is attractive as an alternative for occupancy.

Some research indicates that perhaps installing magnifying cosmetic mirrors mounted on the wood siding may frighten the woodpeckers away. Another potential deterrent is to hang hawk mobiles from the eaves with monofilament line so they move in the breeze. Persistent

noisemakers such as pie tins banging together may also be a deterrent; however, there is no reliable research to support this idea. Bird netting (1/2 – 1 inch mesh) or hardware cloth can be installed from the eaves to the ground, 3 inches from the siding as a preventive. This will detract from the historic appearance of the structure and is NOT recommended. Reflective Mylar strips that move in the breeze and flash light reflections may also be a deterrent. Early action is necessary as woodpeckers are reluctant to give up “territory” once it has been established. Of all these different options, the most practical are a combination of wood-inhabiting insect prevention in addition to providing woodpecker nest boxes.

DETERMINATION OF THE DRUMMING SITE (IF DRUMMING IS A PROBLEM)

The Gila woodpecker is a potential pest species since their hammering on historic structures can cause property damage and disrupt the work of staff. The drumming site can be covered with padding. An alternative drumming site can be provided (two overlapping boards, the back one firmly secured and the front one fastened at one end) as a reasonable substitute.

Removal of dead limbs or trees that harbor insects and attract woodpeckers may also help. However, insect management may not be sufficient as the woodpeckers often drill into sound wood. Individual trees can be draped with netting or 1/2 inch hardware cloth as a deterrent. Plastic netting is least harmful to woodpeckers.

Lethal action on woodpeckers requires a “depredation” permit from the U.S. Fish and Wildlife Service, Department of the Interior.

GREAT TAILED GRACKLE (*Quiscalus mexicanus*)

The great-tailed grackle is a large icterid blackbird which is also referred to simply as “blackbird.”

Great-tailed Grackle

Its range stretches from Kansas in the northeast to southern California in the northwest down to northwest Peru and northwest Venezuela in the south. The grackle's range has been expanding north and west in recent years, and is common in Texas and Arizona in the southern regions. It is commonly found in agricultural regions and suburban environments, feeding on fruits, seeds, and invertebrates.

Males reach up to 17 inches, including a tail that is almost as long as the body. They are jet black with a violet-blue iridescent sheen to the feathers. Females are significantly smaller at about 13 inches, and are mainly brownish-black with a pale brown throat and belly.

This bird has a large variety of raucous, cacophonous calls, and is widely considered to be a noisy pest species, though its range expansion has not been aided by human introduction. It is a native species whose potential for resource damage and potential impacts to human health and safety are minimal. However, grackles perch on structures, leaving excrement in staff and public use areas.

Some species of grackle, usually the great-tailed, are confused with an American crow when people unfamiliar with bird identification are asked to identify a dead blackbird. This usually occurs when birds need to be identified as candidates for West Nile Virus.

AMERICAN KESTREL *(Falco sparverius)*

American Kestrel

The American Kestrel is perhaps the most colorful raptor in the world, and is the most common falcon on North America. It is found from Alaska to Tierra del Fuego, and in towns as well as wild lands.

The males have blue-grey wings with black spots. The tail is rust colored on the back with a broad black band and a white or rust colored tip. The female has rust colored wings and both sexes have dual black stripes on the face.

The kestrel is the smallest falcon, also known as a Sparrow Hawk. It competes for nesting sites with other cavity builders and hunts on the fly. The diet consists mostly of small vertebrates, some insects and occasionally birds.

The habitat includes borders of woodlands, farmlands, open fields, pastures with scattered trees, marshes, suburban areas, grasslands, and arid plains. The kestrel is often seen perched on wires along roads in rural areas.

American kestrels are native to CAGR. They are predatory birds that aid in managing the population of smaller birds within the Great House. They are a beneficial species and a natural form of pest management.

BROWN-HEADED COWBIRD *(Molothrus ater)*

Brown-headed Cowbird

The brown-headed cowbird is a small brood parasitic icterid of temperate to subtropical North America. They are permanent residents in the southern parts of their range; northern birds migrate to the southern United States and Mexico in winter, returning to their summer habitat in March or April. They resemble New World orioles in general shape but adults have a short finch-like bill and dark eyes. The adult male is mainly iridescent black with a brown head. The adult female is grey with a pale throat and fine streaking on the under parts.

Brown-headed cowbirds occur in open or semi-open country and often travel in flocks, sometimes mixed with red-winged blackbirds, as well as common grackles or European starlings. These birds forage on the ground, often following grazing animals such as horses and cows to catch insects stirred up by the larger animals. They eat mainly seeds and insects.

Before early settlement, the brown-headed cowbird followed bison herds across the prairies. Their parasitic nesting behavior complemented this nomadic lifestyle. Their numbers expanded with the clearing of forested areas and the introduction of new grazing animals by settlers across North America. As the brown-headed cowbirds are parasitic nesters, they could potentially impact species diversity within CAGR.

This bird is a brood parasite: it lays its eggs in the nests of other small perching birds, particularly those that build cup-like nests. The cowbird eggs have been documented in nests of at least 220 host species. The young cowbird is fed by the host parents at the expense of their own young. Brown-headed cowbird females can lay 36 eggs in a season. More than 140 different species of birds are known to have raised young cowbirds.

Egg Rejection: Host parents may sometimes easily notice the cowbird egg, to which different host species react in different ways. Rejection manifests in three forms: nest desertion, burying of the egg under nest material, and physical ejection of the egg from the nest. Brown-headed cowbird nestlings are sometimes expelled from the nest.

Parasite Response: Cowbirds may periodically check on their eggs and young after they have deposited them. Removal of the parasitic egg may trigger a retaliatory reaction where the cowbird returns to ransack the nests of a range of host species when their egg was removed.

AMERICAN BADGER *(Taxidea taxus)*

American Badger

The American badger has a flat body with short legs and a triangular face with a long, pointed, tipped-up nose. It has long brown or black fur with white stripes on its cheeks and one stripe running from its nose to the back of its head. It has small ears on the side of its head and long, sharp front claws.

Badgers measure 20 – 34 inches from head to tail and weigh 8 – 26 pounds. The body is flattened and the legs are short and stocky. The fur on the back and flanks of the animal will range from grayish to reddish. The face is distinct: the throat and chin are whitish and the face has black patches. A white dorsal stripe extends back over the head from the nose. In southern populations, the stripe continues over the back to the rump. Males are significantly larger than females.

Dens and burrows are a very important part of the badger's life. A badger usually has lots of different dens and burrows. It uses them for sleeping, hunting, storing food and giving birth. A badger may change dens every day, except when it has young. Badger dens have one entrance with a pile of dirt next to it. When a badger is threatened, it will often back into a burrow and bare its teeth and claws. It may then plug up the burrow's entrance.

Badgers are found primarily in the Great Plains region of North America; however, they occur north through the central western Canadian provinces, in appropriate habitat throughout the western United States and south throughout the mountainous areas of Mexico. They have expanded their range since the turn of the 20th century and are now found as far east as Ontario, Canada. Badgers prefer to live in dry, open grasslands, fields and pastures. They are found from high alpine meadows to sea level.

The home range of both male and female badgers expands during the breeding season, indicating that males and females travel more extensively to find mates. Males have larger home ranges that are likely to overlap with the home ranges of several females. Mating occurs in late summer or early autumn but embryos are arrested early in development. So although a female is technically pregnant for seven months, gestation is a mere six weeks. Females are able to mate when they are four months old, but males do not mate until the autumn of their second year.

Female badgers prepare a grass-lined den in which to give birth. Badgers are born blind and helpless with a thin coat of fur. Juveniles disperse at five to six months. The average lifespan in the wild has been estimated at from four to ten years. Yearly mortality is estimated at 35%.

Badgers are solitary animals and are active mainly at night. They tend to be inactive during the winter months. They are not true hibernators, but spend much of the winter in cycles of torpor that usually last about 29 hours. They emerge from their dens on warm days in the winter.

Badgers are excellent diggers. Their powerfully built forelimbs allow them to tunnel quickly through the soil. Their burrows are constructed as far as nine feet below the surface and contain about 30 feet of tunnels with an enlarged chamber for sleeping. They use multiple burrows within their home range, and may not use the same burrow more than once a month.

Small burrowing animals like ground squirrels, rats, gophers and mice make up most of the badger's diet. It digs its prey out of the ground with its strong, sharp claws. The badger will sometimes dig into the burrow of an animal and wait for it to return. Coyotes will often stand by while a badger is burrowing and catch animals that come out of a tunnel trying to escape the badger. The badger also eats snakes, birds and reptiles. It will sometimes bury extra food to eat at a later time.

The badger is well protected from its predators. Its muscular neck and thick, loose fur protect it when it is captured by a predator. This gives the badger time to turn on the predator and bite and claw it. When a badger is attacked, it also hisses, growls, squeals and snarls. It also releases an unpleasant musk odor that may drive a predator away.

Badgers can cause extensive and rapid damage to archeological sites due to their burrowing and digging up burrows of the animals that they hunt. Thus, if evidence of this species is observed impacting archeological resources, the IPM Team must be consulted as soon as possible to discuss whether or not action should be taken to address ongoing and potential resource damage.

STRIPED (*Mephitis mephitis occidentalis* Baird) and SPOTTED (*Spilogale gracitis phenax* Merriam) SKUNKS

Striped Skunk

Striped skunks are common and spotted skunks may rarely be encountered. Striped skunks are black with two wide white stripes the length of the body, converging on the head. Striped skunks are about 20 – 30 inches long (including the wide, bushy tail) and will weigh up to ten pounds. The spotted skunk is smaller and has white spots instead of stripes. Their forefeet are strong and have long nails for digging. Litters of one to seven young are born from late April to early June.

Skunks are nocturnal and forage beginning at sunset. Skunks are omnivores and feed on mice and other small rodents, lizards, frogs, birds, eggs, garbage, acorns and fallen fruit. They also dig for beetles, insect larvae and earthworms. Skunks may travel five to ten miles in their 30 – 40 acre territory searching for food.

The black and white coloration is a warning to people and other potential predators. This protective color advertises the skunk's presence to ward off enemies. Their protection is the noxious odor which is ejected accurately up to 25 feet, from two anal glands under the tail. Skunks only discharge this chemical armament when provoked.

Automobiles and the Great Horned Owl are the skunk's only enemies.

MANAGEMENT

Exclusion is effective in keeping skunks out of buildings. As skunks are excellent diggers, provide a metal barrier down the stem wall to 18 inches deep, then out at least six inches to prevent burrowing beneath the building.

Sanitation includes not feeding skunks and removing food or edible garbage from outside structures. Garbage should be contained in pest-proof metal containers.

ARIZONA POCKET MOUSE *(Perognathus amplus)*

Arizona Pocket Mouse

The Arizona pocket mouse, also known as the Sonoran Pocket Mouse, is a rodent native to the Sonoran desert. It is a small mouse with a thinly-furred tail that is smooth from base to tip. In color it ranges from tan to orange. It is a nocturnal, burrowing animal which eats seeds which is carries back to its burrow in its cheek pouches.

The Arizona pocket mouse is from the order Rodentia. It has a single pair of incisors in each jaw. These teeth will grow continually throughout its life. It has a high rate of reproduction, and this is one key factor in attributing to the success of this species.

The Arizona pocket mouse is found in, but not necessarily limited to, the United States.

BANNER-TAILED KANGAROO RAT *(Dipodomys spectabilis* Merriam)

Banner-tailed Kangaroo Rat

The banner-tailed kangaroo rat is a large, four-toed, long-tailed kangaroo rat with its tail about 1.5 times as long as its head and body and a distinct white tuft at the end. Its hind foot is broad and the upper parts are dark buff; black facial markings and conspicuous tail stripes.

This large kangaroo rat appears to be limited in distribution to sparsely brush-covered slopes and low hills. It is most abundant on slopes covered with scattered, mixed stands of creosote bush and acacias on hard and moderately gravelly soil. It has never been encountered in loose soils or drift sands.

The large complex mounds of these rats are unmistakable evidence of their presence. As many as a dozen openings admit the rat to the complex system of galleries and side branches, and from them lead conspicuous trails across the surrounding sparse vegetation to the feeding areas.

These rats are very fleet and agile, and to catch them at night by running them down is difficult. Once caught, they can inflict painful wounds with their teeth unless handled carefully.

Their food is almost entirely plant materials with seeds ranking high on the list. Green vegetation is eaten on occasion. Large quantities of food are stored in the dens to carry them over periods of scarcity. They seldom drink even if water is present.

The breeding season begins in January and continues into August. The young begin to appear in March and nearly full-grown juveniles are common by April. The gestation period is not known. The young are born in an underground nest composed of fine vegetation and chaff refuse from the food.

Their known natural enemies include badger, bobcat and coyote.

Banner-tails are of economic importance locally. In periods of drought, they may do serious damage to rangelands by gathering and eating grass seeds.

SOUTHERN GRASSHOPPER MOUSE *(Onychomys torridus)*


Southern Grasshopper Mouse

The southern grasshopper mouse, like its relatives, is primarily nocturnal and is active throughout the year. This is a stocky mouse, grey or pinkish-cinnamon above; white below. It has a thick, short, bicolored tail with a white tip, which is between a third and a half the total length of the animal. The juveniles are grey. Their length is 4 – 6 inches and they weigh up to one ounce.

It is common in the arid desert habitats of the Mojave Desert and the southern central valley of California. Alkali desert scrub and desert scrub habitats are preferred with lower densities expected in other desert habitats.

In Arizona, the home range of the male extends up to 28 acres, an unusually large area for a small rodent. Although this species eats small amounts of seeds, its diet consists almost entirely of animal material: scorpions, beetles, grasshoppers and other small mammals, especially harvest and pocket mice. Like the large carnivores, grasshopper mice have developed efficient strategies for dispatching prey. When capturing certain beetles that produce a defensive secretion from the back of the abdomen, grasshopper mice hold the beetles in their forepaws and jam the abdomen into the sand to avoid the secretion. They kill small mammals with a bite through the back of the neck. Before killing scorpions, they immobilize the deadly tail.

The southern grasshopper mouse either digs its own burrow or appropriates the burrow of another small mammal. The social unit includes one pair and its offspring per borrow system. The male and female both actively care for the young, although the male is excluded from the nest by the female for the first three days after birth. The highly territorial male employs a high pitched, wolf-like call to ward off other males.

Peak breeding is from May to July, but may start in January under ideal conditions, and may continue year around. Gestation is 27 – 30 days. Litter size averages four young. Both males and females care for the young.

Predators include raptors, snakes and predatory mammals.

WHITE-THROATED WOOD RAT *(Neotoma albigula)*


White-throated Wood Rat

The white-throated wood rat is a relatively large rodent measuring 13 inches from the tip of the nose to the end of the tail, and weighing about ½ pound. This native rat is distinguished from non-native rats by its well-haired, bi-colored tail, which is brown on the top and white underneath. Fur on the back and hindquarters is brown interspersed with black hairs. The belly and throat are white. Throat hairs are white to the base, distinguishing this wood rat from others.

It is found throughout the southwest and into central and western Mexico from sea level to as high as 8,000 feet in elevation. This wood rat occurs throughout Arizona except in the area northwest of the Colorado River.

The white-throated wood rat resides primarily in arid regions across a variety of habitats. It can be encountered on rocky mountainsides, scrublands and cactus flats, and in pinyon-juniper forests and most other arid habitats. In cities, these rats commonly are found in mountain parks, areas of desert washes and undeveloped washes.

During the day, these nocturnal rats retreat into rock crevices, caves, hollow trees or dens that they build themselves. This species remains active throughout the year. It is often referred to as a “packrat” because it builds large dens using cactus pads or branches, woody vegetation from trees and shrubs, and an assortment of other items (ranging from empty rifle shells to bottle caps and bones). These thorny homes offer protection from predators and insulation from the scorching heat. They are usually built in and around palo verde, yucca, cholla, prickly pear or mesquite plants. Some packrats do not build elaborate dens, using rock crevices instead. These crevices are also filled with sticks, cacti and other objects.

White-throated wood rats feed primarily on cactus, particularly prickly pear. They also eat various parts of mesquite, yucca, acacia, cholla and juniper plants, most often the seeds, fruits or bark. Moisture in the cacti they eat appears to provide them with water and they may not require it from other sources.

MANAGEMENT

This is one of the more common native rodents in urbanized areas. Its ability to co-exist closely with humans occasionally creates problems. Wood rats sometimes use vacation homes, cabins and other seldom-used buildings for shelter. Their stick nests can be extensive and their physical presence and droppings can create a mess. Wood rats sometimes carry diseases and ectoparasites (fleas, ticks, etc). Therefore, close association with humans is undesirable.

The best management measure is to prevent the problem through adequate exclusion. Cracks and openings in building foundations, and any openings for water pipes, electric wires, sewer pipes, drain spouts and vents must be sealed. Also check for openings in attic or roof vents, broken roof shingles or other gaps next to eaves. No hole larger than ¼ inch should be left unsealed. Make sure doors, windows and screens fit tightly. If gnawing is a problem, cover edges with sheet metal. Coarse steel wool, Stuf-Fit, ¼ inch hardware cloth and lightweight sheet metal are excellent materials for plugging gaps.

COCKROACHES

GENERAL

Cockroach infestations are among the most widespread and persistent of all pest problems. The five most common types of cockroaches in urban areas of the United States are: German, brown-banded, American, oriental, and smoky-brown cockroaches. The smoky-brown cockroach is normally only found in the southern states and will not be addressed here. Six additional cockroach species sometimes found in other than buildings include: brown, Australian, Surinam, woods, Asian and Turkistan cockroaches. The two types of cockroaches found at CAGR and addressed within this IPM Plan are the American and desert cockroaches.

Except for size, most cockroaches are relatively similar in overall shape and appearance. They like tight places where their bodies touch surfaces both above and below them. Once inside a building, cockroaches find harborage in cracks, crevices, and voids, and easily move among floors, rooms, and compartments through hollow walls, electrical and plumbing access holes, on conduits and ducts. In dining halls, cockroaches are commonly found under work benches, tables, and counters where spilled food accumulates, behind and under refrigerators, stoves, and other bulky equipment, in serving-line areas, near raw garbage storage, in wall voids, and in hollow legs of equipment and tables.

The most common pest cockroaches inhabiting buildings are nocturnal and remain in the dark whenever possible, only emerging to search for water and food. Large infestations should be suspected when cockroaches are seen in the open or in the light during the day.

Cockroaches are strongly attracted to food and water. Although they can survive many days without food, they must have frequent access to water. Newly hatched cockroaches die in three days without water, and although adult cockroaches may live 20 to 30 days without it, during that time they are unable to reproduce. Because of the wide range of food available to cockroaches, they cannot be starved out of a building; but, good sanitation and cleanliness may prevent cockroach populations from increasing.

HAZARDS OF INFESTATION

Cockroaches affect more people than any other insect. They vomit partly-digested food materials and continually defecate while eating and pose significant health hazards by transmitting diseases (bacillary dysentery, typhoid fever, cholera, polio, amoebic dysentery, urinary-tract infections, diarrhea, and infectious hepatitis). In some parts of the country, even human allergy is attributed to cockroaches.

Cockroaches are scavengers that live on food waste and are attracted to human foods, particularly bakery products, cereals, meat, and cheese, which they contaminate since they also feed on dead animals and animal feces. Cockroaches also feed on or damage items like leather, wallpaper paste, book bindings, soiled clothing, artwork, books, legal documents, postage stamps, draperies and banknotes. Cockroaches are attracted to electrical switches, outlets, and smoke detectors, where their bodies and body fluids corrode points, activate or deactivate alarm systems, create pump failures, and cause short circuits in or damage to computers.

Cockroach droppings, body parts, and dead cockroaches may accidentally be incorporated into human meals. Cockroach excrement, scent-gland secretions, and regurgitations spoil the

palatability of human food. They strongly attract more cockroaches to established feeding sites, causing additional staining and contamination of food, food packages, and kitchen cabinet cracks and crevices where cockroaches gather.

AMERICAN COCKROACH (*Periplaneta americana*)

American Cockroaches

The American cockroach is very common in the southern U.S., where it is sometimes called “waterbug" or "palmetto bug." This cockroach is about 1 1/2 inches long, reddish brown with light markings on the thorax, and has fully developed wings. True flight is not common; flying American cockroaches are usually found in the southern states. Adult males, however, can glide extended distances. The pronotum on this cockroach may be ringed by various irregular patterns of light color that darken toward the center; the rear margin is always light colored.

Females can produce a 5/16 inch long by 3/16 inch wide egg capsule each week during the 12 to 24 weeks of spring and summer, each containing 14 to 16 eggs. She carries an egg case for about a day and then deposits it in a protected spot. A very high population should be suspected when egg cases are found in the open. Incubation lasts from one to two months. Mature American and Oriental cockroach nymphs can be difficult to tell apart. American nymphs normally go through 13 molts before reaching maturity in from seven to 20 months.

Where climate allows, American cockroaches normally live outdoors and enter buildings through holes from crawlspaces or underground ducts, steam tunnels, manholes, and sewer line drains. American cockroaches are found in warm and moist basements, around water heaters, in boiler rooms, floor drains, and water sumps. Large numbers of American cockroaches may move into buildings when triggered by blocked drainage systems, heavy rains, or changes in barometric pressure.

DESERT COCKROACH (*Arenivaga investigata)*

Desert Cockroach

These cockroaches live in the sand with less than 1% moisture most of the year. During the day in spring, summer and fall, they burrow in the sand at a depth of 7 – 23 inches, while at night when surface temperatures have cooled, they burrow within ½ to 1 inch of the surface. In winter they are rarely found near the surface, remaining active at lower levels during both night and day.

The larvae and adult females are photonegative and remain at lower levels during the day, even though daytime temperature and humidity are sometimes favorable near the surface. In the summer, they migrate to the surface after dark.

The desert cockroach feeds on decaying leaves and the roots of desert shrubs. Since the latter have 35-38% moisture, they are probably the main source of water for these animals.

INSPECTION AND MONITORING

Inspection

When daytime occupants of a site report seeing cockroaches, a thorough inspection of a structure is necessary to discover the presence and centers of cockroach activities in order to be able to identify them and the available harborage, food, and water sources before management treatments should be initiated. Estimates of the pre-treatment size of cockroach populations compared with post-treatment population estimates provide important data for evaluation of the effectiveness. Placing sticky monitoring traps in suspected harborage area the evening before the inspection will provide valuable information about the pest population.

Refrigerators pose weak links in cockroach management programs because they provide heat, harborage around coils, constant water supply, and hiding places that are difficult to treat. The presence of surface molds and water damage under or around refrigerators will help pinpoint concealed cockroach habitat.

Make inspections, if possible, during evening hours when cockroaches leave harborage. During the day, cockroaches remain deep within cracks. Use a flashlight during inspections (even if the area is not dark) to help concentrate your focus. Inspect for cockroaches every two weeks unless a decrease in roach problems justifies extending the time between inspections to 28 days. When management methods have reduced pest populations to near zero, quarterly thorough inspections may be sufficient if monthly monitoring is continued.

Monitoring

A thorough inspection and the use of sticky traps to determine approximate pest numbers should identify reported infestations. This would provide pre-treatment data for evaluation of the effectiveness of management measures. There are several effective sticky traps, some with attractive food baits such as the ALo-Line@that have entered the commercial pest management market.

Numbering traps and analyzing their locations and captures, which should be indicated on room diagram maps, helps to identify cockroach harborage and needs for additional attention to sanitation measures, exclusion, or pesticide treatments.

Monitoring is done by placing sticky traps strategically in rooms and kitchens where harborage, warmth, water, and food are plentiful. The best trap locations are near corners where cockroaches congregate. Place traps against walls, fixtures, and under appliances; do not place them in the open or where they may become wet. Cockroaches tend to stay close to cracks and crevices when foraging for food.

Examine cockroaches found on traps to determine the direction from which they entered the trap. Placing sticky monitoring traps in a standardized approach (always the same way) helps to determine direction of travel. This information will help point out likely harborage sites. Additional follow-up monitoring with sticky traps is necessary four to eight weeks after the first monitoring session to see if young cockroaches are still hatching, and to determine if management methods are effective.

COCKROACH MANAGEMENT

Action Thresholds

When an average of five or more cockroaches per night per sticky trap is caught in a room, daytime sightings are probable. The action threshold should be set at two to three captures, so that corrective action can be taken before the population expands.

Prevention of Cockroach Infestations

Infestations can be prevented by reducing conditions which support cockroaches, including access to structures and harborage, moisture, and food. Otherwise, cockroach populations are very difficult to manage because small, residual populations can survive in even the most sanitary of environments. Further, residual populations can explode into major problems. The use of pesticides, however, cannot be regarded as a substitute for either prevention or good sanitation practices. Pesticidal suppression of cockroach populations without a change in environmental conditions that support them only gives a false and temporary sense of security and may also result in chemical resistance in the pest populations.

Good building maintenance is mandatory if cockroaches are to be denied access to structures. This requires elimination of holes and cracks used by cockroaches to gain entry into buildings. To eliminate access to structures, install tight-fitting windows, doors, screens, and door sweeps; caulk all exterior and interior cracks and holes in foundations, walls, sills, floors, splash boards, and water, heating, and electrical service chases; screen open sewer lines and drains; and repair leaking plumbing facilities. Remove other sources of moisture.

An effective prevention program should contain the following major elements:

X Careful inspections of areas surrounding the building, noting and correcting conditions which attract or provide harborage for cockroaches such as stacks of firewood, dead tree stumps and branches, vines and other vegetation on or next to the building, piles of bricks, stones, or wood, and leaf litter.

X Careful inspections of building exteriors from foundation to attic; noting and correcting all possible points where cockroaches or other pests could enter the building.

X Careful inspections of building interiors, attics, and crawlspaces from floor to ceiling, noting and sealing all cracks, crevices, holes, and voids which could harbor cockroaches or other pests. Stainless-steel baskets can be used in sink and floor drains to prevent entry of cockroaches from sewers.

X Inspection of structures for accumulations of cardboard or wooden boxes, paper and plastic grocery bags, empty aluminum cans, beverage cartons, furniture, dried pet foods, seasoned firewood, and potted plants, through which cockroaches are often imported into a structure and in which materials cockroach populations flourish. Tactfully advise occupants about needs for improved sanitation.

X Inspection for accumulations of food scraps that are often found under refrigerators and other kitchen equipment and in cupboards. Tactfully advise occupants not to leave dirty dishes or puddles of water on cupboards, clean up all food scraps immediately after eating, store food in pest-proof containers, use tight-fitting lids on garbage containers and take garbage out every

day.

Management of Existing Cockroach Infestations

Cockroach problems almost always indicate the presence of excessive moisture and poor sanitation. Effective management measures should include physical, mechanical, and cultural changes. When those methods are not sufficient, pesticide bait measures may also be utilized.

Physical, Mechanical, Cultural Measures

Because of adjoining rooms, attics, crawlspaces, pipes, and other connections, serious cockroach problems in structures usually require an intensive management program for the entire building. One area left untreated will supply cockroaches to other areas of the structure.

Exclusion

The entire building should adequately be sealed and secured against cockroach entry. Carefully check for and seal cracks and crevices in walls, around sinks, and gas, water and electrical lines, cupboards, and baseboards to eliminate all cockroach hiding and breeding habitats. Cockroaches may travel between portions of buildings in and along electrical conduits and enter rooms through open prong holes in electrical outlets; keep outlets covered at all times. Fit self-closing devices to screen doors and check that screens are not broken.

Repair leaking faucets, water and drain pipes, and ventilate or dry out moist areas such as crawl spaces. Remove any other sources of moisture available to insects. Be sure indoor plants are not over watered. Place screens on fish tanks. Cover all air and ventilation vents with fine-mesh wire screens.

Direct runoff away from buildings. Remove rotting leaves from window wells, dense vegetation from around building foundations, and trim trees that touch the building. Place outside lighting away from the structure to prevent attracting cockroaches and other flying insects to the building.

Sanitation

Occupants should be instructed in the following procedures to eliminate all food, moisture, and harborage available to cockroaches:

X Remove unnecessary equipment and stored materials from the building to eliminate harborage areas.

X Store food in insect-proof metal cans, plastic jars, glass jars with tight-fitting lids, or keep in the refrigerator.

X Remove food and grease from stove doors, hinges, burner tops, joints and crevices each day. Thoroughly clean food particles on and under tables and counters as soon as possible after meals. Wash dishes promptly after use. Discourage eating in non-dining areas. Do not use liners on shelves or in drawers, as they provide harborage for cockroaches and other insects under loose edges.

X Place all food, garbage, empty drink and food cans, and other materials providing potential insect food in sealed plastic bags or tightly sealed canisters as soon as possible. Do not store empty aluminum cans or bottles inside the building. Keep garbage cans tightly covered and take garbage out daily. Do not permit garbage to remain exposed overnight.

X Clean cockroach infested "focus" sites by emptying all kitchen or Abreak room@ cabinets, drawers, and pantries and wash them out with soapy water before replacing items. Empty stored clothing from boxes and bags, and wash and dry them before repacking in sealed plastic bags or in new, clean boxes.

X Egg cases and adult insects are frequently imported into structures on foodstuffs and containers coming from other cockroach-infested areas. A quarantine area should be set up to accept any incoming food or other material into the building. Cockroaches hide and breed among folds of paper sacks and in voids of corrugated cardboard boxes. Carefully inspect (or sterilize) all incoming containers and shipments for cockroaches and egg cases before putting items on shelves. Seal all paper sacks and cardboard boxes in plastic garbage bags as soon as they are emptied and properly dispose of them.

Provide written information and graphic handouts to familiarize occupants with cockroach management programs and of the needs for sanitation. Occupants should understand and be willing to follow steps to reduce the availability of food and harborage to cockroaches and to take measures to prevent reinfestation.

No amount or frequency of pesticide application is sufficient to control or eliminate cockroach infestations where sanitary conditions are not met.

Direct Controls

Sterilize equipment and furniture that is infested with cockroaches or egg cases by steam cleaning or in dry heat (in excess of 140ºF) for 30 minutes. This method is useful when occupants move from an infested area to another location.

Pesticide Treatments

When deemed necessary, pesticide applications shall be performed by licensed applicators only. Applications shall be made according to the procedures guidelines, according to pesticide label directions, and following applicable laws and regulations.

Pesticides provide only temporary relief from insects in structural units unless moisture, food particles, and grease, found in kitchens or other areas are eliminated. When pesticides dissipate, cockroaches may reinvade structures. Thus, good exterior area sanitation is just as important as inside sanitation and management. To be effective, any short-residual pesticide treatment should attain 95% or greater cockroach kills within the first few days and later follow-up treatments should concentrate on the remaining cockroach reservoirs. Before any pesticide is applied, it is vital to know the kind(s) of cockroaches present and where they are hiding so harborage areas can be effectively treated.

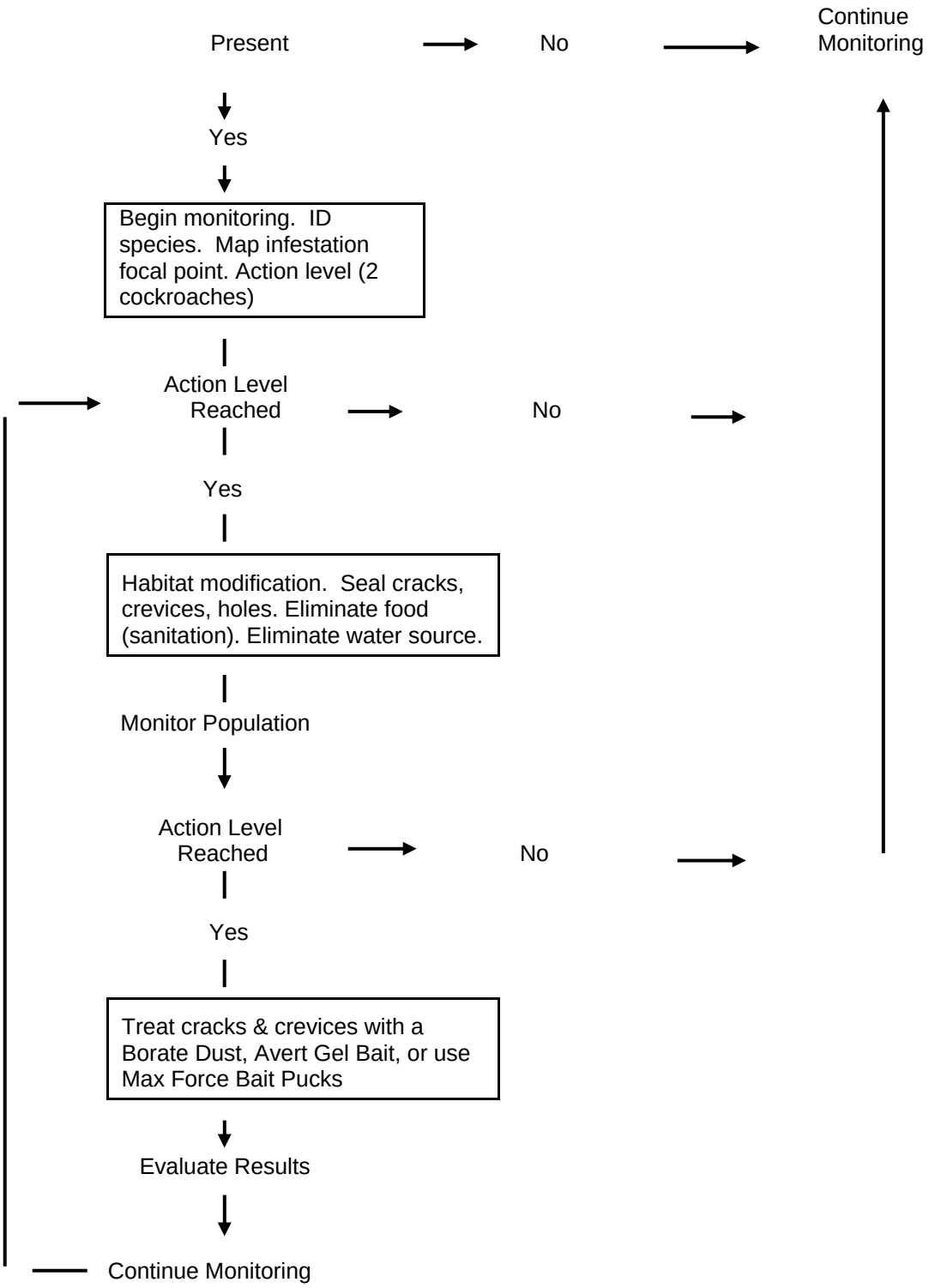
Borate based dusts can be used for effective treatments. This pesticide is applied through a narrow diameter tube into harborage cracks and crevices where cockroaches live and breed. Borate dusts may also be applied under cabinets, drawers and around pipes. When applied in cabinets, be sure to remove utensils and supplies and apply the dust into cracks. Do not treat shelf surfaces. Refined, pesticide grade, 99% borate dust should be used. Borate dusts are harmful (as are most pesticides), therefore, a dust mask, goggles, and gloves should be worn during the treatment process. Various brands and formulations of borates are commercially available, some use aerosol carriers which makes application into small cracks easier.

The Borates may take seven to fourteen days to kill cockroaches, whereas other pesticides may kill some cockroaches in a shorter time. Borates remain active for a long time, and do not evaporate away. After over fifty years of use, cockroaches have not become resistant to the Borates. There are also several borate baits available on the market.
After applying pesticide dusts into cracks and crevices, caulk cracks and crevices to eliminate future harborage and to keep out moisture.

Various types of solid, semi-solid, and liquid cockroach bait stations are commercially available. Many contain low-risk chemicals that are attractive to cockroaches and help control cockroach populations. Normally, about 12 or more bait stations are placed in cockroach harborage areas in a normal sized kitchen. Some bait stations (or pucks) contain Hydramethylnon which is effective for cockroach management and has reduced risk to occupants. Some bait stations have sticky tape on the back for applying baits to vertical surfaces. However, if sanitation is poor in a site, bait performance will also be poor because of the availability of alternative foods.

Several new toxic paste or gel baits have been developed that are attractive to cockroaches. One of the more effective gel baits for crack and crevice treatment contains Abamectin (a low-risk pesticide). Toxicants can be stomach poisons, nerve poisons, chitin inhibitors, or insect growth regulators (IGRs). Also, bait guns have been developed to inject paste or gel baits directly into the cracks and crevices or other places where cockroaches hide.

COCKROACHES



ARGENTINE ANT (*Iridomyrmex humilus [Mayr])*

The Argentine ant, native to South America, now widely ranges throughout the United States and the world. This highly adaptable ant is the most common of the trailing ant species that invade structures in search of foods. Its natural range is only limited by cold temperatures. The Argentine ant has one node on the petiole, a musty odor when crushed, carries no known diseases, and has no public-health importance. It is very aggressive, has no natural enemies, and drives other ants away. Although the Argentine ant bites, it doesn't normally attack human beings.

Argentine ant nests are usually located in moist areas around refuse piles, under stones or concrete, rotten wood, bird nests, beehives, and in tree holes. In winter, colonies move deep into the soil. Although it seldom nests indoors, nests are sometimes found in buildings near heat sources. This ant is multi-queened, very prolific, and supports large colonies (thousands to tens of thousands) but seldom swarms, because breeding takes place in the nest. The Argentine ant is a major pest in structures, and is commonly seen near baseboards, windows, and water pipes, seeking food or to escape too-wet or too-dry outdoor conditions. It is often found on potted plants because it tends scales, mealy bugs and aphids, from which it obtains honeydew. Indoors they feed on meats, sweets, dairy products, eggs, fats and oils, but prefer sweets. Argentine ants also feed on termites, other ants, fly larvae, and cockroaches. Argentine ant eggs hatch in 28 days, the larval stage lasts 31 days, the pupal stage lasts 15 days, and complete life cycle is 78 days.

Argentine Ant

RED HARVESTER ANT (*Pogonomyrmex barabatus*)

The red harvester ant is a large (.2 - .28 inch) ant common in the southwest United States. The chief food source for these ants usually consists of seeds which they hoard in great numbers, hence their name. After mating, the male usually dies while the fertilized queen returns to the ground to search for a suitable nesting site. Once she has chosen a site, she sheds her wings and begins to reproduce, producing “worker ants” for 1 – 20 years until her death.

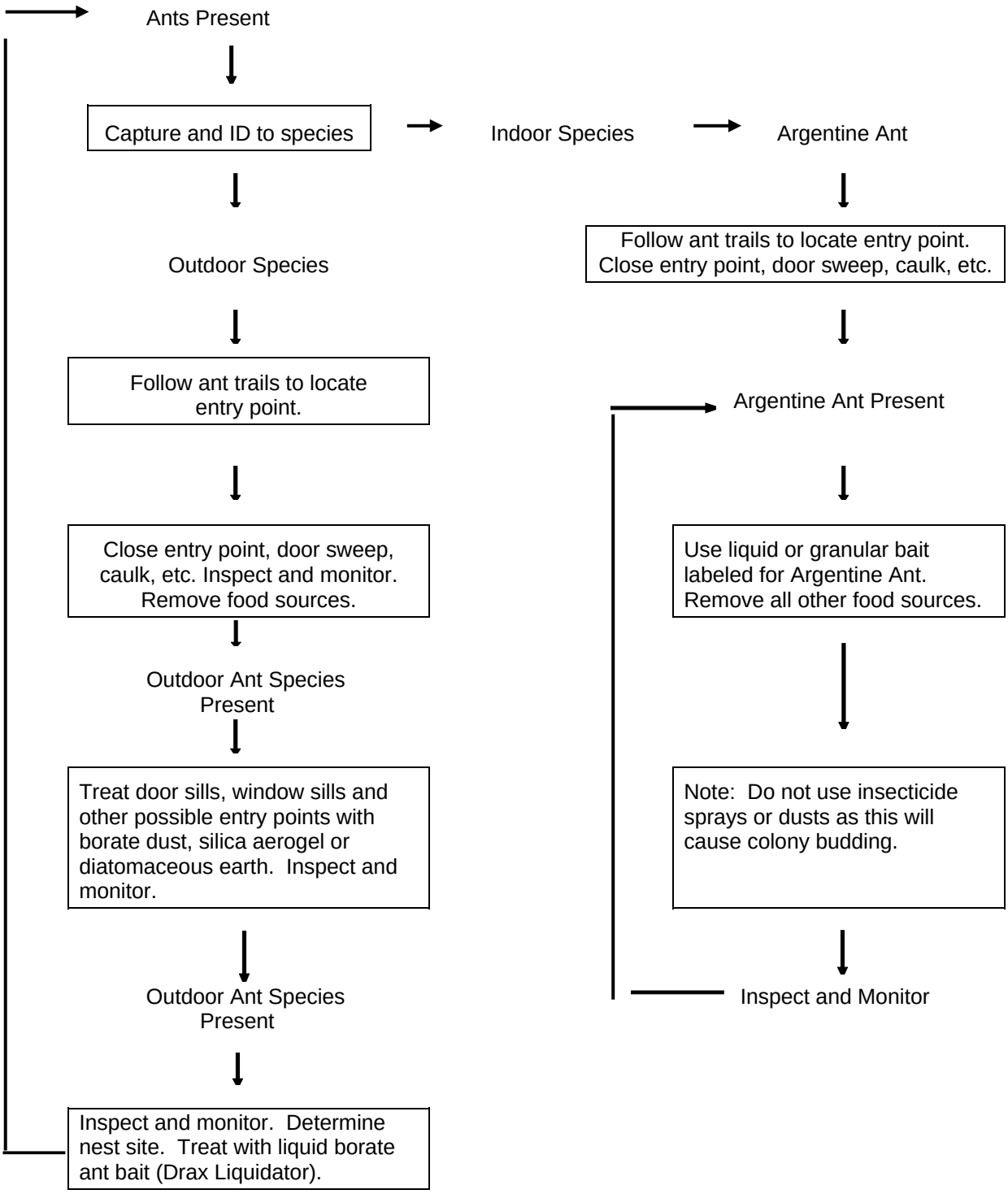
Red Harvester Ant

Red harvester ants can be aggressive and have a painful sting that spreads through the lymph nodes. They can also bite ferociously.

Recently their numbers have been declining; this being attributed to competition for food with the invasive red imported fire ant and the argentine ant. Their decline has affected many native species which prey on the ant, particularly the horned lizard. This is why the ants should not be treated with insecticides. Red harvester ants are often mistaken for fire ants, but are not related to any fire ant species.

Red harvester ant nests are characterized by a lack of foliage and small pebbles surrounding a hole that is usually at grade. The mounds are typically flat and broad. Three to eight trails typically lead away from the mound, like arms.

ANTS


Ants Present
Capture and ID to species
Indoor Species
Argentine Ant
Follow ant trails to locate entry point. Close entry point, door sweep, caulk, etc.
Outdoor Species
Follow ant trails to locate entry point.
Argentine Ant Present
Close entry point, door sweep, caulk, etc. Inspect and monitor. Remove food sources.
Use liquid or granular bait labeled for Argentine Ant. Remove all other food sources.
Outdoor Ant Species Present
Treat door sills, window sills and other possible entry points with borate dust, silica aerogel or diatomaceous earth. Inspect and monitor.
Note: Do not use insecticide sprays or dusts as this will cause colony budding.
Outdoor Ant Species Present
Inspect and Monitor
Inspect and monitor. Determine nest site. Treat with liquid borate ant bait (Drax Liquidator).

BEES AND WASPS

CHARACTERISTICS AND RECOGNITION

General

There are thousands of different kinds of bees and wasps in North America, most of which are small wasps that are parasitoids of other insects and solitary burrowing bees. However, there are only 50 or so species of stinging wasps and bees that are troublesome to people. These are generally divided into two groups: the social wasps and bees (including hornets, yellow jackets, umbrella wasps, and honey bees); and the solitary wasps and bees which include mud dauber wasps, tarantula hawk wasps, and carpenter bees.

Social wasps and honeybees build nests in and around structures. Typical nest sites include beneath eaves, on porches, behind blinds, in trees, shrubbery, and vines, in stone walls, and in the ground. Most of the social wasps prey on destructive insects (house flies, blowflies, caterpillars, and moths) that they feed to their young (larvae). From this standpoint, they are considered beneficial. Honey bees gather nectar from flowers and convert it into a thick viscous liquid we call honey, which is fed to both adults and larvae. Solitary wasps prey on insects they paralyze and place, along with eggs, into individual nests. After the eggs hatch, the larvae feed on those insects until they can emerge from the nest.

Social Wasps

Social wasps live in colonies that have a caste system (division of labor) with overlapping generations, and a single fertile reproductive female called the queen produces all offspring. The other two adult forms in social-wasp colonies are the fertile males that mate with queens and the female workers, which are sterile. Their social colonies may persist for many years, unlike other stinging wasps which start anew each year.

All social wasps develop in similar ways. In the autumn, queens and males leave the nest to mate. The males die after mating, but the queens hibernate over winter in some protected area such as a crack, under tree bark, in buildings, attics, and basements, or in a hole in the ground. Next spring, the queens come out of hibernation, find a suitable nest site, construct simple, small, paper-like nests made from masticated wood and plant fibers mixed with water, and lay 25 to 70 eggs. The queen will not lay more eggs until that first brood has matured. Larvae hatch in a few days and glue themselves into the cells. The queen will feed the larvae chewed up bits of insects over the next 12 to 18 days until larvae mature. When mature, larvae spin a silken cap to close the cell and pupate (undergo metamorphosis into an adult). Once the first brood emerges as adults, the queen resumes egg-laying. Subsequent larvae produced by the queen are fed by the first generation of workers who also expand the comb or nest. The queen and workers do not eat the insects they collect for larvae. They subsist entirely on flower nectar and a sweet liquid provided by larvae when fed. With the onset of cold weather, wasps abandon the nest, which disintegrates from actions of weather, birds, or squirrels. The only member of the colony that over-winters is the fertilized queen.

Although yellow jackets and umbrella wasps are closely related and have similar life histories, their nest-building habits differ.

Umbrella Wasps

The nest of the umbrella wasp best demonstrates a basic building pattern. Nests are made of paper-like material produced by the wasps, but appear as a flattened, circular-shaped comb of cells opening downward.

Umbrella Wasp & Nest

These are initiated by the umbrella wasp queen, which starts the nest with a thick paper-like strand attached to an overhanging structure, then adds a small number of cells.

Umbrella wasps are slender, elongated wasps, about 3/4 – 1 inch long. They are black, brown or red with a few yellow markings. An umbrella wasp nest usually contains less than 250 individuals.

Hornets and Yellow Jackets

Hornets and yellow jackets build two different kinds of nests.

Aerial Nest Builders: Aerial nest builders include hornets and some yellow jackets, which build large football-shaped nests from paper materials similar to those of the umbrella wasp. These nests do not consist of a single, flat comb like that of the umbrella wasp, but contain from four to six wide circular combs, one hanging below the other, and all enclosed in an exterior multi-layer oval paper envelope which provides insulation. These nests are usually found on branches of trees, in shrubbery, and on gables. Hornet nests may only contain 500 to 600 workers, but yellow-jacket nests can support up to 10,000 individuals.

Yellowjacket & Underground Nest

Bald Faced Hornet Nest

Underground Nest Builders: Underground nest builders include other yellow jackets that place a protected nest in a natural ground depression, rodent or animal burrow, or into building wall voids, attics, hollow trees, and other enclosed spaces instead of in the ground.

Once workers begin to care for the nest, they enlarge the entrance hole and try to expand the nest. Combs are placed in tiers, one above the other. Nests can become very large and contain up to 15,000 individuals.

Hornets and yellowjackets are black with yellow or white markings and are more compact appearing than umbrella wasps.

Hornet and yellowjacket queens measure about 3/4 inch long. The males and workers are about 1/2 inch long. These wasps are feared because they sting. Populations are at a peak from late July to late September. Hornets and yellow jackets become more aggressive and easily irritated in the fall as the colony becomes old and there are fewer larvae to provide foraging adults their "sugar hit."

Solitary Wasps and Bees

Solitary wasps and bees do not build large social nests. The female digs a hole in the ground, tunnels into wood, or builds a nest out of mud. She then constructs a cell or group of cells into which she deposits eggs, provides them with a food source (pollen, or paralyzed insects), and abandons the nest, leaving the young to hatch and mature on their own.

Mud Dauber

Mud Daubers

Mud daubers are slender wasps, about 3/4 – 1 inch long. They are black and yellow, metallic blue, or shiny black, and do not sting unless provoked. Their nests are long clay cells placed in such protected places as electric-motor housings, stored machinery, sheds, outhouses, attics, on building siding under overhangs, and under porch ceilings. Occasionally, wasps construct their nests on painted surfaces, which may create an added burden of repainting the area after the nest is removed. Mud daubers stock their clay nest tunnels with a paralyzed spider, caterpillar, or other insect. Then, inside a silken cocoon, they deposit a fertilized egg on the prey and close the nest hole. The egg hatches and the larvae feed on the prey.

Adults emerge in the spring. In the fall and spring, abandoned nests often house carpet beetle larvae that feed on residual organic debris in the open clay tunnel. Indoor carpet beetle infestations have been traced to abandoned mud-dauber nests.

Honey Bee

Honey Bees

Honey bees make social colonies of up to 60,000 individuals that live through a number of seasons. Individuals survive the winter by clumping together into a tight group to conserve heat and feed on honey collected and stored during the preceding summer. The number of individuals in a honey-bee colony increase during the spring nectar flow (flower bloom) and the members develop a queen cell. Before the new queen hatches, the old queen and about half of the bees leave (swarm) the colony and establish a new one in a protected hollow tree, rock void, attic, or building void.

Both the original and new colonies increase in number over summer and swarm again the next spring. Africanized or “Highly Defensive Bee” colonies have the same life cycle as the European honey bee in the United States, except that Africanized honey bees produce less honey during summer and the colonies swarm much more frequently. Wild (colonies not housed in hives) honey-bee combs appear as long, hanging tiers of cells joined together at the top and made from wax that worker bees produce.

Honey bees, both feral and managed, are frequent visitors at flowers, and often remove 80% or more of the floral resources produced. This can result in competitive displacement of native fauna that use the floral resources. Feral honey bees may also reduce seed set in species due to inefficient transfer of pollen. Competition from feral honey bees could cause species that are not threatened to become threatened.

HAZARDS OF INFESTATION

Hazards

Yellow jacket problems develop in August or later, when their populations and nest activities are the greatest. Yellow jackets are extremely aggressive wasps and, when stinging, release odors that further enrage the entire colony.

When disturbed, bees and wasps drive a needle-like stinger into a victim's flesh and inject a venomous fluid. The venom causes painful swelling that may last several days. Stings may prove fatal to persons allergic to the venom who do not immediately use an anti-venom or consult a doctor.

Africanized honeybees or “Highly Defensive Bees” are a serious health and safety threat due to their aggressive nature. The Africanized bees will respond to threats to the hive by sending out as many as ten times the number of European bees to protect the hive, resulting in more incidences of bee stings and multiple sting events. Africanized bees have also been known to follow a moving target after stinging has begun.

Africanized bees and European honeybees can live almost anywhere around buildings, making the Africanized bee an even greater threat. Nesting sites include hollow tree wells, chimneys, storage, in trees, in abandoned automobiles, under eaves or overhangs and anywhere they can find shelter from the sun large enough to protect their wax combs. Eliminating access to potential nesting sites when possible is one way to prevent honeybee infestation. This can be accomplished by:

- Removing and discarding stored items around the exterior of buildings and grounds.
- Repairing holes in exterior walls to prevent bees from nesting in the hollow wall areas.
- Install fine meshed (1/8 inch) hardware cloth) screens over tops of rain spouts, vents and openings in utility boxes.
- Secure sheds and outbuildings; close void areas if possible.

INSPECTION AND MONITORING

Inspect areas above doorways, holes leading into structures, and hollow trees or rotten tree stumps for stinging-insect nests. Monitor garbage cans for the numbers of wasps or bees feeding there over a set period of time. Take management action when fifteen or more foraging wasps or bees visit an open garbage can in ten minutes. Good records should allow correlation of stings with numbers of foragers. This monitoring information can be used to predict when action may need to be taken to manage these generally beneficial insects.

Heed the following precautions when working with wasps and bees:

- Listen for buzzing indicating presence of bees nearby.
- Use caution when entering sheds, outbuildings, prehistoric architecture, or any storage area that is infrequently accessed.
- Inspect work areas before using outdoor power equipment including lawnmowers, leaf blowers and weed cutters.
- Perform exterior inspections of historic buildings, prehistoric architecture and outbuildings regularly (at least twice per year).
- From spring to fall, check once or twice a week for bees entering or leaving the same area of the building or yard.

- Teach staff to be cautious and respectful around all bees.

Treatment for Wasp and Bee Stings

If stung by a wasp or bee, take the following steps:

- Go quickly to a safe area inside a building and close the door.
- Remove stinger(s) as soon as possible.
- Don= t squeeze the stinger; pressure will release more venom.
- Scrape the stinger out with fingernail, knife blade or credit card.
- Wash the sting area with soap and water.
- Apply an ice pack for a few minutes to relieve pain and swelling.
- Seek medical attention if breathing is troubled, if stung numerous times or if allergic to bee stings.

MANAGEMENT

Sanitation

Good sanitation manages the amount of food available to wasps. Denying food forces worker wasps to find less abundant natural prey and limits the amount of nutrition which larvae receive during periods of exponential colony growth. This ultimately restricts the colony size. Following are sanitation measures which will reduce wasp and bee problems:

- Keep garbage cans tightly closed.
- Check cans often for gaps and holes; request frequent garbage pickup.
- Install garbage liners in cans and promptly clean up garbage spills.
- Frequently clean both inside and outside of garbage cans with steam or soap and water.
- Move dumpsters and trash barrels away from doorways or other areas of human traffic.
- Prevent the accumulation of standing liquid waste from garbage or dumpster containers underneath the dumpster or in low-lying areas.
- During summer, yellow jackets are attracted to meat; keep food covered.
- Clean up all food or drink spills that attract bees and wasps. Wipe outdoor food-preparation surfaces and picnic-table tops with appropriate cleaning solutions.

Exclusion

Some methods of exclusion appropriate to a public building site are:

- Assure that all doors and windows close tightly and that screens are in good condition.
- Frequently and carefully inspect structural exteriors and seal all possible wasp or bee entry spots.
- Seal holes in hollow trees and remove rotten stumps.

Physical, Mechanical, and Cultural Measures

Whenever working around wasps and bees, wear protective bee veils and coveralls. Do not allow bystanders and pets to remain nearby. Approach honey bee nests on warm and calm days. Bees are more aggressive on cloudy and windy days when foraging is not possible. Avoid walking through the flight paths of foraging wasps and bees leaving and returning to the colony. At night,

avoid shining lights or casting shadows on the nests; use red lights when working on colonies at night. Walk softly near ground-nesting bees and wasps to avoid making vibrations that alert the bees. Carefully and slowly brush off a bee or wasp that lands on a person, or wait until it flies off. Inspect and remove all small wasp nests early in the spring, while nests are still small. Removal at this time of the year is easily done with a broom, vacuum cleaner, garden hose, or other mechanical means. Later, nests will be much larger and better guarded by workers. Watch for honey bee swarms in April and May when they begin to search for new nesting places: including holes leading into structural voids. Swarms can be discouraged from nest establishment in buildings by various mechanical means such as providing a hive box.

Nesting pests in wall voids can be detected by using a stethoscope. Yellow jacket nests in wall voids do not necessarily require removal since they do not contain honey and are not reused in the following year. Abandoned nests, however, may attract fabric pests such as dermestid beetles. Do not seal up active nests before killing the insects. If wasps or yellow jackets are sealed into wall voids without an exit, they will chew through the wall to exit somewhere else, even into the interior of the building. If honey bees are sealed into wall voids, melting honey will spoil, rot, and stain the wall. After destroying and removing nests, close up holes with copper gauze, caulk, duct tape, spackle, putty or screening.

Use outdoor lights that are not attractive to insects. Remove stumps, dead limbs and hollow trees that can be used for nest sites. Remove plants that attract wasps and bees, including those that are vulnerable to scale or aphid attack which produce honeydew food sources for wasps.

Sticky or jar traps may be used to capture wasps, however, traps reduce only a small number of foragers.

Keep a list of local bee keepers who may voluntarily remove honeybee nests. Remove dead honeybee colonies and residue from walls so remaining organic debris and odor does not attract more insects.

Don't go barefoot; don't make unnecessary movements, and don't strike at individual wasps or bees flying nearby. In areas frequented by such insects, avoid wearing perfumes, scents, hair spray, suntan lotion, shaving lotions, talcum powder, cosmetics, and brightly colored or highly patterned clothing, which are attractive to bees and wasps. Examine wet towels before use to see if insects are taking moisture from them. Reduce honey bees on lawns by closely mowing clover and flower heads.

Other Measures

Biological

Biological methods show little promise; parasites, predators, and pathogens are mostly effective only on small, weakened colonies.

Heat

Wet or dry temperatures of 130ºF effectively kill wasps and bees. If an infested area is covered with a plastic tarp, the summer sun generates sufficient heat to kill them.

Vacuum

Wasp and bee nests can be removed with an industrial vacuum cleaner. (Wear protective clothing.) Be sure the vacuum nozzle is placed over the only entrance hole before disturbing the nest. When the last of the colony is removed, plug the vacuum bag with cotton and heat it in the sun to kill the

insects.

Pesticides

Poison Baits

When deemed necessary, pesticide applications shall be performed by licensed applicators only. Applications shall be made according to National Park Service policy and procedures guidelines, according to pesticide label directions, and following applicable laws and regulations.

A number of commercial pesticides are available which foraging wasps and bees carry into the nest. Choose the appropriate bait material to mix with the insecticide depending on feeding habits, which change with the season. Poison baits should not be accessible to children and nontarget insects and animals.

Aerosol Sprays for Aerial Nests

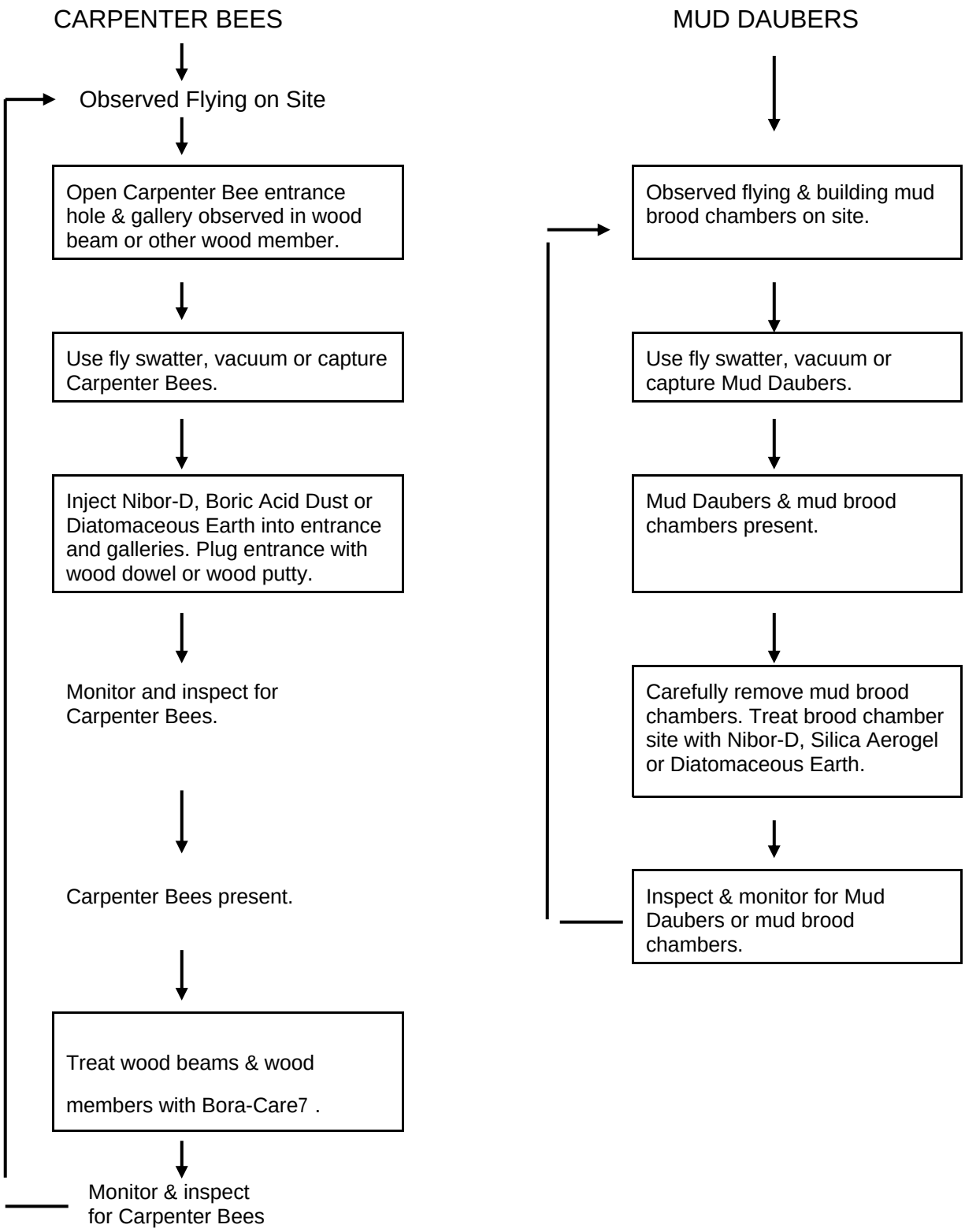
A number of commercial aerosol preparations are available that quickly and safely destroy aerial wasp and bee nests. Follow label directions.

Insecticides for Subterranean Nests

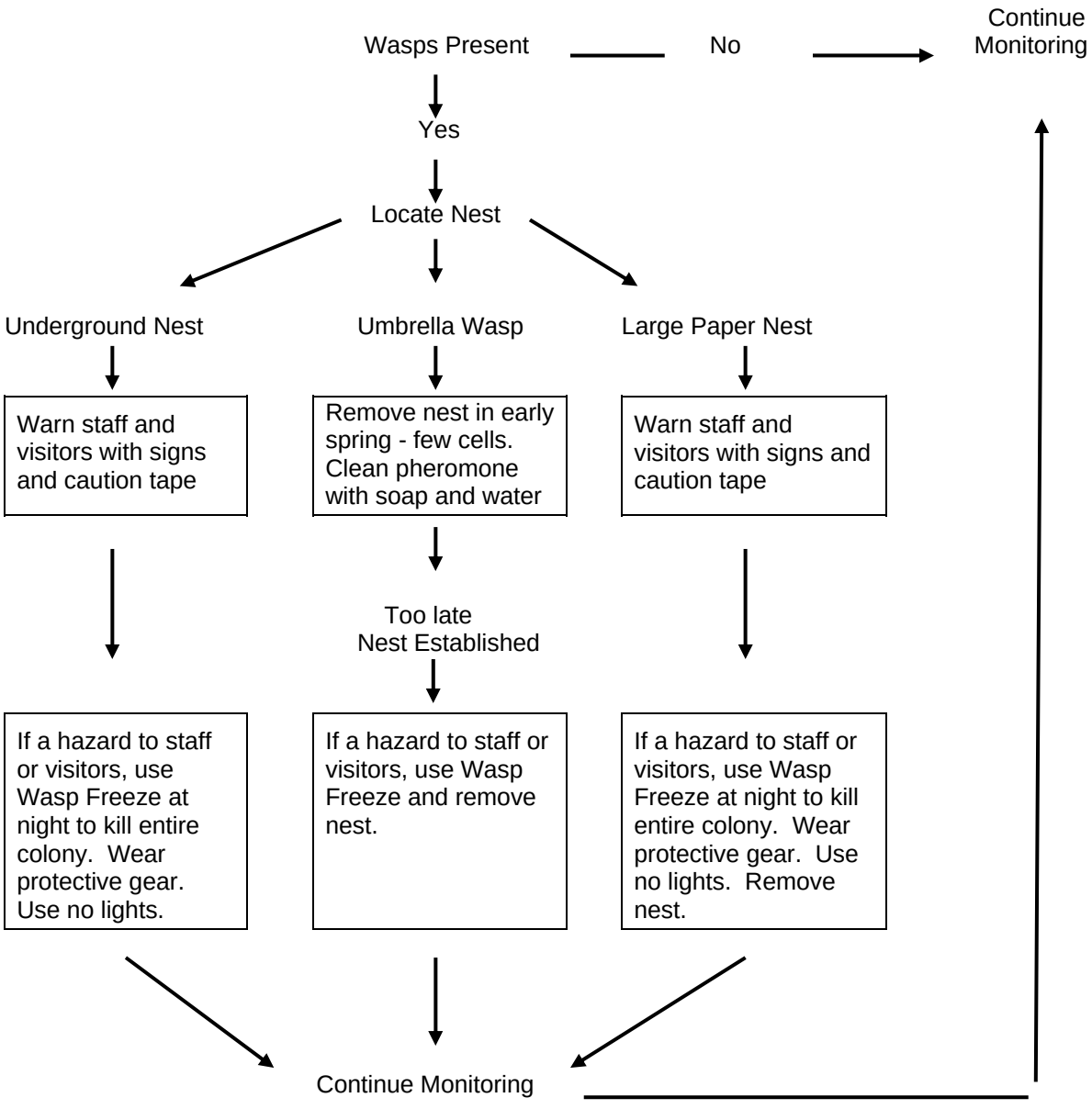
After locating and sealing all entrances but one, properly labeled insecticides can be poured into subterranean colonies and the entrance plugged.

Dusts and Aerosols for Wasp and Bee Nests in Wall Voids and Attics

A number of residual pesticide dusts and aerosol formulations are available to treat nests in building walls and attics. Follow label directions. Having found the location of a nest (listening for buzzing behind plasterboard), drill a hole and inject aerosol or dust directly into the colony. Killing honey bees in walls with pesticides causes deterioration of honey and nest combs and attracts other bees and troublesome insects; melting honey and wax may stain walls unless the structure is opened up to remove the debris. Contact your local beekeeper association for assistance, if necessary, to remove honey bees by means other than pesticides. Do not seal all entrances of nests located in building walls without killing the colony since wasps and bees may find an exit into the interior of the building.


CARPENTER BEES
Observed Flying on Site
Open Carpenter Bee entrance hole & gallery observed in wood beam or other wood member.
Use fly swatter, vacuum or capture Carpenter Bees.
Inject Nibor-D, Boric Acid Dust or Diatomaceous Earth into entrance and galleries. Plug entrance with wood dowel or wood putty.
Monitor and inspect for Carpenter Bees.
Carpenter Bees present.
Treat wood beams & wood members with Bora-Care7 .
Monitor & inspect for Carpenter Bees
MUD DAUBERS
Observed flying & building mud brood chambers on site.
Use fly swatter, vacuum or capture Mud Daubers.
Mud Daubers & mud brood chambers present.
Carefully remove mud brood chambers. Treat brood chamber site with Nibor-D, Silica Aerogel or Diatomaceous Earth.
Inspect & monitor for Mud Daubers or mud brood chambers.

WASPS


Wasps Present
No
Continue Monitoring
Yes
Locate Nest
Underground Nest
Umbrella Wasp
Large Paper Nest
Warn staff and visitors with signs and caution tape
Remove nest in early spring - few cells. Clean pheromone with soap and water
Warn staff and visitors with signs and caution tape
Too late
Nest Established
If a hazard to staff or visitors, use Wasp Freeze at night to kill entire colony. Wear protective gear. Use no lights.
If a hazard to staff or visitors, use Wasp Freeze and remove nest.
If a hazard to staff or visitors, use Wasp Freeze at night to kill entire colony. Wear protective gear. Use no lights. Remove nest.
Continue Monitoring

HOUSE CRICKET *(Acheta domesticus [Linnaeus])* (Worldwide)

House cricket adults are 3/4 – 1 inch long and have a light-colored head marked with three dark cross bands, yellowish-brown to straw-colored body, long and thin antennae, and heavy mandibles. House crickets fly but also have large rear jumping legs like a grasshopper. Crickets are nocturnal insects that enter structures in spring or before winter. They are attracted to shelter, light, moisture, and warmth. House crickets are mainly attracted to warm areas around stoves, fireplaces, and furnaces, but they can also be found throughout the structure.

Nymph & Adult House Crickets

Incessant nocturnal chirping by the male makes this a nuisance pest. Outside, house crickets live in compost piles, debris, and garbage dumps. Usually there is one generation per year. Eggs laid in sandy soil during fall hatch in late spring. Nymphs often enter structures under doors or through cracks and voids and complete their life cycle indoors, where they develop all year and lay eggs in cracks. Nymphs mature in mid- to late-summer.

Outside, house crickets feed on plants and other insects. Inside, their diet is more diverse: they feed in early evening on bread crumbs, fruits, vegetables, liquids, paper (such as soiled news-print), clothing, rubber, silk, wool, linen, rayon, fur, feathers, meat and meat products, dead insects, and leather. House crickets contaminate food by walking over it.

INSPECTION AND MONITORING

Outside: Inspect for the presence of house crickets near the structure. Also check for moisture near the building, and for organic material (mulch, leaves, etc.) that provides harborage and food. Look for cracks, crevices and other openings (drains, pipes, vents) into the structure that provide entry for house crickets.

Inside: Conduct an inspection for the presence of moisture, food sources, clutter, cracks, crevices and other openings. Place and check WEEKLY sticky trap monitoring devices at floor/wall junctions and other likely or critical areas where house crickets may occur.

FIELD CRICKETS *(Gryllus spp.)* (North America)

Field Cricket

Field crickets are common pests attracted indoors by light; however, once inside, they die before early winter because they cannot adapt to indoor conditions. Adults are 1/2 to 1 inch long and look very similar to house crickets, except that field crickets are usually black to dark brown in color, and have brown wings, a shiny head, and antennae much longer than the body. Males have two spear-like appendages at the tip of the abdomen. Females have three similar appendages.

The field cricket also flies and jumps. In northern parts of the United States, eggs deposited in the ground are the overwintering stage for most field crickets. The small remainder pass the winter as half-grown nymphs under leaves, trash, and debris. There is only one generation per year. Females lay 150 to 400 eggs about 1/4 – 1 inch deep in the soil in late August to September. Eggs hatch in May to June and nymphs develop in nine to 15 weeks. Adults are only found outside from late July until the first hard freeze. Field crickets migrate into structures during fall, when populations are large, or as vegetation dries up.

Indoors, field crickets are attracted to such warm, dark areas as water-heater closets and large appliances. They are usually found in basements and ground-floor levels where they feed on human food, debris, and clothing. Field crickets do not live long indoors. However, they can cause damage to cotton, wool, linen, silk, synthetics, and leather and fur items.

INSPECTION AND MONITORING

Outside: Inspect for the presence of field crickets near the structure. Also check for moisture near the building and for organic material (mulch, leaves, etc.) that provides harborage and food.

Inside: Conduct a thorough inspection for the presence of crickets, moisture, food sources, clutter, cracks, crevices and other openings. Place and check WEEKLY sticky trap monitoring devices at floor/wall junctions and other likely or critical areas where field crickets may occur. Inspect water heater closets, utility rooms and areas of high humidity and temperature.

CAVE OR CAMEL CRICKET *(Ceuthophilus spp.)* (Worldwide)

Cave or camel cricket populations build up indoors during fall, when large numbers of these insects move under doors and through cracks, seeking dark, cool, damp areas in crawlspaces, basements, utility rooms, garages, and outdoor sheds. They are rarely found in occupied spaces. Their natural habitat is outside, where camel crickets live under stones and logs or in animal burrows. Camel crickets have a rounded, hump-backed appearance with a head bent downwards. They are light brown in color with darker brown bands and markings. Camel crickets are easily identified by their long antennae and long and large jumping hind legs. They are wingless, don't chirp, and are not attracted to light. Most importantly, camel crickets serve as a warning or indicator of excessive moisture problems. Camel crickets can feed on cotton, linen or other cloth material.

Cave or Camel Cricket

INSPECTION AND MONITORING

Outside: Inspect for the presence of cave crickets near the structure. Also check for moisture near the building and for organic material (mulch, leaves, etc.) that provides harborage and food. Look for cracks, crevices and other openings (drains, pipes, vents) into the structure that provide entry for pests.

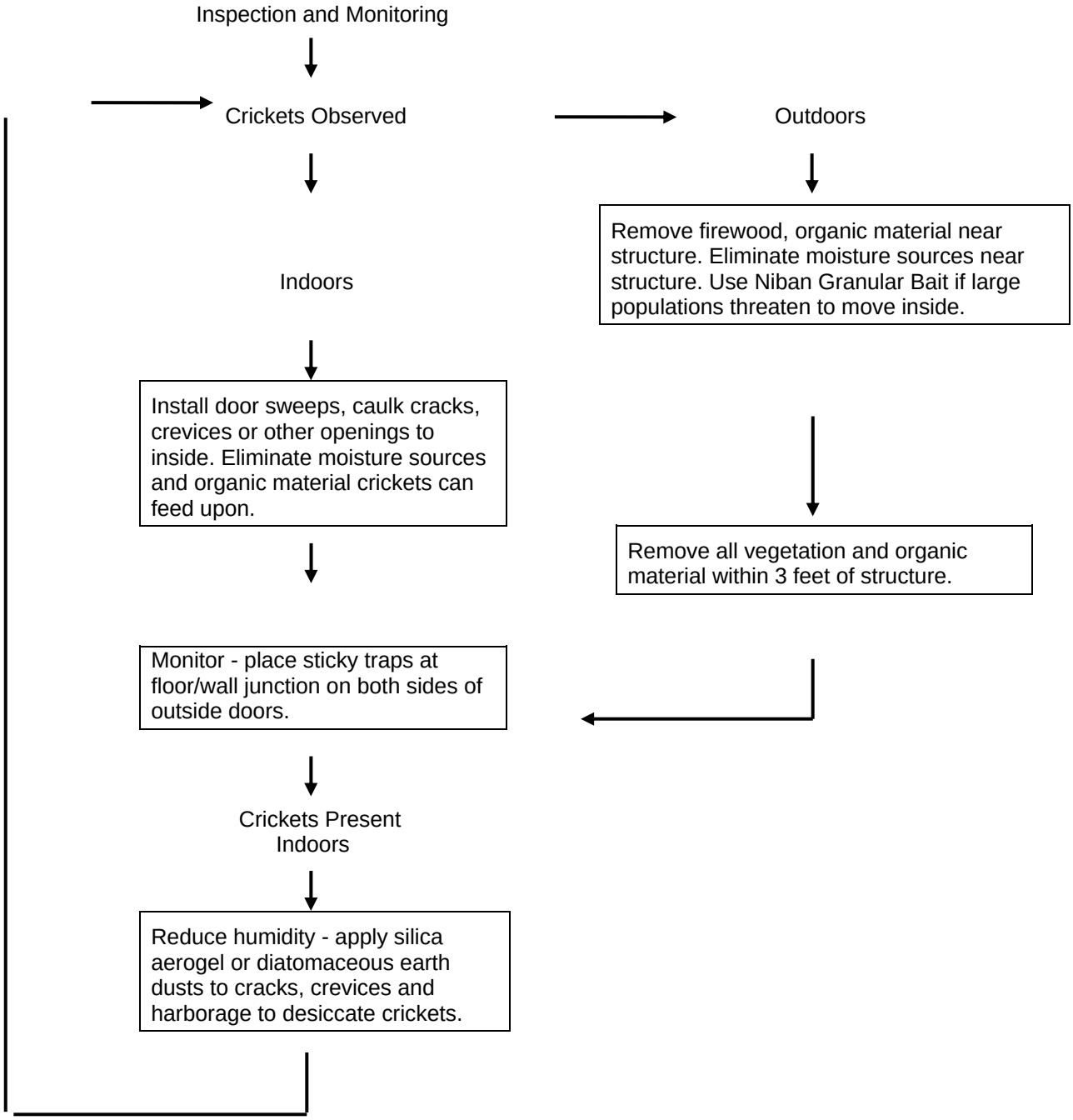
Inside: Conduct a thorough inspection for the presence of crickets, moisture, food sources, clutter, cracks, crevices and other openings. Place and check WEEKLY sticky trap monitoring devices at floor/wall junctions and other likely or critical areas where cave crickets may occur. Inspect water heater closets, utility rooms and areas of high humidity.

MANAGEMENT

Outside: Remove all organic material (mulch, leaves, etc.) from within 3 feet of the structure (replace with a 3/4 – 1 inch mulch or gravel) and eliminate moisture and standing water in this area. Install effective door sweeps on all outside doors and eliminate other entry points into the structure.

Inside: Reduce humidity levels and eliminate leaks and other water sources. Keep corridors, offices, exhibits and storage spaces clean (no organic material available to the pest). Eliminate clutter, caulk cracks, crevices and close hiding places. Dust cricket harborage with diatomaceous earth (DE) or borate insecticide.

CRICKETS


Inspection and Monitoring
Crickets Observed
Outdoors
Remove firewood, organic material near structure. Eliminate moisture sources near structure. Use Niban Granular Bait if large populations threaten to move inside.
Indoors
Install door sweeps, caulk cracks, crevices or other openings to inside. Eliminate moisture sources and organic material crickets can feed upon.
Remove all vegetation and organic material within 3 feet of structure.
Monitor - place sticky traps at floor/wall junction on both sides of outside doors.
Crickets Present Indoors
Reduce humidity - apply silica aerogel or diatomaceous earth dusts to cracks, crevices and harborage to desiccate crickets.

SILVERFISH AND FIREBRATS (Worldwide)

Silverfish

Silverfish (*Lepisma saccharina L),* are wingless, flat and carrot-shaped insects, about 1/2 inch long, and covered with a sheen of silvery scales. They have two long antennae and possess three long, slender filaments that project rearward from the abdomen. Silverfish prefer temperatures between 70 – 81 ºF, and high humidity. Adults may live from two to eight years, and can survive as long as a year without food. Silverfish feed on starches like flour, glue, paste, and textile and paper sizing, but they can also digest cellulose.

Silverfish populations build up around materials upon which they feed, such as corrugated cardboard boxes in damp basements, and on insulation, glue, and stored books. Silverfish lay eggs in cracks over an extended period of time, which hatch in about 30 days. Immatures reach maturity in three to four months. Their feeding leaves irregular, yellow-stained holes in textiles and paper, damaged surfaces on corrugated cardboard, and irregular chewed areas on cloth-bound books. Damaged materials often have dark fungus growing on them supported by humidity and insect fecal pellets. Large populations of silverfish spread into other humid areas within the building from basements and wall voids penetrated by pipe ducts and electrical conduits.

Firebrats (*Thermobia domestica [Packard])* are similar insects but not silver-colored, rather mottled dark gray and dull yellow. Their size, shape, and appendages very much resemble silverfish, but firebrats prefer decidedly higher temperatures and surroundings, to 90ºF or above. Firebrats are commonly found in furnace rooms, steam-pipe tunnels, hot bathrooms, and partition walls of water-heater rooms. The firebrat female lays one to three batches of average 50 eggs per batch depositing them in cracks. It takes two to four months from egg to adult under optimum conditions 90 – 100ºF with 76 – 85% relative humidity). Firebrats feed on carbohydrates and proteins such as bond paper, linen, cotton, silk, dried beef, etc.

Firebrat

HAZARDS OF INFESTATION

Silverfish and firebrats are destructive to books, paper, fabrics, and may contaminate foods. These insects are often found in libraries, book shelves and areas where old books and papers are stored.

INSPECTION AND MONITORING

In a quarantine area, thoroughly inspect incoming goods, furniture, books and other materials for the presence of silverfish or firebrats. Remove or treat any items that are infested.

Conduct a thorough inspection for the presence of pests, moisture, food sources, clutter, cracks, crevices and other openings. Inspect water heater closets, utility rooms and areas of high humidity and temperature. Bookcases and books are especially attractive to these pests.

MANAGEMENT

Exclusion

For pests the size of silverfish or firebrats to be excluded, use caulk, Stuf-Fit, oakum, weather stripping, door sweeps, screens and other repair approaches. Once done, excluding silverfish and firebrats is usually passive and permanent.

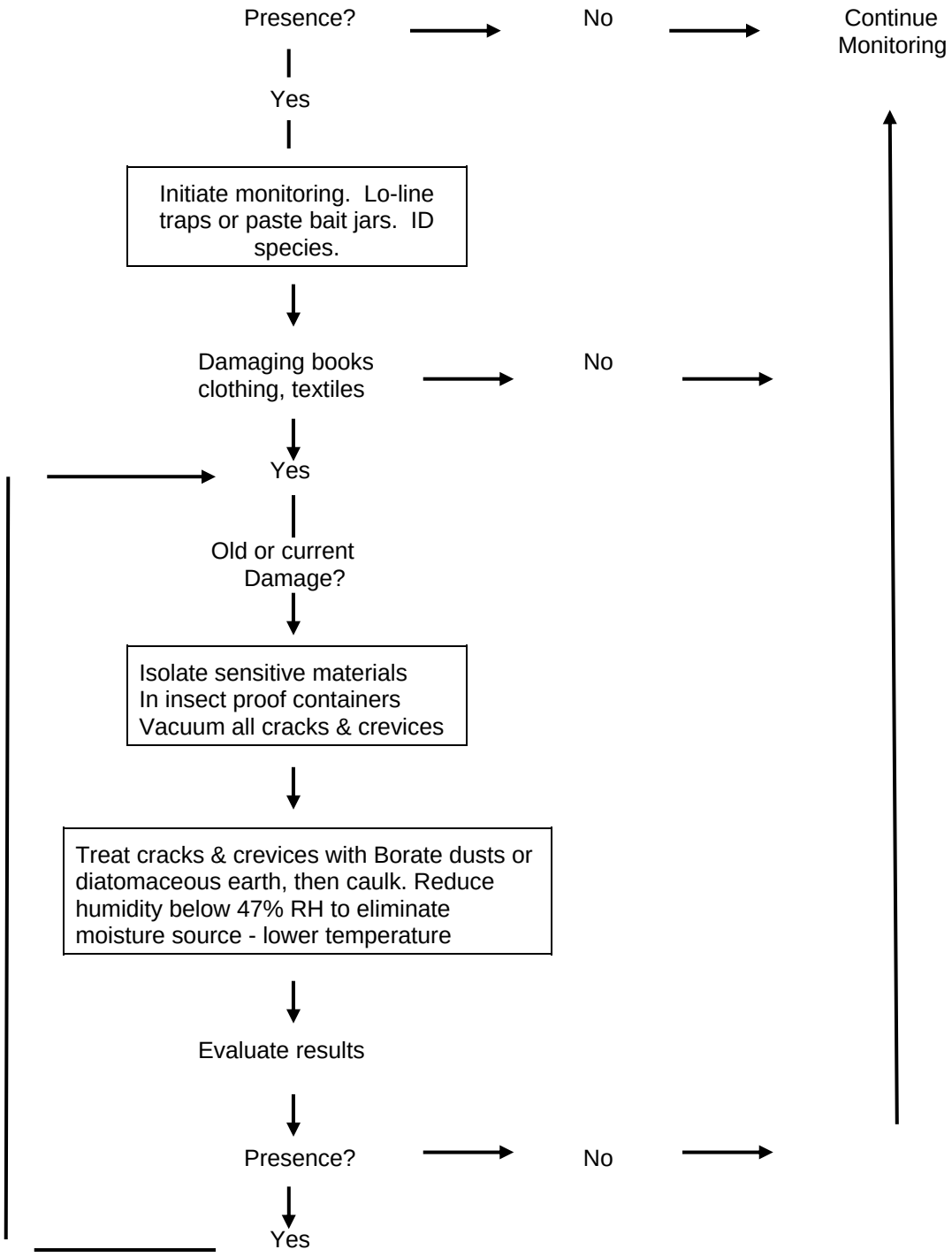
Sanitation

It doesn't take much organic material to feed silverfish or firebrats. Water in any form, condensation, leaks or moisture in potted plants, etc., should be eliminated. Silverfish and firebrats like to be in an area where they feel safe – in between things. Clutter that builds up in corners, on cabinets, shelves or on the floor becomes harborage for firebrats, silverfish that can attack and ruin irreplaceable historic artifacts. Sanitation is active and must be conducted on a daily basis.

Habitat modification

Eliminate food, water and shelter. Other means are raising or lowering temperatures or reducing humidity to levels intolerable by pests, and increasing lighting. Habitat modification is relatively passive and semi-permanent.

SILVERFISH AND FIREBRATS



FLIES

CHARACTERISTICS AND RECOGNITION

In terms of both numbers and health concerns, flies make up one of the largest groups of insect pests. Although the major features and management measures given here are for urban pest flies, the principles generally apply to all flies.

The main fly pests at Casa Grande Ruins National Monument are the house fly and the little house fly, each of which has very similar life cycles. Adults seek moist garbage, dead animals, or manure in which females deposit eggs. Eggs develop into grub-like larvae (or maggots) that feed on the food source on which eggs were deposited. After a week or so, larvae leave the food source and spend another week or so in a non-feeding, cocoon-like form (pupa) from which adult flies emerge in a few days. Adult flies quickly mate and may move from the breeding site into human occupied structures through open doors and windows, seeking food.

Food for a fly consists of almost any organic material. House flies (among many others) eat solid food by vomiting digestive enzymes onto the food source and macerating it into a liquid form that can be lapped up with sponging mouth parts. Since flies continually vomit and defecate while feeding, germs are deposited on the food they feed on.

HOUSE FLY (*Musca domestica L.)*

Worldwide, the common house fly is one of the most widely distributed insect pests. House flies are soft-bodied, gray-colored, about 1/4 inch long, and have only one pair of wings that span about 5/8 inch. Their faces have two soft stripes that are silver above and gold below. The upper surface of its thorax is marked with four dark longitudinal stripes, and the abdomen is yellowish-white at the sides and base. House flies are active year-round outdoors in mild weather and indoors during fall and winter.

House Fly Life Cycle

The house fly rarely moves more than a mile to food from its breeding sites. They have an excellent sense of smell, which leads them to food and water. Their range of vision is about eighteen inches. They are attracted to red colors.

Over her lifetime, a female house fly will lay from 350 to 900 eggs in any moist excrement, garbage, decaying fruit, vegetable waste, and soil containing organic matter. After eggs hatch, larvae feed and eventually migrate to cool sites (for instance, soil beneath boards or stones), where they pupate. In three days to four weeks, depending on temperature and humidity, adult flies emerge from pupae. Normal adult life span of the house fly is two to three days if denied food, but flies live up to 54 days when food is present. The time from egg to adult ranges from seven to 45 days, and in warm weather two or more generations can be produced per month. House fly populations may be greatest in early fall (September and October). Because larval house flies produce a glycerol compound, which keeps their body fluids from freezing, they mostly over-winter as maggots or pupae. Various similarities in appearance and behavior make it important to be sure that suspected "house fly" problems are not really flesh fly problems, which originate with dead animal carcasses.

LITTLE HOUSE FLY (*Fannia canicularis)*

Little House Fly

The little house fly is generally most numerous during the spring and fall months. As temperatures rise in the summer, populations diminish.

Adults are approximately two-thirds the size of the house fly and lack their distinctive thoracic stripes. *Fannia* at rest hold their wings over their backs more than the house fly does, creating narrower V-shape to the wing. Flying clusters of males form in areas with still air such as breezeways and porch areas of structures, maintaining a position 5 or 6 feet above the ground. Strong air currents tend to disperse these male aggregations.

Larval little house flies are adapted to tolerate a wide moisture range, making them a difficult nuisance fly to manage. Egg laying and larval development occur in animal wastes, but moist organic materials can serve as suitable substrates. The larvae are brown in color, more flat than round, and have numerous fleshy spines. The development time from egg to adult is longer for the little house fly at all temperatures.

Little house flies tend to congregate in outdoor areas such as patios, entryways and garages or carports. As temperatures decline, they seek cover in buildings or protective vegetation. They seldom land on human foods and are not considered a significant carrier of human disease agents. However, their habit of hovering at face level makes them annoying, though they move readily out of the way when approached.

As with all nuisance flies, eliminating breeding sites is the preferred method of managing *Fannia*. Accumulations of manure or other decaying organic matter are ideal developmental sites. These sites must be removed or spread thin to fully dry. *Fannia* are not attracted to the same baits or traps that collect house flies. Some relief can be obtained by placing fans in areas where *Fannia* tend to swarm, as the increased air movement will make the site less attractive to them.

HAZARDS OF INFESTATION

Flies in General

Flies provide great potential for disease transmission because of their feeding habits. Along with mosquitoes, flies are responsible for spreading serious diseases like malaria, sleeping sickness, leishmaniasis, and filariasis. Other disease-causing organisms that have been collected on flies include germs causing dysentery, tuberculosis, cholera, tularemia, anthrax, poliomyelitis, yellow fever, and typhoid.

House Flies

House flies alone transmit more than 20 human diseases and parasitic worms (including salmonella, typhoid and paratyphoid fever, cholera, summer and infantile diarrhea and dysentery, tuberculosis, and anthrax) which adhere to the fly's sponging mouth parts, sticky foot pads, wings, body surface, or live within the fly's gut.

Little House Flies

They seldom land on human foods and are not considered a significant carrier of human disease

agents.

IDENTIFICATION, INSPECTION, AND MONITORING

Identification

If it is difficult to identify flies, request assistance from state health departments or preserve flies in alcohol and send them to university departments of entomology when necessary.

Inspection

Do not stop inspecting after finding the first breeding site, nor concentrate efforts only on those areas where flies were seen. Seek out all possible places which could contain decaying material, garbage, rotting fruits, vegetables, meats, dead animals or grass clippings. When inspecting for fly-breeding sites, first search for wet areas: floor drains, open drums, buckets, cans, bottles, potted plants, dish washers, machinery, and around cracks, roof lines, and loose tiles. Look for moist animal feces, garbage, wet mops, and towels. House fly maggots on floors or pupae under carpets signal the probability of fly-breeding sites inside the building.

Begin inspections outside by intensively searching for breeding sites, first concentrating on garbage and refuse areas. Look under equipment for maggots in dead animal carcasses (mice, trapped animals, dead rodents), and in garbage and drain sludge. Examine building cracks and crevices, dumpsters and garbage cans, drains and refuse piles. Cat, pigeon, and rodent feces and dead rodents are ideal breeding sources. Develop maps of likely breeding sites and periodically re-check those areas for live fly larvae.

Inside the building, inspect trash container interiors and areas prone to litter (such as break rooms and lounges). Look for empty soda cans, coffee cups, rotting fruit products, misplaced lunch bags, wet towels, and debris in locker and lounge rooms. Inspect all cracks at baseboard level, crevices around loose floor tiles, hollows and voids, and inaccessible areas in machinery that are caked with dirt and organic matter. Inspect potted plants and grease traps.

In kitchens and food processing areas, thoroughly search for decaying food. Inspect floor drains, floors under work counters and equipment, and enclosed counters which permit water or food to accumulate inside or beneath them. Look under ovens, and in both hard-to-reach and under clean machinery at floor level

General Monitoring

Flies have certain preferred resting places. During the day and when not feeding, adult flies may be found resting on floors, walls, ceilings, in crack and crevices, and other interior surfaces as well as outdoors on the ground, fences, walls, privies, garbage cans, clothes lines, and vegetation. To monitor for adult flies, place scatter grids out for 30 seconds (or other standard time limit) in locations near preferred resting places and count the numbers of flies landing on grids. Sticky tape, 3 x 5 inches wide sticky paper, or sticky strings can also be used to monitor adult flies.

When problem flies are attracted to light, place light traps in dark places or capture flies at windows. Use monitoring information to establish levels of infestation upon which to base management actions.

Monitoring Information on Specific Kinds of Flies

House Fly

Sticky or light-trap monitoring which produces, on the average, 50 to 75 house flies per trap per day indicates a moderately heavy population. More than 150 house flies per trap per day indicate a heavy population.

MANAGEMENT

Mistakes in Fly Management Programs

The following are the most common mistakes made in fly management programs:

- Failure to properly identify flies and to find and correct conditions providing breeding sites.
- Stopping after finding the first breeding site; all possible breeding sites must be discovered and eliminated.
- Trying to manage adult flies without first managing larval breeding sites. Management of adult flies may be helpful to alleviate complaints, but it is not as effective as managing larval breeding sites.
- Attempting to manage flies with only pesticide chemicals. Pesticides alone will not eliminate fly problems and are only effective when good sanitation and exclusion are practiced as primary steps.

Physical, Mechanical, Cultural Measures

Sanitation

General: The first step in any successful fly program is to reduce fly numbers; the key to that is an effective sanitation program for potential breeding sites.

Outside:

- Eliminate conditions responsible for fly-breeding sites around buildings by properly disposing of food materials and garbage (especially under dumpsters), preventing accumulations of moisture, and removing weeds.
- Do not throw waste water from cleaning operations onto the ground; pipe it into covered drains. Keep areas around garbage cans clean. Assure that tight-fitting lids on garbage receptacles are used.
- During warm weather, steam-clean and rinse out garbage cans and dumpsters with disinfectant solutions on a weekly basis.
- Be sure that garbage is picked up twice weekly so larvae will not have time to develop into adults.
- To assure that fewer flies will enter structures, keep garbage cans and dumpsters tightly closed and as far from buildings as possible.
- Keep dumpster bottoms as dry as possible by installing bottom drains and lead water drainage into sewer systems.
- Release fly parasitoids *(Pteromalidae)* near areas where flies may pupate to prevent adult fly emergence.
- Seal cracks and crevices that lead to the inside to prevent adult cluster flies from entering.

Inside:

- Fit garbage cans and dumpsters with tight-fitting lids and always keep receptacles closed.

- Routinely clean cans and dumpsters with disinfectant solutions.

- Seal all wet and dry garbage up in plastic bags before placing it into receptacles; this excludes flies and reduces both odors and the attractiveness of garbage to flies. Be sure to take garbage out every night.
- Keep floors, walls, cooking, and food-preparation surfaces clean and dry.
- Examine plumbing pipes for possible leaks and water condensation.

Notes on Management of Flies

Housefly: House fly management requires a fully integrated approach based on exclusion and improved sanitation. Reliance on pesticides usually fails in the long-term since house flies have developed resistance to most pesticides.

Exclusion

Exclusion is second only to sanitation in effective fly management programs, because flies are always attracted to the warmth and odors of buildings.

- Assure that all doors, windows, air curtains, and door closing devices are in good repair and maintained to keep flies from entering the structure. Fit windows and doors with 16 mesh-to-the-inch, tight-fitting screens and install self-closing door devices.
- Screen doors should open outward; double sets of screen doors may be required.

Other Management Methods

Heat: Flies die in 30 minutes when exposed to 120ºF dry heat.

Vacuum: A vacuum may be used to collect flies in groups.

Sticky traps: The best place to put sticky traps is where flies usually rest: in corners, on edges, on thin objects (suspended wires or strings), and on ceilings. Sticky paper and sticky strings are useful to capture house-flies, but flies are also trapped when encouraged to light on cotton balls.

Live-Capture Fly Traps: Outdoor, mechanical, and food-attractant fly traps are useful in some locations to lessen fly numbers, but they require attractive fly bait.

- Home-made fly trap: Place one cup of sugar, one cup of vinegar, and one banana peel in an empty two-liter bottle; fill with water to within 4 to 5 inches from the top; tie a heavy cord around the neck to hang it from a tree. This trap catches flies all season long.

Insect Light Traps

Electric and ultraviolet (UV) insect light traps (ILTs) offer good captures when used according to manufacturers' directions. Correct use of ILTs can help solve many flying pest problems in small facilities. Proper maintenance of ILTs requires annual (or more frequent) lamp replacement, weekly trap cleaning to manage dermestid beetle problems, and a sufficient number of properly located traps. Locate traps 12 or more feet from doorways so flies cannot see them from the outside (to prevent attracting flies into the building), less than 5 feet from floor level, and at ceiling level in front of large overhead doors, but not facing outside. Each situation is different and it should be determined in advance how flies enter and move through a building. Clean light-trap trays often, both to monitor efficacy and to prevent scavenger insect problems.

Outside Lighting

If practical, place outside lamps on poles away from buildings but shining onto doors, so as to attract night-flying insects away from the building. High-pressure sodium-vapor lamps help to minimize flies when installed at, but not over, entrance ways.

Temperature

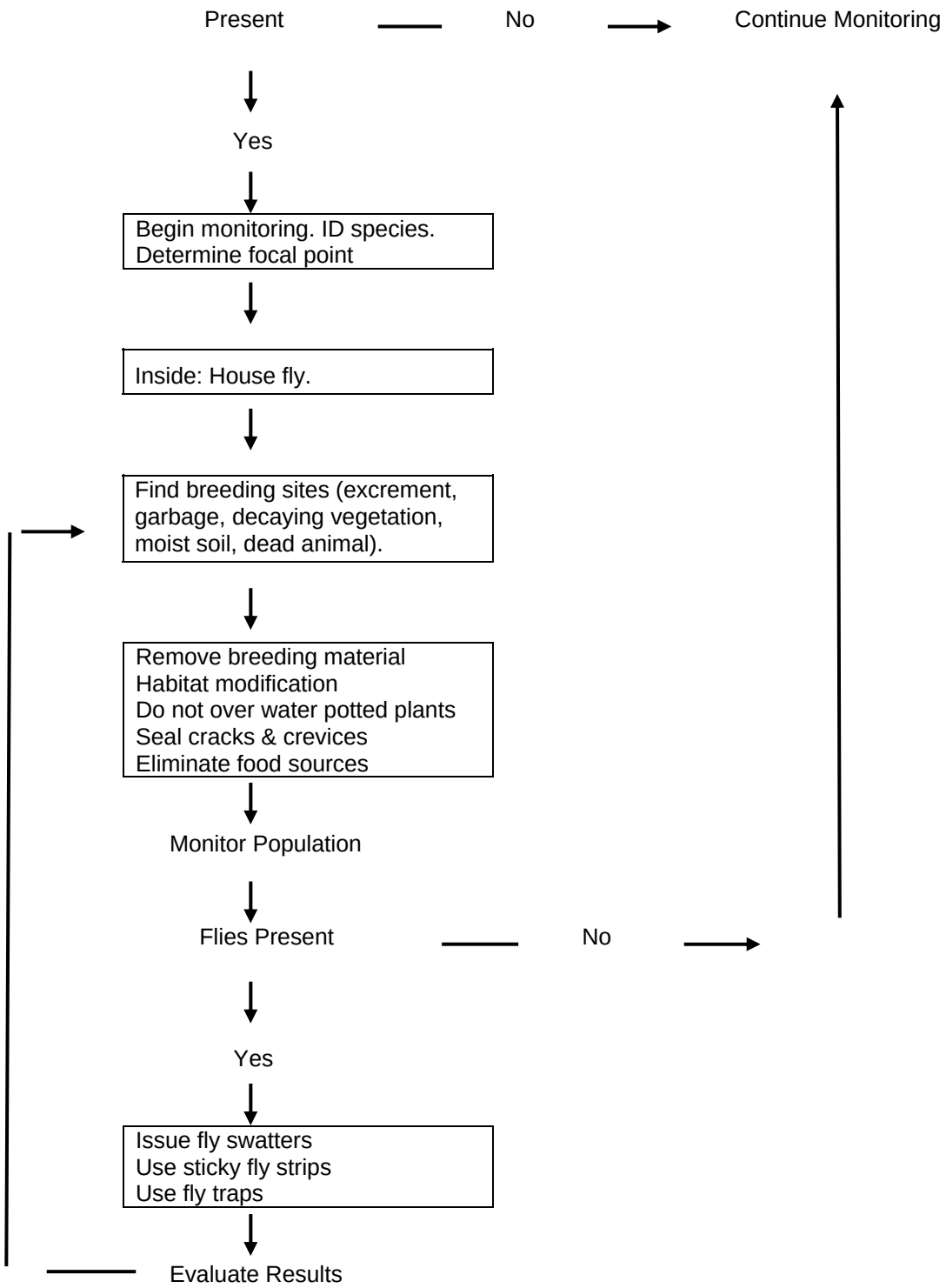
Flies become sluggish or do not fly in lower temperatures. Keep inside temperatures as low as practical.

PESTICIDES

When deemed necessary, pesticide applications shall be performed by approved licensed applicators only. Applications shall be made according to National Park Service policy and procedures guidelines, according to pesticide label directions, and following applicable laws and regulations.

Pesticide applications for flies are generally unnecessary since sanitation, cultural controls and exclusion will reduce or eliminate fly infestations in structures. Do not treat for cluster fly in attics or wall voids.

FLIES


Present
No
Continue Monitoring
Yes
Begin monitoring. ID species.
Determine focal point
Inside: House fly.
Find breeding sites (excrement, garbage, decaying vegetation, moist soil, dead animal).
Remove breeding material
Habitat modification
Do not over water potted plants
Seal cracks & crevices
Eliminate food sources
Monitor Population
Flies Present
No
Yes
Issue fly swatters
Use sticky fly strips
Use fly traps
Evaluate Results

SPIDERS

CHARACTERISTICS AND RECOGNITION

General

Only a few species of spiders live in structures; most are accidentally carried into buildings on firewood, laundry, or plants. Since they feed on insects, they are rarely problems in buildings that do not have an insect food source. They are objectionable pests to people fearful of them, even though most are harmless. There are only two spiders considered dangerous to human beings in the United States: the black widow and the brown recluse. These generic names, however, represent several different species. The following discussion describes these two spiders, but generally applies to all spiders.

Black Widow Spider

Several kinds of black widow spiders are widely distributed over the eastern, southern, western, and northwestern states of this country. Black widow spiders are normally outdoor species that sometimes move or are accidentally brought indoors. Young spiders may migrate inside on ground-floor levels. Outside, the black widow can be found in crawl spaces and bird nests, on low-growing plants, under porches, garages, and sheds. They are also found in stacked pots, baskets, boards, firewood piles, rodent burrows, and water meters, and under bricks and stones.

Female Black Widow with Egg Sac

Female Black Widow

The female black widow has poison glands and fangs with which she kills insect prey. These spiders can go for as long as three to four months without eating. Although the female black widow rarely leaves the web, males are more adventurous, especially when seeking a mate. When they first hatch, males are slightly venomous, but the potency of venom is lost as they mature. Male black widow spiders are not dangerous to people.

The adult female black widow spider has a shiny black abdomen that is usually decorated on the underside with red or yellow-red markings resembling an hourglass. This mark is visible when the female hangs upside down in the web. The markings, which may be absent, vary in different individuals from that of a typical hourglass shape to a pattern of two or more triangles; occasionally, some spiders may only possess a long, irregularly colored area. Male black widow spiders are small,

white, and streaked with red, white, or yellow. Female black widows are about 1/2 inch long; males are only about half that size and have longer legs.

The adult female black widow spider is primarily nocturnal. She weaves tangled webs of coarse silk in dark locations, and in late summer she begins to lay batches of eggs in units of 300 to 400 on the web. Four to nine batches of eggs, covered with a silken sac, can be produced during a season. The female guards the egg capsules and moves them as necessary when repairing the web. Females tend to be hungry and aggressive after egg laying, during which time most human-related bites seem to occur. Eggs hatch in eight to 10 days, and the young disperse by riding air currents on short strands of web. Young black widows mature in about four months and only mate once. Although some believe the female kills the male after mating (hence, the name "widow"), others contend that the female rarely does so. The life span of a spider is from eighteen to twenty-four months.

Brown Recluse Spider

Seven varieties of brown recluse spiders make up this group. These are dusky-tan or brown spiders that range over most of the United States, sometimes "hitch-hiking" into dwellings on luggage or household furnishings imported from other places.

Brown Recluse Spider

The brown recluse spider is an outdoor species that hunts at night. It doesn't use a web to capture prey; but rather runs fast to overtake it instead. In the south, the brown recluse lives under loose bark, in woodpiles, under sheds and beneath debris. In the north, it has to live indoors, especially in the sleeves of clothing hung for long periods of time in closets. The brown recluse spider has a high moisture requirement, and is often found near water heaters. It may also be found behind or under furniture and boxes.

The brown recluse is a medium-sized spider (about 5/16 – 1/2 inch) and smaller than the black widow. Unlike the black widow, the brown recluse has an oval abdomen that is uniformly tan-to-dark brown and without markings. A dark "violin-shaped" fiddle back mark is obvious on the cephalothorax (combined head and thorax portions) on most species. The broad base of the fiddle begins at the eyes and the narrow part of the fiddle neck ends just above the attachment of the abdomen. The brown recluse has three pairs of eyes (in groups of two) placed in a semi-circular pattern (rather than four pairs for most other spiders). Its legs are long, the second pair longer than the first.

Although the brown recluse makes a fine, irregular web, it wanders around to hunt after maturing. During a lifetime, females produce one to five egg cases of 30 to 50 eggs each. Eggs are placed on the web in a loosely woven sac of wispy sheets of silk. Usually one or two young spiders per brood survive, because adults are cannibalistic (and also feed on black widow spiders). Recluse spiders mature in seven to twelve months, and they generally live one or two years.

HAZARDS OF INFESTATION

Black Widow Spider Bites

Death results in less than four percent of persons bitten by black widow spiders. Strong, healthy adults rarely succumb to a bite, but young children are more vulnerable. Deaths among the elderly are usually the result of complications beyond the spider's bite.

Female black widow spiders are quite timid and usually make no effort to bite, even when provoked. Bites may occur when a spider is accidentally squeezed against a person's body. Spiders make webs in the folds of clothing, shoes, or under objects in dark corners.

The severity of the black widow bite depends on the amount of venom injected, age and condition of both the victim and the spider, part of the body bitten, degree of immunity of the victim, and treatment given. A black widow spider bite is not always felt, and in most cases, only two tiny spots along with redness appear at the bite site. Pain begins to increase around the bite after half an hour or more, along with other symptoms such as headache, dizziness, shortness of breath, and abdominal and back pain. The pain lasts for 12 to 48 hours and is generally worse by the second or third hour. Muscles in the victim's abdomen become rigid, and the person may develop nausea and, in some cases, convulsions.

How to Treat a Black Widow Bite

Anyone bitten by a black widow spider should be treated for shock by being kept quiet, preferably in bed and covered with a blanket. Victims should receive hospital treatment as soon as possible; antivenom is readily available to most physicians. If a doctor is not available, wash the skin around the bite but make sure any venom still remaining on the skin is flushed away from and not into the wound. A recommendation is to continually apply ice to the bite site, since cold delays absorption of the poison and gives the body an opportunity to neutralize the venom. Never administer alcohol since it increases sensitivity to the venom. Give the patient plenty of water and sweet weak tea.

Brown Recluse Spider Bites

Brown recluse spiders generally avoid areas of human activity, and are usually found only in unused rooms. Even though indoor infestations may be large, household residents are seldom bitten. The brown recluse is not aggressive but bites and causes severe wounds when squeezed against a person's skin, as in putting on shoes or clothing (most bites occur on arms and legs). Bites can be expected when previously unused rooms are occupied or when clothing stored for a long time in closets is brought out for use. Brown recluse bites sometimes produce a sharp sensation at first, which may be mistaken for a bee sting or insect bite. However, it may not be noticed at all. Victims may not realize the full extent of the trouble for eight to 12 hours, when pain becomes intense. A reddened area and accompanying painful swelling develop at the bite, and nausea, vomiting, fever, and a rash may follow. The site of the bite becomes dark and dry and after seven to 14 days, tissue surrounding the bite becomes an open ulcerous wound. Without prompt medical attention and over a period of days, the ulcerous wound becomes a festering sore. Although scabs may form over the wound, they tend to fall off and the wound continually grows deeper and fails to heal for several months (up to a year). There is always the potential for gangrenous infection and skin grafts are sometimes required to close the wound. Death from bites is extremely rare, but bites are very debilitating and traumatic.

How to Treat a Brown Recluse Bite

Apply ice to a bite as soon as possible, elevate the limb, and take the victim and captured spider (if possible) to a physician. The brown recluse is a delicate spider and after a bite it can usually be found near where it was slapped by the victim. The spider should be killed (without destroying it so it can be identified) and taken with the victim to the physician. Identification of the spider is important for proper treatment because a few other biting arthropods produce similar injury.

Other Hazards

Some spider webs may clog vent pipes and trap fumes or odors inside structures.

INSPECTION AND MONITORING

Move cautiously when inspecting or treating any sites where there is potential spider harborage.

Inspecting For Recluse Spiders

Wear long sleeves, long pants, socks, and gloves and use a flashlight during inspections along walls in little-used, cluttered storage areas such as closets and attics. Look for loose irregular webs, cast skins and silky egg cases (about 1/3 inch in diameter) but avoid placing hands into dark places. Spiders shed their skins in order to grow. These "cast" skins are fragile but retain a characteristic violin marking. Such skins indicate infestation.

Inspect behind and under furniture, in kitchen and bathroom cabinets, closets, ceiling light fixtures, stacks of firewood, and water heater closets. Other locations for inspection should include mattresses and bedding; walls and floors and stacked boxes, bags, papers in store rooms and sheds; behind picture frames; under stairs; and hanging clothing that has not been used for some time. Concentrate on areas outside daily traffic patterns.

Outdoors, brown recluses are found between the soil and foundations, under door stoops, and in window wells.

Monitoring Brown Recluse Spiders

The presence of brown recluse spiders can be monitored in sticky traps. Tent-top or other sticky traps with covers seem the most effective.

MANAGEMENT

General

Spiders should be conserved whenever possible; they are natural control agents for many pests.

Major Mistakes in Spider Management Procedures

The following are the mistakes made in spider management procedures:

- Spiders are re-introduced into structures by way of firewood, laundry, and flowers.
- Failure to eliminate the insect food source.
- Over-responding in management measures due to spider misidentification.

- Extensive pesticide application when only a few harmless spiders are present, which could be managed by physical or mechanical means.

Physical, Mechanical, and Cultural Measures

Sanitation

Habitat modification, good sanitation, and exclusion are absolutely necessary for long-term spider elimination; inform occupants of the need and the techniques.

Frequently and thoroughly vacuum (with an industrial vacuum) all cracks and crevices, closets, behind furniture, and mop floors to destroy webs, egg sacks, and young spiders. Clean dark corners inside the structure using leather or rubber gloves. Concentrate efforts for brown recluse management in seldom-used rooms. Remove webs off exterior of building so that spiders leave.

Remove lumber, scrap, rubbish, and debris from near and under buildings and frequently clean rain gutters. Stack firewood, brick, and stone piles away from buildings; inspect firewood for spiders and egg sacs. Keep grass mowed and cut very short next to buildings; establish a three foot swathe of gravel cleared of vegetation all around buildings. Keep trees and shrubs trimmed back at least three feet from structural walls. Pick up leaf litter and other debris in yard, especially next to buildings.

Make occupants aware that spiders are often introduced into structures on firewood, lawn furniture, garden implements, and children's toys. Remove the bark from firewood before bringing it inside; don't bring in any more wood than will be burned in an hour or two.

Perform annual spring cleaning: turn mattresses, clean closets; dispose of unused items, rotate seldom-used items in garages, under beds; neatly stack items inside away from walls; remove and wash all bedding; remove and clean drawers from dressers and remove cobwebs. This is very important for brown recluse management because it interrupts the spider's reclusive habits. Re-inspect spaces disturbed by dusting, vacuuming, and mopping the same evening, and kill any moving spiders.

Inspect winter clothing and other unused closets during spring and summer. Before returning clothing to storage, clean it and pack it in sealed plastic bags.

Repair all water leaks and sources of condensation on pipes.

Reduce the numbers of insects in and around building. To avoid attracting spiders, arrange outside lighting so as not to attract insects. Move lights onto poles and away from structures. Trim weeds and remove debris around foundations, caulk entry holes, install tight-fitting screens and door sweeps. Spiders need a ready supply of insects to survive and invade structures infested with insects.

Regularly clean floors and baseboards and remove debris. Do not leave old clothing, bedding, boxes or piles of paper on floors.

Thoroughly clean attached garages and basements, crawlspaces, and outbuildings.

Dry out crawlspaces or spider problems will recur.

Exclusion

Inspect doors and window casings to be sure screens function properly. Caulk holes large enough to admit spiders including openings around water pipes and electrical lines. Keep tubs, sinks, and drains stopped at night. Install tight-fitting door sweeps to exclude spiders and crawling insects.

Other Measures

Biological

Mud dauber wasps, birds, rodents, and predatory insects prey on spiders.

Heat

Infested rooms can be treated by heating them to over 120ºF for one-half hour.

Direct Measures

Step on individual spiders, kill them with a fly swatter, or remove them with a vacuum.

Pesticides

When deemed necessary, pesticide applications can be performed by licensed applicators only. Applications shall be made according to the National Park Service Integrated Pest Management policy and procedures guidelines, according to pesticide label directions, and following applicable laws and regulations.

Pesticides, when used, should be combined with nonchemical measures. Although spiders are susceptible to most insecticides, chemicals are seldom used because of difficulties in getting spiders into contact with pesticides: they do not ingest pesticides during grooming and walk on hairs on their feet which prevent surface contact.

Web-building spiders seldom leave their webs.

Pesticide dusts, however, are sometimes applied in attics and crawlspaces. If a good spider reduction is done in the fall, few problems should occur until early to late summer of the next year.

When using pesticides to treat structures for spiders, warn occupants to be cautious in rooms that were treated, because spiders not killed will wander for a few days following treatment.

Carefully analyze the microhabitat occupied by problem spiders and use appropriate nonchemical and management methods.

Indoors

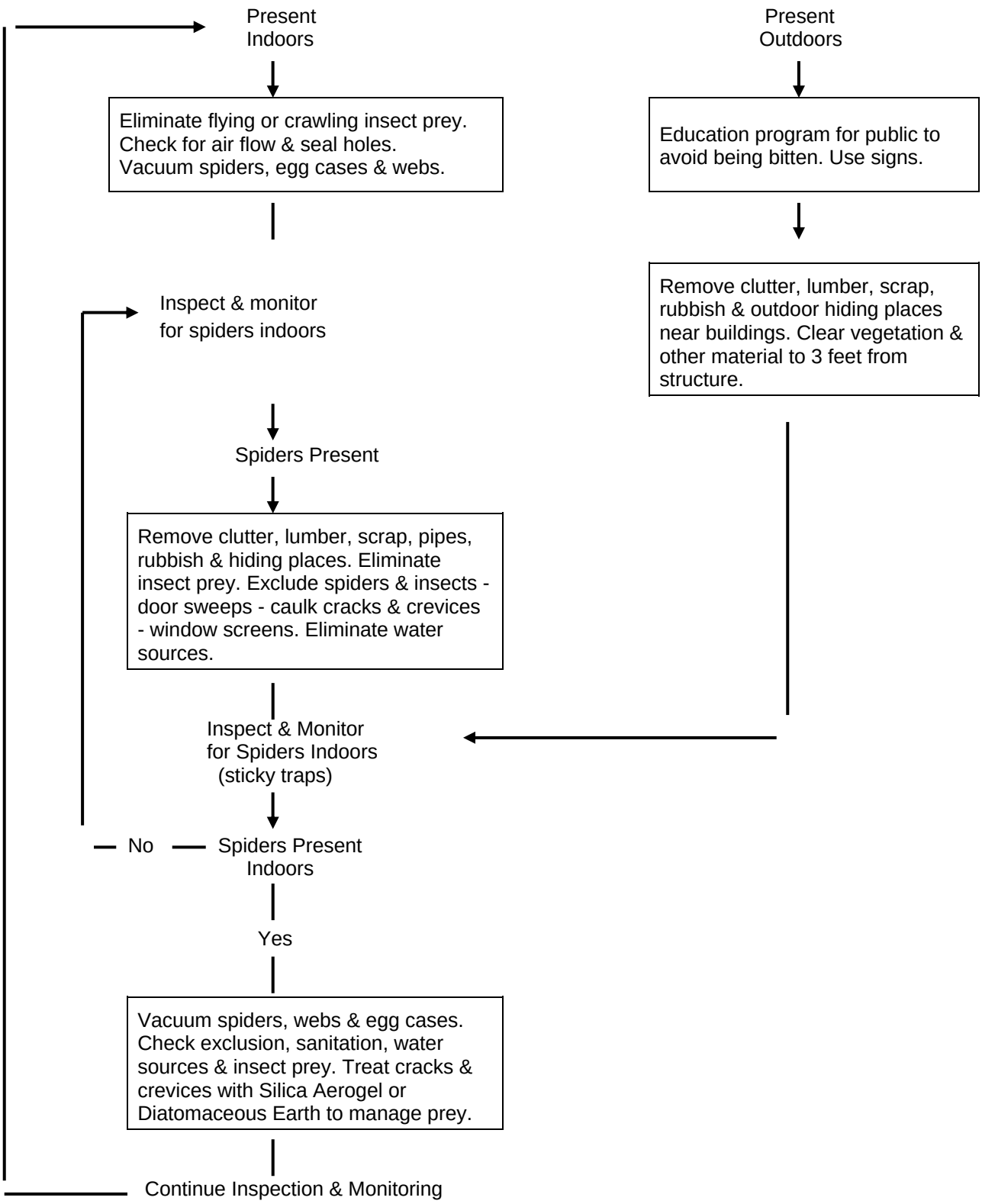
If necessary, use crack-and-crevice application dusts such as diatomaceous earth to treat the structure, including attic and crawlspace, window and door frames and casings, baseboards, cracks and crevices, room corners, beneath and behind furniture, closet bottoms, and garage in order to reduce insects spiders feed on. Since web-building spiders recycle silk (eat and digest old webs); light dust applications on webs may be effective.

If spider populations are not reduced, spot-treat areas of infestation with residual pesticides by directing insecticide into voids, cracks, and crevices.

Outside

Using the above techniques and materials, treat around foundations, windows, doorways, pipe openings, wooden fences, weep holes in brick walls or veneers, and building perimeters. Dustings should be wide-spread to eliminate spiders before they enter the dwelling. There is no need to treat the lawn. Follow label directions.

SPIDERS


Present
Indoors
Present
Outdoors
Eliminate flying or crawling insect prey. Check for air flow & seal holes. Vacuum spiders, egg cases & webs.
Education program for public to avoid being bitten. Use signs.
Remove clutter, lumber, scrap, rubbish & outdoor hiding places near buildings. Clear vegetation & other material to 3 feet from structure.
Inspect & monitor for spiders indoors
Spiders Present
Remove clutter, lumber, scrap, pipes, rubbish & hiding places. Eliminate insect prey. Exclude spiders & insects - door sweeps - caulk cracks & crevices - window screens. Eliminate water sources.
Inspect & Monitor for Spiders Indoors (sticky traps)
No
Spiders Present Indoors
Yes
Vacuum spiders, webs & egg cases. Check exclusion, sanitation, water sources & insect prey. Treat cracks & crevices with Silica Aerogel or Diatomaceous Earth to manage prey.
Continue Inspection & Monitoring

TERMITES AND THEIR MANAGEMENT

INTRODUCTION

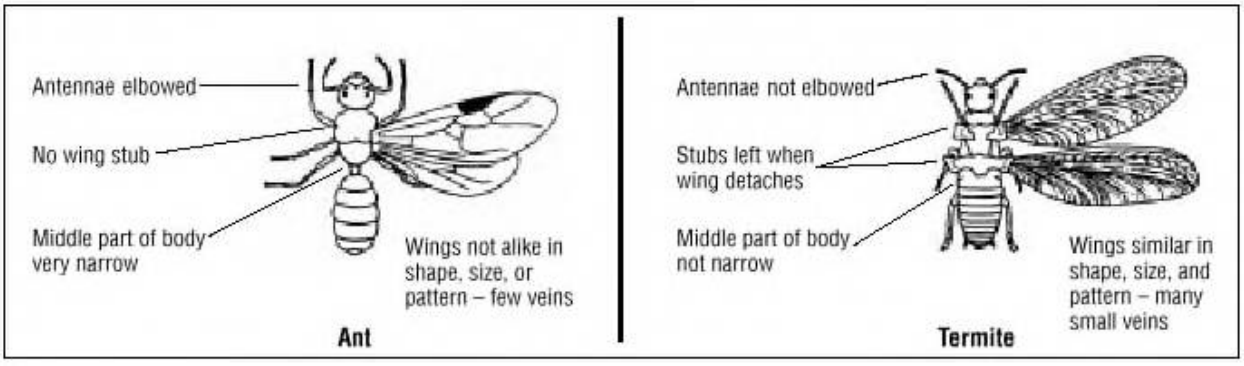
Termites are the most destructive wood-destroying insects in the U.S., costing hundreds of millions of dollars each year in prevention efforts, direct damage to structures and trees, and corrective costs. In older structures, about one of every ten is infested to some degree, while in newer structures; perhaps one in 20 is infested.

Termites are social insects belonging to the order *Isoptera* (meaning equal wings) and, like the cockroaches to which they are closely related, have been around for hundreds of millions of years. As inhabitants of forests, they serve a valuable function in the ecosystem by consuming dead and decaying wood. When people began to build wood structures, these structures became additional food sources and habitat for termites. Termites sometimes endanger the structural integrity of buildings.

Termites are classified according to their primary habitats subterranean, dampwood, and drywood termites. By far, the subterranean termites are the most widely distributed. They occur throughout most of the 48 contiguous states, Hawaii, lower Alaska along the pacific coast, and the Caribbean territories. Because of the ever-present threat to housing and other wooden structures, vigilance is necessary to prevent, mitigate, and eliminate termites.

CHARACTERISTICS AND RECOGNITION

Usually, the first experience with termites is when they swarm around structures by the thousands during spring. For the termites, this is a dispersal flight as they begin spreading to new areas. People usually report "flying ants" and immediately call their exterminator. The pest management supervisor identifies these flying insects as termites, and points out the differences between true flying ants, which have two pair of unequal wings, elbowed antennae, and a narrow waist, and termites, which have two pair of nearly equal wings, straight antennae, and a thick-waist.



Typically, the subterranean termites swarm in the early spring on a warm day after a rain. Warmth, sunlight and moisture are the three elements necessary for the survival of this species, and the reproductive termites sense that these conditions will enhance their chance of survival. Close inspection of the building may show piles of detached termite wings, the small (less than 1/4 inch) white worker termites in wood below ground, and their galleries in wood structures.

BIOLOGY OF SUBTERRANEAN TERMITES

Subterranean termites, the most widespread and destructive termites in the U.S., have their nests underground and within easy access of wood which is their only food. They are social insects with a complex division of functions including a queen, king, soldiers, supplementary reproductives and workers.

King & Queen

Reproductive

Workers

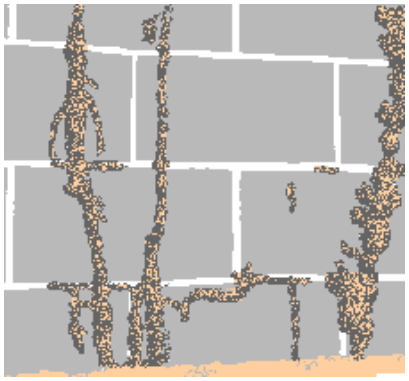
Soldier

The life of the colony depends on the queen, which is a greatly enlarged, light brown, winged termite about 1/2 inch long. The queen can lay millions of eggs over her lifetime of over 25 years. Her egg-laying activities are augmented by supplementary wingless reproductives as the queen ages or the colony outgrows its original nest. The king is the same size and color as the queen and also has two pair of wings. It exists only to mate with the queen, and lives, as does the queen, entirely within the subterranean nest once it is established.

The supplementary reproductives are light in color, about 1/4 inch long, and have two pair of wing pads. They also stay entirely within the underground nest. The soldiers are white, except for an enlarged brown head capsule, and are about 5/16 inch long. They defend entrances to the nest against enemies, particularly ants which are the primary enemies of termites.

The workers, which are actually nymphs, are entirely white, about 3/16 inch long, and do all of the foraging and feeding activity of the colony. They may live up to five years, and are the ones that venture above-ground into structures, construct the galleries, bring wood back to the nest, and build the mud tubes that connect the nest to the galleries and the structure. They also feed the young nymphs and other castes which cannot feed themselves.

Since the termites' ability to digest cellulose is totally dependent upon the protozoans living within their midgut, it is imperative that workers exchange anal fluid containing these organisms so that young termites can digest their food. This is accomplished by grooming among workers, a process that is important in selecting a pest management strategy.



Subterranean Termite Mud Tubes

The conditions that termite colonies need to flourish are rather basic, but critical. They include relatively high moisture content in their living and feeding areas, adequate shelter and temperature, and a plentiful food source. The colony will not flourish if any of these is lacking. The high moisture content need is met by the soil in most parts of the country. Even coastal beaches, deep in the sand, provide ample moisture for

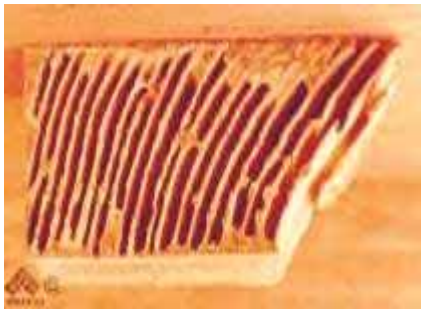
termite colonies. The soil also provides termites the necessary protection from desiccation, since their cuticle is rather permeable and they can easily die from exposure in air. It has been theorized that the connecting mud tubes from above ground food sources to nests (built from mud, digested wood, and termite secretions and excretions) protect termites against dehydration along the journey from the nest to the food source and back.

These tubes may also provide protection against enemies, primarily ants. The minimum tolerable temperature for termites is -22ºF. This does not mean that termites can flourish at this temperature, but rather that they can withdraw deep enough into the ground to survive that outside air temperature for a short period, usually a matter of weeks. If they have to stay too deep for too long, however, they are deprived of their primary food source, decaying wood.

Human habitats are ideal for termites. They provide the cellulose needed for food and the temperatures beside and underneath the building allow year-round activity by the colony. It does not take much wood to attract a mated pair of termites to set up housekeeping; a piece of a discarded 2 x 4 inch piece of wood in a foundation void will do it. Of course, once that food source is exhausted, termites will move on through cracks in the foundation to find another food source, usually in the interior of the structure.

Damage

The damage done to wooden structures may take years to reach the point when any evidence is visible. Often the area of damage is inaccessible, such as behind basement walls, in crawl spaces, or where floor joists meet the wall studs. Termites prefer to eat the softer portions (the spring sapwood) of beams, joists, studs, door jambs, window sills, or wood paneling, leaving behind enough of the harder summer sapwood to keep the structure intact.



Termite Damage

Termites will also eat through plastic sheathing, foam insulation, and any other soft obstacles on their path to their foraging sites. If there is moisture in the wood, the destructive process is accelerated by fungi carried on termites' bodies. Their activities also tend to increase the moisture content in the wood they forage in. Termites deposit their frass (droppings) inside the galleries or use it together with earth and decayed wood to construct mud tubes. The mixture of feces, frass, and decaying wood gives the galleries a dirty appearance.

Over a period of years, the wood may become so thin that literally only paint is holding it together and just touching it can cause the wood to give way. Ultimately, the building may become structurally unsound, and major supporting members may require replacement.

INSPECTION AND MONITORING

Foundations

In order to inspect and monitor for termites, it is important to understand structures and the structural defects that lead to termite infestation.

For subterranean termites, the most common routes of infestation are the basement or ground floors of structures including:

- Poured-concrete slab foundations,
- Raised concrete foundations and footings,
- Vertical void concrete masonry block foundations,
- Brick foundations, and
- Stone and rubble foundations.

Other than solid poured concrete basements, the floor slab is usually supported by footings underneath and at the perimeter, and walls rest on top of the slab.

Subterranean Termite Entry Points

The slab usually has underlying gravel. Caps at the tops of foundations can be solid block caps, poured-concrete caps, top course of hollow blocks filled with concrete, or brick caps.

Sometimes supporting posts or stairs extend through the concrete slab to the soil below. Wherever there is a joint between the wall and floor, or the wall and cap, there is opportunity for cracks to develop which become entry points for termites. Similarly, cracks in the wall, mortar between blocks, bricks, or masonry provide entry points for termites. Faults in the blocks may also provide access for termites to the joists.

Poured concrete wall and pier construction, brick, hollow block, masonry walls, or wooden piers, are all used in buildings constructed on raised foundations. Piers constructed of poured concrete, concrete blocks, bricks or treated wood provide support for the girders and floor joists. Termites gain access through cracks or voids that occur. Access through piers or directly from the crawl space itself are easy portals of termite entry, since the distance is short and mud tubes may escape notice. Subterranean termites commonly gain access to structures by building shelter tubes from the ground to the wood over concrete piers, foundation walls, and from underneath exterior soil-filled porches and patio slabs.

Slab-on-grade construction has become very common in the last 30 years. The monolithic slab, consisting of a solid, unitized pad and footing, offers protection against termite infestation. The supported slab is another type, which is tied at its ends to the foundation wall. The floating slab is the third type, which is structurally independent from the foundation wall. It "floats" over a gravel layer.

All three types of slabs provide access for termites once cracks develop in the slab or foundation wall. This scenario is most likely to occur at the expansion joint of the floating slab. Once in the building, termites have ready access to the wooden studs, joists, floor sheathing, and finished interior wood.

Site History

The pest manager should be familiar with the history of the site. Sites that were once heavily wooded areas, particularly with softwood trees, often have dense populations of termites. Sources of moisture in structures may also be areas where termites are attracted, and need careful scrutiny. Utility pipes and electrical conduits that run under a structure or up from the ground are natural paths for termites to invade. These termite highways should be checked carefully for mud tubes.

Tools

The tools of inspection are a flashlight, awl or ice pick, small hammer, moisture meter, hacksaw blade, measuring tape, and electronic stethoscope or other sound-listening device. In addition, an inspector needs coveralls, knee pads and bump hat to safely get into tight areas under the structure and graph paper to diagram termite entry points and damage. A stepladder is needed to gain access to the attic and to high areas of the exterior.

THE INSPECTION

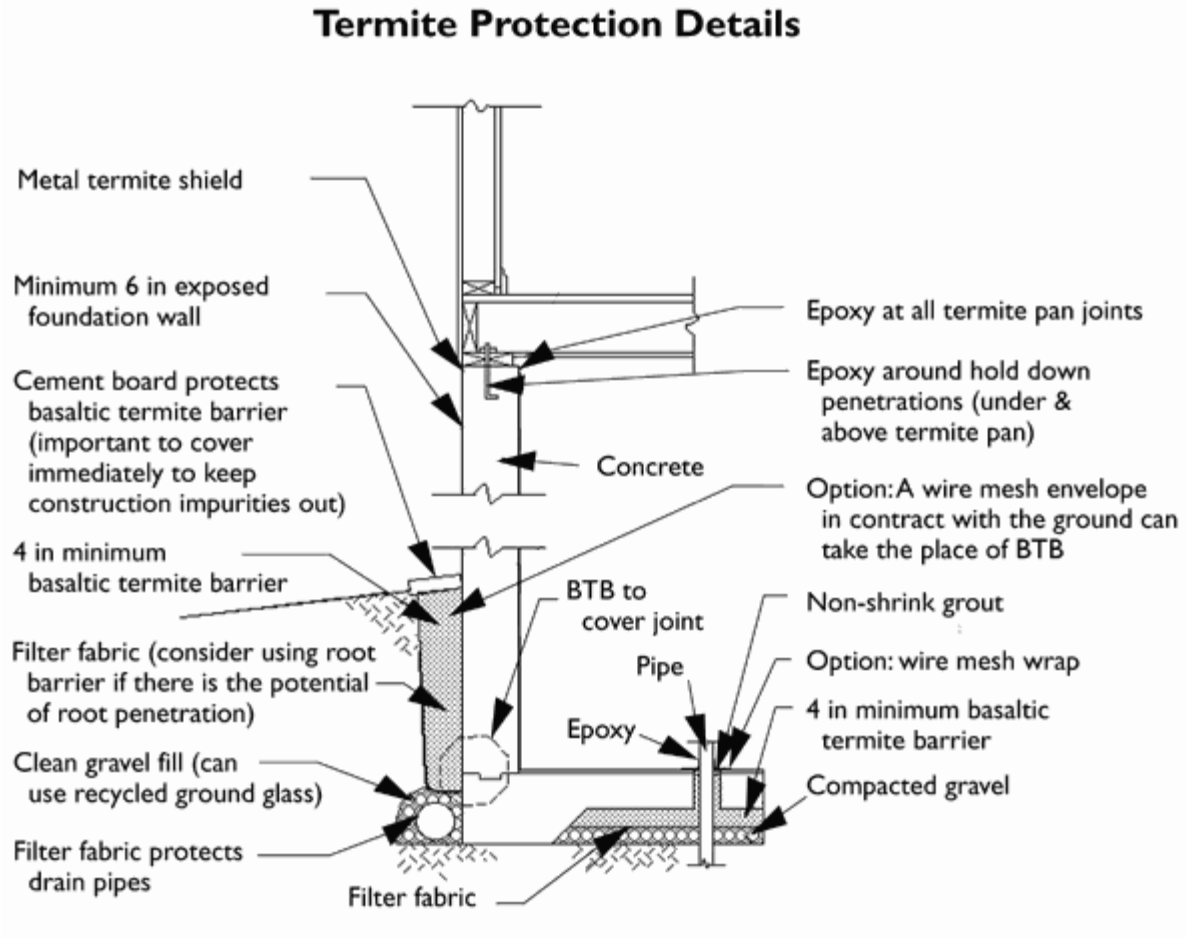
Before starting the inspection, always interview the occupants. Often they have some knowledge of previous termite problems, where moisture occurs, and possible hidden joints or voids. Next, size up the exterior of the structure and draw a diagram on graph paper, noting dimensions, grading, drainage, garages, decks, any structural wood in contact with soil, and location of wood piles. The graph also should account for hidden joints, voids in porches, and moisture-laden areas.

Note any exterior wood that shows excessive moisture or decay. Inspect the interior areas adjacent to this decay for further evidence of damage or infestation. Also, observe any possible roof leaks either under the shingles, around chimneys, or toward the structure after exiting downspouts. Blistered paint, insect or woodpecker attack areas, and evidence of insect exit holes, feces, or sawdust are additional points of concern. Outside, in areas where there are planters or earth-filled porches, use a hacksaw blade to insert under window and door sills. The blade should not penetrate beyond the sills or headers. Note any areas where the outside grade is higher than the top of the foundation or slab. This “faulty grade” condition will allow direct access for termites to the wall studs and will contribute to excessive moisture and decay.

In the interior, examine every room systematically. Look for possible signs of decay, damage, and moisture in all wooden structures. For example, if there is a drip or leak under the sink, fill up the sink and examine underneath after it empties to see if water appears at the bottom of the cabinet. If water is leaking from any area, "sound" (tap and listen for a hollow sound) the nearby wood with a hammer, then look for possible mud tubes in adjacent areas. In walking through a structure, notice whether or not floors seem to sag or buckle in places. Sagging members may indicate termite damage. Similarly, water stains, buckling paint, or bulging plaster are indicative of moisture-laden areas which bear further scrutiny. Stained walls may occur where subterranean termites have been depositing mud on inside surfaces of walls. Sound baseboards as well since these are primary areas of attack. Examine cracks occurring around door or window frames since these may be portals of entry.

Inspect bathrooms carefully. Pay particular attention to shower pans and shower or bathtub enclosures as these areas often leak, causing decay and contributing to dry rot and termite infestation. Toilet leaks are common at the point of contact with the floor. Decay or rot is also common at the floor area around the toilet.

In the basement, carefully examine areas around the base of stairs and support posts which may extend through the floor slab. Also, examine the floor joists at the juncture of basement wall for signs of sawdust, feces and spider webs. Probing suspect timbers with an ice pick or sounding, using a small ball peen hammer, may yield a positive finding. Inspect plumbing accesses throughout the structure, as these often will reveal frass, mud tubes, or feces if termites are present. Carefully inspect the underside of stall showers and toilets for leakage, dry rot or termite infestation. Stall showers should be water tested for 15 minutes and inspected for leakage from the basement or substructure if these areas are accessible.



In slab-on-grade construction, look carefully at the expansion joints when these joints are visible for inspection. Occasionally subterranean termite infestations will extend into moist attic areas. Inspect bracing and rafters carefully for evidence of damage or mud tubes. Note any inaccessible areas in the report. Pay particular attention to evidence of leaking water, especially around chimneys, vent pipes, and roof sheathing.

Carefully inspect every part of the crawlspace by using a flashlight, since it is a likely area for hidden termite mud tubes because of the proximity of ground and the first floor wood substructure. Also check the storage sheds and temporary buildings which usually give termites easy access to the structure, if attached or nearby. Pay close attention to areas in which infestation, damage, excessive moisture or faulty grade conditions were noticed from interior or exterior inspection. Signs of infestation or damage may also exist in the substructure. Inspect the areas adjacent to earth-filled porches for evidence of subterranean termites entering from the earth fill. Finally, review carefully any unseen areas and voids, and record such data on the inspection diagram.

Regardless of the type of termite infestation, it is imperative to describe as thoroughly as possible the origin of infestation as well as its extent. In addition to the diagram, a descriptive report must be prepared for future reference, whether or not there is an actual infestation. A list of areas to inspect when performing a termite inspection can be found at the end of this chapter.

PREVENTIVE MEASURES

The implementation of preventive measures discussed in this section can minimize costly repairs of termite damage.

Subterranean Termites

Subterranean termites cannot thrive without ample moisture in the wood of structures, in the adjoining soil, or both. Therefore, repairing defects and correcting patterns that allow water or excess moisture into any part of the structure, will help minimize termite damage. For example, if the ground slopes toward a structure, it should be regraded to redirect the runoff. It is also necessary to ensure that the water from roof, downspouts, porches, driveways, patios, and slabs runs away from the structure, and that leaky drains, baths, toilets, and plumbing are repaired inside the building. If crawl spaces have no ventilation, installation of vents will prevent moisture accumulation. Gutters should be clear of debris so that water does not pour over the top during rainstorms. Roof flashing must not allow water to flow under the membranes and shingles. Flashing around chimneys and vents should be tight and sealed so that water cannot run down into the structure. Tree branches which are moist and close to the structure should be cut back.

It is also necessary to remove wood debris from under the building or near the foundation, firewood that is closer than three feet to the building, and wooden planters next to the building. Modify untreated wooden structural members so that they are more than 18 inches away from the soil. This may involve regrading if siding or joists are too close to the soil, or installing metal termite shields or a concrete barrier beneath the wood. If decay is evident but slight, treat unpainted wood with a suitable wood preservative such as BoraCare or TimBor. Treat exposed untreated wood. Replace supporting posts, stairs, and fences made of untreated wood with pressure-treated wood. Caulk areas where moisture can enter around windows, door frames, or sills. Remove bark or wood chip mulches next to the structure and replace with decorative rock mulch.

Foam insulation has become a concern in recent years since termites, while not digesting foam, easily tunnel through it to reach wood. Where foam insulation is in close contact with the ground, it might mask termite tunnels and hide structural damage. Therefore, it is essential to ensure that it does not extend closer than 18 inches from the soil. Even with this precaution, most termite-control companies will not guarantee against termite infestation if a building has foam insulation, because of the high risk of non-detection.

LOW RISK MANAGEMENT METHODS

Termi-Barrier: An innovative, non-toxic treatment, first suggested by Dr. Walter Ebeling in 1957, has been in use by Live Oak Structural, Inc. since 1989 in the San Francisco Bay area to prevent subterranean termites from entering structures. The "Termi-Barrier" is a layer of untreated sand that the termites cannot penetrate because the small particles are too big for the termite to grasp and move with its mandibles, yet the largest particles are not big enough to allow the termites to crawl between. The sand particles, ranging in size from .1 to .06 inch, form a barrier that prevents termite penetration; however, particles larger or smaller than the narrow size range may allow termites to tunnel through. Sand barriers can be installed before concrete slabs are poured over them, or in crawl spaces around the foundation perimeter and under pier foundations.

The sand is placed 3 to 6 inches deep next to foundation walls and tapered down to 1 inch deep over a 20 inch or more lateral distance from the wall. Occasionally the entire crawl space must be covered if termite activity is intense. Barriers outside the foundation must be capped with concrete

or

asphalt to prevent movement away from the wall by rain or other means. Periodic inspection of the integrity of the barrier is an integral part of this approach.

Termite Shields: Sheet-metal strips called termite shields have been installed historically during construction, ostensibly to prevent hidden termite entry through masonry walls. In actuality, termite shields are seldom properly installed, and once installed are rarely maintained. They are intended to force termites to build mud tubes over the metal so that they may be observed and treated. However, they are easily damaged and may hide termite activity if frequent observations are not made on the inside, as well as the outside, of the masonry wall. In this situation, termite entry is unimpeded.

Steel Mesh: A stainless steel mesh barrier, developed by Termi-Mesh, Ltd., is commercially available in the U.S. for installation during construction. Termi-mesh can also be installed post-construction in certain situations.

Diatomaceous Earth: Diatomaceous earth (DE) can be used as a termite barrier by applying it in strategic places. Natural DE is sold under the brand name Perma-Guard, which is available with or without pyrethrins.

THE FUTURE

Termites have been an economic burden to owners of homes and other structures that contain wood, paper or cellulose products for many years. A great deal of research has been, and is being conducted, to develop better and safer means to manage this costly structural pest.

The Sentricon System is now available by DowElanco to selected companies in the commercial pest control industry. Since 1988, Dr. Nan-Yao Su has worked on developing the method, which utilizes a monitoring system for subterranean termites and the biology and behavior of the termite to achieve management. According to Dr. Su, if no termites, keep monitoring. If termites show up in the monitoring device, then a bait tube is provided for the termites in a recruiting chamber. The bait material contains a chitin inhibitor (the juvenile growth hormones hexaflumuron or noviflumeron), which is passed throughout the colony by the termites' normal recruiting and feeding behavior, and eventually leads to the demise of the colony.

Beneficial nematodes have been marketed for subterranean termite control with mixed results. When research with nematodes yields consistently effective results for most sites and soil conditions, it will be considered a "low risk" method.

CHEMICAL PREVENTIVE BARRIERS

When deemed necessary, pesticide applications shall be performed by licensed applicators only. Applications shall be made according to the National Park Service Integrated Pest Management policy and procedures guidelines, according to pesticide label directions, and following applicable laws and regulations.

Since few buildings are termite-proof, a preventive chemical-barrier treatment around buildings located in high risk infestation areas is a traditional precaution. Preconstruction treatment of structural wood can be accomplished with a dip-diffusion method, with a 10% disodium octaborate tetrahydrate solution. Such "TimBorized" lumber is available in some areas commercially. Additionally, sodium borate solutions can be applied to exposed structural wood during construction ("dry in" stage) or after construction is completed, which is also suitable for all wood that is not in contact with the ground and not exposed to rain. Applications can be made to wood in attics, walls,

around windows, floors and sub floors, joists, and sill plates.

Sodium borate solutions penetrate into the wood, treating more than just the surface, and protect and preserve the wood permanently. Sodium borate functions as a slow-acting stomach poison in insects and decay fungi. Termites accumulate the active ingredients while they feed. These slow-acting poisons allow the termites to move throughout the colony to spread the insecticide by the feeding of nymphs, soldiers, and reproductives. Sodium borate solutions can be brushed or sprayed onto bare wood or drilled and pressure treated into known infestations.

A soil pre-treatment performed during construction usually provides an effective barrier for a specified time. The principle is to provide a pesticide barrier in the soil that will be in contact with the foundation and slab. Apply termiticide according to the label at the recommended rate. Before pouring concrete pads, a moisture barrier of polyethylene sheeting should be in place.

Soil treatment termiticides shall be applied in strict accordance with the recommended rates of the manufacturer which are shown on the container label.

Post-Construction Treatments for Subterranean Termites

If a structure has had termites in the past, or if there are conditions conducive to termites (evidence of infested wood around the foundation along with cracks in the foundation or porch voids), it is reasonable to assume that a chemical barrier is necessary to protect against future infestation. When an infestation occurs, the *entire* barrier requires re-establishment. Treating just the area of infestation often fails to prevent termite entry, and results in costly callbacks.

Unpainted or unsealed termite-infested wood can be remedied by painting (brushing) or spraying sodium borate solution on it. At the same time, eliminate moisture problems that may have led to and sustained the moisture needs of the colony. Wood with known infestations or galleries should be drilled and pressure-injected wherever possible.

Slab construction requires that pesticide not only provide a barrier around the outside, but also underneath the slab so that any possible cracks are protected.

If the infested areas are mainly structural, extensive, and inaccessible, fumigation may be selected. This is an expensive and highly technical procedure that should be undertaken only by licensed fumigators. It, however, offers no protection against future infestations. The basic procedure is to wrap the entire building in gas-tight tarps made of nylon, rubber, neoprene, or plastic. Seams between sheets of the tarps are rolled together and joined with metal clamps or heat-sealed. The bottoms of the tarps are anchored to the ground with "sand snakes" (sand in bags). It is essential that the entire structure is airtight for fumigation, so careful attention to each detail is necessary. The building is fumigated with sulfuryl fluoride, or other registered fumigant. Fumigation exposure with sulfuryl fluoride is usually a 24-hour process. Additional time will be required for the aeration process.

In some states, the aeration period for Vikane (sulfuryl fluoride) gas is 24 hours. After the aeration period, the structure is reopened and the fumigator measures gas residues with a fumiscope. When the structure contains less than 5 ppm of Vikane, the fumigator can certify the structure for reoccupancy. Warning signs must be posted and maintained from the time the fumigant is introduced until the fumigator clears the building, prohibiting entrance into the building treated. During the fumigation and aeration process, secondary locks remain on the structure to guard against access until the building is safe to occupy.

Infested, stand-alone items such as furniture, construction timbers, or crates can be treated in a

fumigation chamber or with heat in similar fashion as buildings.

AREAS TO INSPECT WHEN PERFORMING A TERMITE INSPECTION

Substructure
- Foundations
- Porches
- Sub floor
- Plumbing
- Pier posts, pier pads
- Heating ducts (high humidity)
- Mudsill, floor joists and header joists
- Ventilation
- Shower drains and sub floor adjacent to the shower
- Toilet drains and sub floor adjacent to the toilet
- Inaccessible areas

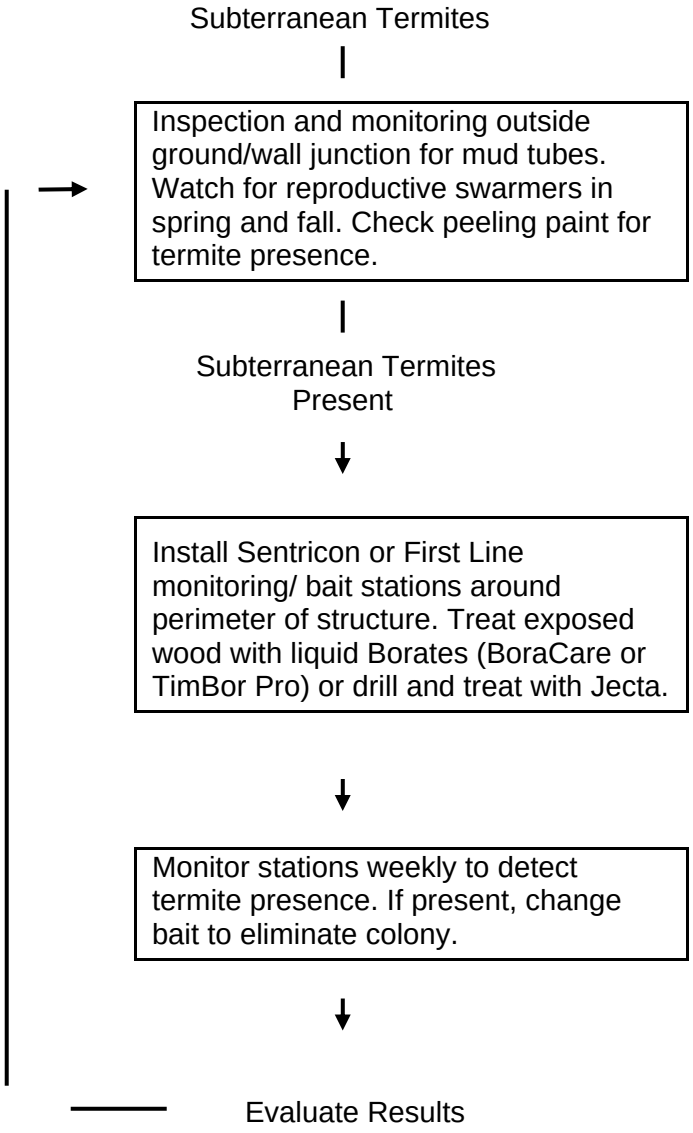
Exterior
- Foundations
- Porches
- Patios
- Eaves, fascia boards and rafter tails
- Exterior grade level
- Drainage
- Ventilation
- Exterior siding
- Exterior stucco
- Columns and abutments
- Attached fences, sheds, wood decks
- Visually inspect the roof
- Window sills
- Porte cochere
- Carports

Interior
- Baseboards
- Window ledges, sills and frames
- Floors
- Paneling, plaster board and other wall covering
- Ceilings
- Cabinets
- Plumbing fixtures
- Shower and bath tub enclosures
- Toilet areas
- Fireplace
- Door jambs
- Hollow doors
- Door sills, thresholds
- Inaccessible areas

Attic
- All framing (joists, rafters and sheathing)
- Ventilation
- Heating and air conditioning system

Roof / Inaccessible areas

TERMITES


Subterranean Termites
Inspection and monitoring outside ground/wall junction for mud tubes. Watch for reproductive swarmers in spring and fall. Check peeling paint for termite presence.
Subterranean Termites Present
Install Sentricon or First Line monitoring/ bait stations around perimeter of structure. Treat exposed wood with liquid Borates (BoraCare or TimBor Pro) or drill and treat with Jecta.
Monitor stations weekly to detect termite presence. If present, change bait to eliminate colony.
Evaluate Results

ARABIAN / MEDITERRANEAN GRASS *Schismus arabicus* Nees

Schismus arabicus

Schismus arabicus Nees and *S. barbatus* (L.) were introduced from western Asia and Europe. They prefer sandy soil at 1,000 to 4,000 feet in elevation in the open desert. These are low-growing annual grasses with narrow, inrolled blades with fine marginal hairs at the orifice.

S. arabicus is not very shade tolerant and becomes abundant in open areas and between widely spaced shrubs. This grass is green when young, turning purplish as it ages.

The seeds are very small (dust like) and disperse into small cracks and depressions in the soil. A small fraction of the seeds germinate in a given year, leaving most seeds as a reserve for future years.

The seeds germinate in early winter following a light rain (0.4 inches). Growth is slow over winter until spring rains and higher temperatures accelerate growth from seedling to flowering in a few weeks.

Schismus barbatus

Hand pulling of the grass is difficult due to its small size and extensive root mats. Glyphosate or other herbicides can reduce the population if carefully and thoroughly applied.

BARNYARDGRASS *Echinochloa crus-galli* (L.) Beauv.

Barnyardgrass was introduced from Europe and has become widespread throughout the west, especially in irrigated crops and gardens, and other cultivated areas. It is a vigorous, warm season annual grass growing up to five feet high with many stems that are reddish to dark purple.

Leaf blades are flat, 5/8 inch wide and smooth. Seed heads are crowded in large spikelets with a short, stiff spike. Barnyardgrass grows up to 7000 feet in elevation, in moist ground and along ditches and waste spaces.

Hand pull in the spring before seed heads form, or treat with Glyphosate which translocates into the fibrous root system.

BERMUDAGRASS *Cynodon dactylon* (L.)

Bermudagrass is a wiry, perennial with long, slender, creeping rhizomes. Leaves are smooth with a leaf sheath at each node. Stems in contact with soil will root at the nodes. Upright flowering stems have a group of 3 to 7 spike-like branches, each 1 to 2 inches long containing seeds.

Bermudagrass was introduced from Africa and is widely established in the southwest in lawns. Above-ground (stolens) and below-ground (rhizomes) stems are capable of rooting in the soil. Management of Bermudagrass (elimination) may be difficult. Removing a source of water during the hot summer months will dry out the stolens and rhizomes and reduce its vigor.

Mulches of black plastic or geo-textile cloth in summer can be effective in managing Bermudagrass if all light is excluded. However, this may take some time. The use of a grass-selective herbicide applied in the early spring when new grass is less than 6 inches long can help. Repeat treatments may be necessary. Non-selective herbicides such as Glyphosate kill plants by translocating down into the root system as well as killing the top growth.

BUFFELGRASS *Pennisetum ciliare* (L.) Link

This perennial grass was introduced from India and differs from *P. setaceum* in that it has shorter, denser paniches and shorter bristles. This warm season bunchgrass can form dense thickets utilizing rhizomes and seeds.

Stalks emerge up to 40 inches high with cylinder-like spikes which have numerous bristles and are clustered into burrs.

Leaf blades are bluish-green, two to twelve inches long and 3/8 inch wide. This plant responds to fire with new sprouts immediately afterwards. It prefers desert, grasslands and riparian areas up to about 4100 feet in elevation.

Hand pull early in the spring or treat with Glyphosate that translocates into the root rhizomes.

CRIMSON FOUNTAIN GRASS *Pennisetum setaceum* (Forsk.) Chior.

This perennial grass is tall with tufted stems and narrow elongated blades up to 30 inches high. It is found up to 4,500 foot elevation in disturbed soil and along roadsides.

It has been cultivated as an ornamental under the name “Fountain Grass.” It is a native of Ethiopia.

This plant can easily become a fire hazard. Hand pull while young before inflorescence is formed.

DOWNY BROME *Bromus tectorum* L.

Downy Brome, also called Cheatgrass, is an annual or winter annual that grows to 30 inches tall. Leaf sheaths and flat blades are covered with soft hair.

Downy Brome was introduced from the Mediterranean region and first found near Denver, Colorado. It has become widely distributed throughout North America.

The plant is found along roadsides, waste areas, misused pastures and rangeland. It competes with perennial grasses for moisture due to its winter and early spring growth. When mature, it becomes a nuisance and a fire hazard.

Hand pull before inflorescence is formed in the spring.

JOHNSONGRASS *Sorghum halepense* (L.)

Johnsongrass is a vigorous perennial grass that spreads by seed or by creeping robust, fleshy rhizomes. The erect stems grow two to eight feet tall. Leaf blades are flat about one inch wide with a midvein.

Johnsongrass was introduced from the Mediterranean area as a hay or forage crop. It forms hydrocyanic acid with moisture stress or frost, so is toxic to livestock.

Johnsongrass is throughout Arizona up to 6,000 feet elevation, found in waste places, fields and along irrigation ditches. It flowers from April to November. Rhizomes may be several feet in length when mature.

Hand pull when young. For older, established Johnsongrass, use an herbicide that will translocate to the rhizomes.

LITTLESEED CANARYGRASS *Phalaris minor* Retz.

This plant is a winter annual about 6 inches to 3 feet tall, with bluish-green foliage.

Leaves are ¼ to ½ inch wide and 10 to 18 inches long. The flower head is 1 to 3 inches long in April and May.

It is native to the Mediterranean, Africa and Asia, and is found in Arizona and California in barley and winter wheat fields. It is an exotic, invasive weed first found near Tucson in 1913.

It is used as fodder or forage for livestock and birdseed; however, it is poisonous to some mammals.

Pull this weed in March before flowering.

RED BROME *Bromus rubens*

Red Brome is an annual, cool season bunch grass that spreads by tillers from the base.

B. rubens, also known as Foxtail Brome, is an introduced weed from Europe found along roadsides and waste spaces.

This plant is good forage when young; however, older grasses cause mouth injuries. This brome grows eight to 20 inches with flat blades with dense hairs.

Hand pull in early spring or use Glyphosate which translocates to the shallow root system.

WILD OATS *Avena fatua* L.

Wild oat is an annual, one to four feet tall with erect hollow stems and leaf blades 1/8 to 5/8 inch wide.

Wild oat is native to Europe, but has become common along roadsides, pastures and waste areas throughout the western United States. Seed can remain dormant in the soil for as long as ten years.

Flowering and seed production occur from June to August. The long-awned fruit are injurious to the mouths of animals that eat them. Seedling leaves twist counter-clockwise.

Hand pull before flowing begins.

AFRICAN / SAHARA MUSTARD *Brassica tournefortii* Gouan

Sahara Mustard was first known in California in the 1920s. It has since spread east through the Mojave and Sonoran deserts, and into the Colorado Plateau, mainly along roadsides. Established populations can move into areas of sandy soils, but also silty, rocky soils on hilltops during years of high rainfall.

Seed dispersal can be by herbivores or by wet seeds attaching to vehicles. The mustard plant uprooted or broken off and moved by wind will also scatter seed.

This plant is an annual herb with stems four to 40 inches tall, depending on soil moisture. The leaves can form a rosette up to one meter across. The plants bloom early and monopolize soil moisture as it builds canopy and produces seed before native plants begin to flower. It is somewhat drought resistant and may increase fuel load and fire hazard in some environments.

Hand pull before seed is produced. Herbicide use along roadsides may be necessary to slow its expansion.

BARBWIRE RUSSIAN THISTLE *Salsola paulsenii* Litv.

Barbwire Russian Thistle is a bushy annual about three feet tall when mature. The main stem is usually shorter than the lateral branches. Branches seldom have purple or white striations. Leaves are thread-like, rigid with spiny tips.

Hand pull when young or use Glyphosate before dry.

CARRIZO CREEK GLOBE MALLOW *Sphaeralcea orcuttii* Rose

S. orcuttii is a dicot, annual or perennial herb that is native to California. It is also found elsewhere in western North America.

It may be abundant along roadsides and in fields, usually in sandy soils.

Carrizo Creek globe mallow flowers mainly in spring – March to May.

It is a member of the family *Malvaceae*, which includes cotton (*Gossypium*) and some ornamental plants such as some species of *Hybiscus.*

Hand pull in early spring before flowering.

CHEESEWEED MALLOW *Malva parviflora* L.
COMMON MALLOW *Malva neglecta* Wallr.

M. parviflora and *M. neglecta* are members of the Mallow family and are annual, winter annual or biennial.

These plants are generally low spreading with branches 2 to 20 inches long.

These species were introduced from Europe and are common in waste areas, gardens and cultivated land.

Lavender flowers form in early spring and round, button-like fruit are formed in mid-summer. The seed and plant parts are poisonous if swallowed. These plants need full sun and are drought tolerant.

Hand pull in the spring before fruit is formed.

COULTER'S GLOBE MALLOW *Sphaeralcea coulteri* (Wats.)

This plant is an annual or biennial with leaves shallowly lobed and orange flower petals. The plants are grayish pubescent with thin and soft leaves.

Flowers bud out from January to May. Coulter's globe mallow grows in southern Arizona at an elevation of 2,500 feet and lower, along roadsides, fields and mesas, usually in sandy soil.

This plant should be pulled in early spring before seeding.

GOLDEN CROWNBEARD *Verbesina encelioides* (Cav.)

This plant is a member of the sunflower family. It flowers in July, August and September.

It is found in open disturbed sites, waste areas, cow pens and roadsides, preferring sandy soils.

It is an annual or perennial herb.

Hand pull in the spring before flowering.

HOARY BOWLESIA *Bowlesia incana*

Bowlesia is a species of flowering plant in the parsley family.

It is native to South America and the southeastern and southwestern United States.

This native plant grows in many types of habitat and does well in both sun and shade.

It is a small, annual herb growing thin, spreading stems less than 2 feet long. The leaves are borne on long petioles and have multi-lobed, rounded or kidney-shaped blades less than 1 ¼ inches wide.

The green herbage of this plant is coated in fine, white hairs. The inflorescence of yellow-green flowers appear in the leaf axils. The tiny, inflated fruit are only 1/8 inch wide.

Hand pull in the spring before flowers form or use Glyphosate.

MALTESE STARTHISTLE *Centaurea melitensis* L.

Maltese Starthistle was introduced from Europe and is usually found along roadsides and waste areas. When eaten, this plant may cause “Chewing Disease” in horses.

Yellow flowers on the ends of the branches have sharp thorns. Basal leaves are lobed with a short stalk, whereas stem leaves are lance-shaped and are attached to the stem.

Seedlings appear in early spring and flowers from June into September. Seeds are small.

Maltese Starthistle is found below 4,000 feet in elevation.

Hand pull in early spring or use Glyphosate just before bloom.

NETTLE-LEAF GOOSEFOOT *Chenopodium murale* L.

This plant is a bushy annual 1 to 3 feet high with erect stems. The leaves are 1 to 2 inches long with a pointed tip. Small, greenish flowers are in terminal spike-like panicles and flowers throughout the year.

It is widely distributed in the United States, but is native to Europe. It is found in southern Arizona at elevations from 150 to 8,000 feet in elevation in waste areas and cultivated fields.

Early civilizations throughout the Americas relied on the vitamin and minerals packed within the leaves which were harvested for greens. The leaves and seeds contain saponins which are toxic; however, they were used in streams to kill fish for food.

This annual flowers from July to October and is pollinated by wind. It prefers sandy to clay soils, and does not grow well in shade. Remove this plant before flowers are formed.

REDSTEM FILAREE *Erodium cicutarium* (L.)

Redstem Filaree is a native of Europe or Asia and is found on every continent. It is a winter annual or biennial with stems one inch to two feet long, spreading from a rosette.

The leaves are divided into narrow feather-like lobed segments, and both leaves and stems are hairy.

Purplish-pink flowers are in clusters of two or more. The fruit is five lobed and long-beaked, which break away when mature. When dry, the wiry “beak” is tightly twisted; when wet, it uncoils driving the seed into the soil.

Redstem Filaree is also called Stork’s Bill.

Hand pull in late winter or early spring before flowers form or use Glyphosate.

RUSSIAN THISTLE *Salsola tragus* Sennen

Russian Thistle is a rounded bushy annual, one half to three feet tall, which scatters its seed. The mature plant dries and separates from the root on windy days, tumbling along, scattering the seeds – thus the name “tumbling tumble weeds.”

Fast germination and establishment of seedlings occurs with little precipitation. This exotic invasive weed was introduced from Russia in the late 1880s and has become established in the drier portions of the United States, especially the west.

Stems are usually red or purple striped with long, stringy leaves early with later leaves short and tipped with a spine.

Hand pull early before flower forms, or later before drying treat with Glyphosate.

SALTCEDAR *Tamarix ramosissima*

Saltcedar is a deciduous or evergreen shrub to relatively large tree, five to 20 – 30 feet tall. The bark on saplings and stems is reddish-brown and leaves are very small and scale-like on many branched stems.

Small flowers are pink to white.

Saltcedar was introduced from Eurasia and has become widespread. It takes up large quantities of water through evapo-transpiration through the many tiny leaves.

Few plants can grow beneath Saltcedar due to dense shade and salty soil from mature trees. The wood is dense and makes good firewood when dried.

Pull with a weed wrench when young or cut with a chain saw when mature.

SLENDER RUSSIAN THISTLE *Salsola collina*

Slender Russian Thistle is a bushy summer annual up to three feet tall. The stems are green with white striations. The leaves are needle-like and pliable with a bristle at the end.

Plants dry when mature and break off at the ground with windy weather, dispersing seeds as they tumble along until stopped by a fence or other object.

Hand –pull in the spring when plants are soft and pliable. Before drying occurs, Glyphosate can kill the weed.

SPINY SOWTHISTLE *Sonchus asper* (L.) Hill

Spiny sowthistle is a stout annual with stems 1 to 5 feet in height. Leaves and stems have a milky juice inside. Lower leaves are lobed and toothed with the margins very spiny. Upper leaves on the stem have sharp, stiff prickles and basal lobes clasping the stem.

Flowers are yellow petals, 3/4 to 1 inch in diameter, which occur in clusters at the ends of the stems. A white feathery puffball is formed which is attached to the seeds to spread them with the wind.

The spiny sowthistle has a tap root which may make it difficult to pull out. This plant is found in southern Arizona at elevations from 150 to 8,000 feet, along roadsides and waste ground.

This is an abundant weed found throughout North America, naturalized from Europe. Remove it using a weed wrench.

TREE TOBACCO *Nicotiana glauca*

Tree tobacco is an annual, biannual or short-lived perennial shrub or tree. It grows in Arizona and New Mexico in disturbed soils, vacant lots, along trails and roadsides, in flood plains and along washes and drainages.

As a small tree from 6 to 20 feet tall, it has oval to lance-shaped leaves up to 7 inches long. Flowers are yellow, white, greenish or red trumpet-shaped, about 1 ½ to 3 inches long, showing from March to November.

Most parts of the plant are toxic, and although related to tobacco, it has the active ingredient *anabasine*, an alkaloid. Death can occur due to respiratory paralysis.

Use a weed wrench to remove this plant.

WESTERN TANSYMUSTARD *Descurainia pinnata brachycarpa* (Walt.) Britton

Tansymustard is a biannual or annual plant 6 inches to 2 feet tall and is branched and erect. Young plants are a rosette of basal leaves 4 to 8 inches across.

In the spring (April to July), a flowering stalk develops with alternate leaves with a fern-like appearance. Upper stems have racemes of flowers 2 to 12 inches long. Small yellow flowers bloom in whorls at the end of the racenes, and seed pods (siliques) develop below. The siliques contain 1 to 20 small seeds in two rows.

Tansymustard is usually found in full sun and tolerates dry conditions in sandy or gravelly sterile soil. It grows in waste lands, roadsides, fields and other disturbed sites up to 7,000 feet in Arizona.

Hand pull in early spring before flowering or use a weed wrench to remove the plant when mature.

YELLOW SWEETCLOVER *Melilotus officinalis* (L.) Lam.
WHITE SWEETCLOVER *Melilotus alba* Medic.

M. officinalis

Yellow Sweetclover is an annual or biennial legume, growing two to six feet tall. The trifoliate leaves are serrated back from the tip more than half way. The flowers are small, yellow fading to cream color, arranged in a many flowered terminal and axillary racemes. Seed pods are cross ribbed.

White Sweetclover has white flowers and net veined seed pods, and has similar growth patterns to Yellow Sweetclover.

M. alba

These exotic invasive plants were introduced from Europe and Asia for disturbed site soil stabilization. Their high content of coumarin causes anticoagulation of the blood, and often causes bloat in cattle. The sweetclovers are found along roadsides, waste areas and other disturbed sites.

Flowers are formed in late summer into fall. The plants prefer dry alkaline soils and do not grow well in shade. Hand pull in the spring before flowers are formed.

SAFETY

PESTICIDE SAFETY

Pesticides are insecticides, herbicides, fungicides, rodenticides, disinfectants and other chemicals used to control, prevent, destroy, repel or regulate pests. Pesticides have an EPA registration number on the label. This includes personal repellant products. As poisons, they can affect living organisms and usually may have adverse effects on other nontarget plants or animals, including humans. Because of their biological activity, pesticides can injure (or kill) adults, children, pets, livestock, wild animals, insects, birds, fish and plants. Pesticides must be carefully stored, handled and used to avoid exposure to nontargets.

Certification

Any person (staff or contractor) who is involved in handling or applying pesticides should be trained in proper procedures. Protective equipment must be worn by the person handling, loading, mixing or applying any pesticide. Pesticides will only be applied by personnel who are properly trained and are supervised by a certified applicator or who are certified themselves. In Arizona, certified applicators must receive training, pass a test and attend periodic updating continuing education workshops or training to keep their certification current. The IPM Coordinator should be a state certified pesticide applicator.

Pesticide Information

Pesticide labels contain information on precautions for the safety of the pesticide applicator and cautions to be taken to protect or reduce exposure to other workers and/or visitors. The label is the law. Violating the label directions is a violation of FIFRA. Chemical (pesticide) labels on containers must not be removed or defaced. OSHA Hazard Communication Standard requires workers be trained and provided appropriate protective equipment and information (MSDS) on any hazardous material they might handle. Treated areas will be posted to provide the public (staff and visitors) with information on the pesticide used, the area treated, and the safe re-entry time (5 half lives). Keep an inventory of all pesticides used or stored on site; copies of labels and MSDS should be stored with the products and also with the IPM Coordinator and the Safety Officer.

Pesticide Storage

The pesticide storage facility should contain copies of labels, MSDS and inventory information. The pesticide storage structure must be properly posted with warning signs and securely locked. The structure must be fireproof and ventilated to the outside. Other materials such as cleaning fluids, paint, solvent, fuel oil, gasoline, kerosene or other chemicals should not be placed or stored in the pesticide storage structure because of the increased risk of fire or explosion. Different types of pesticides will be stored on separate shelves or compartments. The local Fire Department will be made aware of the storage location(s) and the types of pesticides stored so that a fire emergency plan is prepared.

Pesticide Disposal

The pesticide label has directions for procedures to follow to dispose of pesticide containers, pesticide and equipment rinsates. U.S. EPA and state regulations also address the disposal of hazardous substances. Limit the amount of material that needs to be disposed by:

- Purchasing only the amount needed for each treatment
- NPS policy limits the quantity of pesticide that can be purchased
- Mixing only the amount needed for the treatment
- Apply remaining mixed pesticide to the treated area according to label instructions
- Upon completion, triple rinse the spray equipment and apply the rinsate to the treated area (follow the label directions)
- Use single dose syringe applicator to apply gel baits
- Use containerized aerosol pesticides which can be reused until empty
- Use dust or granular pesticides that can be returned to the original container, if necessary, for storage

Excess unopened product can be considered to be “surplus property” and transferred to another agency in accordance with federal and state laws and regulations. Retain records of all donations of surplus pesticides.

Training

The IPM Coordinator has attended the NPS IPM course, or can be scheduled to take the course as soon as possible. Other key staff that has responsibilities related to pest management may also attend (maintenance, natural resources, and supervisors). Pesticide applicators must take state certification classes and attend periodic updates. College or university courses on pesticide toxicology, wildlife management, botany, entomology and other life sciences can be useful.

The Resource Management staff will complete the basic NPS curatorial training course and, if possible, the NPS 40-hour IPM training course. The Resource Manager may also maintain state pesticide applicator certification. Staff performing inspections or monitoring should receive at least eight hours of documented IPM training that includes methods of inspecting structures. Staff involved in rodent management should receive at least 16 hours of instruction including inspection and monitoring techniques, disease prevention, rodent management methods, sanitation, safety; tuning, setting and recovery of snap traps; rodenticide use processes and risks. Staff required to manage stinging insects (hornets, honey bees, yellow jackets) will receive at least four hours of training including protective equipment, insect and colony removal procedures, bystander management and emergency first aid. The IPM Coordinator will maintain copies of all staff IPM training documents.

Notification

Areas on the Monument (structures, grounds, etc.) that are scheduled to be treated with any pesticide should be posted at least 24 hours prior to the treatment with warning information (target pest, pesticide to be used, signal word, date of treatment, area of treatment, re-entry date, information phone number). The posted notice should be of a material that will not deteriorate in weather, and should be removed on the re-entry date. The local fire, police and EMS units should also be made aware of the treatment information. Members of the staff and local neighbors who are known to suffer from environmental illness (EI) or multiple chemical sensitivity (MCS) must also be notified at least 48 hours before the treatment so they can leave the area or protect themselves. Please refer to the Pesticide Treated Area Posting Form at the end of this section.

Spills

Pesticide spills need more detailed attention than spills of other materials. The spilled pesticide may also present a long-term hazard at the spill site and to responding or present personnel. If a pesticide spill has occurred, immediate procedures must be taken. The first action is to protect yourself: put on protective clothing, gloves, boots, tyvek coveralls, goggles and respirator. The second action is to isolate the area: do not allow unauthorized and unprotected personnel into the area. Identify the material and determine the hazard. If an unprotected person is involved or has succumbed, perform the rescue and administer first aid, then decontaminate the victim. Contain the spill. For liquids or dusts, dike off the area, stop any leaks, and use absorbent material to soak up the spill. A small spill (one pint or less, or one-half pound or less) may be contained with absorbent cloths, sand, bagged clay, or diatomaceous earth. A larger spill may necessitate soil dikes, sand snakes, commercial bagged clay or other containment efforts. For large spills, the Fire Department or other emergency responders may be called. For large spills of highly toxic pesticides, CHEMTREC can be called for containment and cleanup information. CHEMTREC may call the Pesticide Safety Team Network (PSTN) if a large quantity of pesticide is involved. Removing and decontaminating the material may require special procedures. Exposed staff or other personnel may need to be taken to hospitals for examination and treatment. Additional tests may be necessary over time, depending upon the pesticide exposure. The lesson is to not have toxic pesticides on site, and, if at all possible, avoid spills. Develop procedures for handling pesticides to avoid spills.

Spill kits can be developed and placed at storage, mixing and application sites. The kit should have diking or absorbent material sufficient to contain the amount of pesticide that may be involved (storage areas may need more than mixing areas), protective clothing and equipment, and emergency phone numbers. Absorbent material can be bagged clay, activated charcoal, diatomaceous earth or other highly absorbent material. There are also absorbent pads now available for absorbing pesticides.

HUMAN HEALTH

Disease Concerns

Most arthropod, bird and mammal pests come into direct contact with soil, dead and rotting organic material, and other sources of disease organisms which may provide opportunity for transmission to humans. This potential adverse effect of disease transmission to humans (staff and visitors) is an important reason for an aggressive pest management program.

The advent of Hantavirus illness and death from exposure to rodent urine, feces and saliva poses a real concern for the presence of rodents in structures. Anyone involved in rodent management actions should be aware of the risks of exposure to the deadly Hantavirus, which may be present in rodent urine, feces and saliva. Minimal protection may be necessary when inspecting for rodent activity, monitoring or setting traps (dust mask, surgical gloves). Trapped rodents can be removed by placing a zip loc bag inside-out over your hand, grabbing the trap and captured (dead) rodent with the zip loc bag, then turning the bag right-side out over the trap and dead rodent, zipping the bag closed and placing it into another sealable bag for disposal. If a person is involved in cleaning rodent-infested, enclosed areas (inside a structure) or removing rodent urine, fecal droppings, nesting or other rodent debris, that person must wear approved protective equipment and follow Department of Health or CDC guidelines. Minimum protective equipment includes rubber gloves, goggles, coveralls, and a respirator with a HEPA filter. Other rodent-borne diseases associated with rodents are bubonic plague (flea transmitted), murine typhus, rat bite fever, hemorrhagic fever, and several others.

Other sources of human disease can be transmitted by ectoparasites on rodents, other mammals, birds and insects feeding on dead animals or other organic material. Allergies, asthma and other serious health effects can manifest from contact with exuviae, pheromones and cockroach and other insect body parts and droppings.

Wildlife Concerns

Mice often nest in, under and around structures, and are particularly fond of the cavities (and warmth) in stoves and other kitchen appliances and cupboards. Their gnawing (to keep their teeth worn down) on wiring and other electrical appliances has been the cause of many fires. Some migratory birds are implicated in harboring and transmitting Avian flu through contact with the fecal droppings.

Insect stings by ants, bees, wasps and yellow jackets can also be a concern for human safety, especially those who are sensitized to the stings. Managing these pests where there may be contact by visitors or staff is important. In some cases, notices to wear repellants may be necessary to attempt to ward off mosquitoes, black flies, ticks or other biting pests.

WARNING

PESTICIDE TREATED AREA

An application of a pesticide was deemed necessary to get control of pests that are invading this area.

This notice is ( ) a 24-hour Posting ( ) a 72-hour Posting
( ) an EMERGENCY Posting

Product Name: _____ Mfg. Name: _____

Active Ingredient: _____ US EPA Reg. No. _____

Target Pest: _____

Date of Application: _____

Date Sign May Be Removed: _____ (No less than 72 hours from application)

Signal Word: ( ) Danger ( ) Warning ( ) Caution

If you have questions regarding this notification or require additional information, you may contact the Casa Grande Ruins National Monument IPM Coordinator at 520-723-3172 x 36.

This information as well as other IPM-related records are maintained in the Monument IPM Coordinator's Office. You may review this information by contacting the IPM Coordinator or their designee.

SUPPLIES

Inspection Tools

Inspection Tools

- Flashlight and mirror
- Hand lens, 16x or better
- Probe for testing wood for rot
- Spatula for checking cracks and crevices
- Notebook and pen
- Digital camera
- Moisture meter
- UV light for detecting rodent urine stains
- GPS Unit. Used to collect data points that indicate the location of rodent damage at archeological sites.

Exclusion Materials

- **¼ in. hardware cloth** (stainless steel or galvanized). Used for excluding rodents, birds and larger pests
- **Stuf-Fit** (copper mesh – won't rust). Used for closing small holes, cracks, crevices and around pipes penetrating walls and ceilings. Easy to stuff into openings to prevent access by insects, rodents and other small pests. Compresses easily.
- **Stainless steel wool or scrubbies** (won't rust). Used for filling larger holes to prevent pest access. May be difficult to compress.
- **Dap Brand Caulk**. Many different sealants and fillers to cover cracks, crevices, small holes or openings filled with Stuf-Fit or stainless steel wool, and varied surfaces.
- **Door sweeps**. Metal framed with rubber or neoprene blade to prevent insects and mice from entering a structure under the door. Wooden thresholds may be installed on the floor below the door to close the gap if it is historic. Brush-type door sweeps do not exclude mice, large beetles or cockroaches.

Monitoring Materials

- **Unscented talc**. Used for tracking patches to determine runways of rats, mice or insects inside structures (non-toxic).
- **Lo-Line Crawling Insect Sticky Traps.** Used for monitoring and capturing crawling insects inside structures. Best designed trap on the market at this time.
- **Insects Limited Flying Insect Pheromone Traps.** Many different traps for monitoring presence and capturing flying and other insects. Traps are usually specific to species or groups of species.

Snap Traps

- **Victor Brand** mouse and rat snap traps. The oldest and best snap trap available today. Use only those with the metal trigger (the plastic ones are slower). The metal trigger can be fine-tuned (hair-triggered) with a file and minor adjustments. Must be checked each morning.
- **Rat Zapper** by AgriZap, Inc. An electronic trap that electrocutes rats and mice that enter the tunnel for the bait. Must be checked each morning.

Low-Risk Pesticides (for use in structures, museum and garden areas)

- **Advance Granular Ant Bait.** Abamectin granular bait for ants for use in and around structures.
- **Avert Cockroach Bait Stations.** Abamectin bait station for cockroaches for use in and around structures.

- **Avert Cockroach Gel Bait.** Abamectin gel bait for cockroaches for use in and around structures.
- **BoraCare.** Disodium Octaborate Tetrahydrate (DOT) insecticide with solvent to aid wood penetration for wood-destroying organisms (WDOs). Solution can be mixed with water and applied as a spray.
- **Borid.** 99% Boric Acid powder which can be applied into cracks and crevices in structures to manage crawling insects.
- **Dekko Silverfish Paks.** Boric acid bait for use in inaccessible areas for silverfish and firebrats.
- **Drax Liquidator.** Boric Acid in sugar water bait for sweet-feeding ants. This slow-acting stomach poison is very effective for eliminating ant colonies. An excellent bait station for either inside or outdoor placement.
- **EcoEXEMPT D.** An organic dust insecticide containing clove and other oils for use in and around structures to manage crawling and stinging insects.
- **EcoEXEMPT HC.** A non-selective herbicide concentrate containing clove oil for use on unwanted weeds and grasses.
- **EcoEXEMPT IC.** An organic insecticide concentrate containing rosemary and other oils for use indoors and outdoors for crawling and flying insects.
- **EcoPCO D.** A dust insecticide containing eugenol and other plant oils for use in and around structures to manage drawling and stinging insects.
- **Flea 'n Tick B Gone.** An enzyme treatment made from natural plant sources which has proven to effectively remove fleas, ticks, lice and other pests.
- **Jecta.** DOT in a gel to be injected into posts or wood in contact with soil to prevent or treat for termites, mold, fungi and wood rot; can be used for a spot treatment.
- **Max Force Roach Control System.** Contains Hydramethylnon to control cockroaches in structures.
- **Niban Granular Bait C.** Boric Acid for the control of cockroaches and ants in structures.
- **Nibor-D.** A borate powder used as a dust, liquid or mop solution to kill and prevent infestations of carpenter ants, silverfish and mildew. For both interior and exterior use.
- **OvoControl P.** A ready-to-use bait containing Nicarbazin for use in reducing egg hatch in pigeons.
- **Perma-Guard Commercial Insecticide.** Diatomaceous Earth mixed with Pyrethrin and Piperonyl Butoxide which can be dusted into cracks and crevices to manage crawling insects such as cockroaches, ants and silverfish.
- **Perma-Guard Fossil Shell Flour.** Pure Diatomaceous Earth powder which can be used to manage museum pests such as Indian Meal Moth, grain weevils, etc.
- **Roundup Pro.** A non-selective herbicide containing Glyphosate to manage invasive weeds. Use should be minimal. Associated with non-Hodgkins Lymphoma. Wear full protective gear.
- **TimBor Professional.** Disodium Octaborate Tetrahydrate (DOT) insecticide. For use on insects in cracks and crevices, and treating wood to prevent (or treat) termites, wood-destroying insects, mold and fungi. A powder material for crawling insects that can also be mixed with water and applied as a spray; will penetrate into (and through) the raw wood member.
- **Tri Die.** Pressurized Silica and Pyrethrin dust for management of museum pests and crawling insects in structures.
- **Victor Wasp and Hornet Spray.** Contains Mint Oil and Sodium Lauryl Sulfate for the management of wasps, hornets and yellow jackets.
- **Wasp Freeze.** Spray containing d-trans Allethrin for outdoor use only to manage stinging insects, wasps, hornets, yellow jackets and other stinging insects.

GLOSSARY

ABSORPTION-The process by which a chemical or fluid is taken into the systems of human beings, plants, and animals.

ACARICIDE-A pesticide used to kill mites and ticks. A miticide is an acaricide.

ACTIVE INGREDIENT-The chemical or chemicals in a pesticide responsible for killing, poisoning, or repelling the pest. (Listed separately in the ingredient statement.)

ACUTE TOXICITY-The ability of a pesticide to cause injury within twenty-four hours following exposure. LD_{50} and LC_{50} are common indicators of the degree of acute toxicity. (See also Chronic Toxicity.)

ADJUVANT-A substance added to a pesticide to improve its effectiveness or safety. Same as additive. Examples: penetrants, spreader-stickers, and wetting agents.

ADSORPTION-The process by which chemicals are held or bound to a surface by physical or chemical attraction. Clay and high-organic soils tend to adsorb pesticides.

AEROSOL-A material stored in a container under pressure. Fine droplets are produced when the material dissolved in a liquid carrier is released into the air from the pressurized container.

ALGAE-Simple aquatic plants that contain chlorophyll and are photosynthetic.

ALGICIDE-A pesticide used to kill or inhibit algae.

ANTI-SIPHONING DEVICE-A device attached to the filling hose that prevents backflow or back-siphoning from a spray tank into a water source.

ANTICOAGULANT-A chemical that prevents blood clotting. An active ingredient in some rodenticides.

ANTIDOTE-A treatment used to counteract the effects of pesticide poisoning or some other poison in the body.

ARACHNID-A wingless arthropod with two body regions and four pairs of jointed legs. Spiders, ticks, and mites are in the class Arachnida.

ARTHROPOD-An invertebrate animal characterized by jointed body and limbs. It is usually covered by a hard exoskeleton covering that is molted at intervals. For example, insects, mites, and crayfish are in the phylum Arthropoda.

ATTRACTANT-A substance or device that lures pests to a trap or poison bait.
AVICIDE-A pesticide used to repel or kill birds.

BACTERIA-Microscopic organisms, some of which are capable of producing diseases in people, plants and animals. Some bacteria are beneficial.

BACTERICIDE-Chemical used to kill bacteria.

BAIT-A food or other substance used to attract a pest to a pesticide or a trap.

BAND APPLICATION-Application of a pesticide in a strip alongside or around a structure, a portion of a structure, or any object.

BARRIER APPLICATION-See band application.

BENEFICIAL INSECT-An insect that is useful or helpful to people, such as insect parasites, predators, or pollinators.

BIOLOGICAL CONTROL-Management of pests using beneficial arthropods as predators, parasites, and disease-causing organisms which may occur naturally or are introduced to reduce pest populations.

BIOMAGNIFICATION-The process by which one organism accumulates chemical residues in higher concentration from other organisms which they have consumed.

BOTANICAL PESTICIDE-A pesticide produced from chemicals found in plants. Examples are nicotine, pyrethrins, and strychnine.

BRAND NAME-The name, or designation of a specific pesticide product or device made by a manufacturer or formulator. (A marketing name.)

CALIBRATE, CALIBRATION OF EQUIPMENT OR APPLICATION METHOD-Measurement and adjustment to control the output or rate of dispensing pesticides.

CARBAMATES-(N-Methyl Carbamates). A group of pesticides containing nitrogen, formulated as insecticides, fungicides, and herbicides. The N-Methyl Carbamates are insecticides and inhibit cholinesterase in animals.

CARCINOGENIC-The ability of a substance or agent to induce malignant tumors (cancer).

CARRIER-An inert liquid, solid, or gas added to an active ingredient for delivering a pesticide to the target effectively. A carrier is usually water, oil, or other solvent, used to dilute the formulated product for application.

CARRYING CAPACITY-The number of organisms for which a specific site can provide life support.

CERTIFIED APPLICATORS-Individuals who are certified by the state to use or supervise the use of restricted-use pesticides.

CHEMICAL NAME-The scientific name of active ingredients found in formulated products. This complex name is derived from the chemical structure of the active ingredient.

CHEMICAL CONTROL-Pesticide application to kill pests.

CHEMOSTERILANT-A chemical compound capable of preventing animal reproduction.

CHEMTREC-The Chemical Transportation Emergency Center which has a toll-free number (800-424-9300) for providing 24-hour information only for chemical emergencies such as a spill, leak, fire, or accident.

CHLORINATED HYDROCARBON-A pesticide containing chlorine, carbon, and hydrogen. Many are persistent in the environment, such as Chlordane and DDT. Only a few are registered for use in the U.S.

CHOLINESTERASE, ACETYLCHOLINESTERASE-An enzyme in animals that helps regulate nerve impulses. This enzyme is depressed by N-Methyl carbamate and organophosphate pesticides.

CHRONIC TOXICITY-The ability of a pesticide chemical to cause injury or illness (beyond 24 hours following exposure) when applied in small amounts repeatedly for a longer period of time. Chronic effects can also result from a single exposure. (See also Acute Toxicity.)

COMMERCIAL APPLICATOR-A state-certified applicator who for compensation uses or supervises the use of pesticides classified for restricted use for any purpose or on any property other than that producing an agricultural commodity.

COMMON NAME-A name given to a pesticide's active ingredient by a recognized committee on pesticide nomenclature. Many pesticides are known by a number of trade or brand names, but the active ingredient has only one recognized common name.

COMMUNITY-The different populations of animal or plant species that exist together in an ecosystem (See also Population and Ecosystem.)

COMPETENT-Individuals properly qualified to perform functions associated with pesticide application. The degree of competency (capability) required is directly related to the nature of the activity and the associated responsibility.

CONCENTRATION-Refers to the amount of active ingredient in a given volume or weight of formulated product.

CONTACT PESTICIDE-A pesticide that causes death or injury to pests when in contact with it. The chemical does not have to be ingested. It is often used to describe a spray applied directly on a pest.

CONTAMINATION-The presence of an unwanted substance (sometimes pesticides) in or on a plant, animal, soil, water, air, or structure.

CULTURAL CONTROL-A pest management method that includes changing human habits, such as sanitation, changing work practices, or cleaning or garbage pick-up schedules.

DECONTAMINATE-To remove or break down a pesticidal chemical from a surface or substance.

DEGRADATION-A process by which a chemical compound or pesticide is reduced to simpler compounds by the action of microorganisms, water, air, sunlight, or other agents. Degradation products are usually, but not always, less toxic than the original compound.

DEPOSIT-The amount of pesticide on a treated surface after application.

DERMAL TOXICITY-The ability of a pesticide to cause acute illness or injury to human beings or animals when absorbed through the skin (see Exposure Route.)

DESICCANT-A type of pesticide that draws moisture or fluid from a plant or arthropod pest, causing it to die. Certain desiccant dusts destroy the waxy outer coating that holds moisture within an insect's body.

DETOXIFY-To render a pesticide's active ingredient or other poisonous chemical harmless.

DIAGNOSIS-The positive identification of a problem and its cause.

DILUENT-Any liquid, gas or solid material used to dilute or weaken a concentrated pesticide.

DISINFECTANT-A chemical or other agent that kills or inactivates disease-producing microorganisms. Chemicals used to clean or surface-sterilize inanimate objects.

DOSE, DOSAGE-Quantity, amount, or rate of pesticide applied to a given area or target.

DRIFT-The airborne movement of a pesticide spray or dust beyond the intended target area.

DUST-A finely ground, dry pesticide formulation containing a small amount of active ingredient and a large amount of inert carrier or diluent such as clay or talc.

ECOSYSTEM-The pest-management unit. It includes a community (of populations) with the necessary physical (harborage, moisture, temperature), and biotic (food, hosts) supporting factors that allow a population of pests to persist.

EMULSIFIABLE CONCENTRATE (EC)-A pesticide formulation produced by mixing or suspending the active ingredient (the concentrate) and an emulsifying agent in a suitable carrier. When added to water, a milky emulsion is formed.

EMULSIFYING AGENT (EMULSIFIER)-A chemical that aids the suspension of a liquid in another that normally would not mix together.

EMULSION-A mixture of two liquids which are not soluble in one another. One is suspended as very small droplets in the other with the aid of an emulsifying agent.

ENCAPSULATED FORMULATION-A pesticide formulation with its active ingredient enclosed in tiny capsules of polyvinyl or other materials; principally used for slow release. The enclosed active ingredient moves out to the capsule surface as pesticide on the surface is removed (volatilizes, or rubs off).

ENDANGERED SPECIES-Individual plants or animals with a population that has been reduced to the extent that it is near extinction and that has been designated to be endangered by a federal agency.

ENTRY INTERVAL-See Re-entry Interval.

ENVIRONMENT-Air, land, water, plants, people, animals, and the interrelationships which exist among them.

EPA - ENVIRONMENTAL PROTECTION AGENCY-The federal agency responsible for ensuring the protection of people and the environment from potentially adverse effects of pesticides and other contaminants.

EPA ESTABLISHMENT NUMBER-A number assigned to each pesticide-production plant by the EPA. The number indicating the plant at which the pesticide product was produced must appear on all labels of that product.

EPA REGISTRATION NUMBER-An identification number assigned to a pesticide product when it is registered by the EPA for use. The number must appear on all labels of pesticide products.

ERADICATION-The complete elimination of a (pest) population from a designated area.

EXPOSURE ROUTE OR COMMON EXPOSURE ROUTE-The manner - dermal (through the skin), oral (through the mouth), or inhalation/respiratory - in which a pesticide may enter an organism.

FIFRA-The Federal Insecticide, Fungicide, and Rodenticide Act; a federal law and its amendments that controls pesticide registration and use.

FLOWABLE-A pesticide formulation in which very finely ground solid particles are suspended (not dissolved) in a liquid carrier.

FOG TREATMENT-A pesticide in aerosol-sized droplets (under 40 microns). Not a mist or gas. After propulsion, the fog droplets fall on exposed surfaces.

FORMULATION-The pesticide product as purchased, containing a mixture of one or more active ingredients, and carriers (inert ingredients), with other additives making it easy to store, dilute, and apply.

FUMIGANT-A pesticide formulation that volatilizes, forming a toxic vapor or gas that kills in the gaseous state, penetrating voids to kill pests.

FUNGICIDE-A chemical used to kill fungi.

FUNGUS (plural - fungi)-A group of small, often microscopic, organisms in the plant kingdom which cause rot, mold, and disease. Fungi need moisture or a damp environment (wood rots require at least 19%). Fungi are extremely important in the diet of many insects.

GENERAL USE (UNCLASSIFIED) PESTICIDE-A pesticide which can be purchased and used by the general public. (See also Restricted Use Pesticide.)

GRANULE-A dry pesticide formulation. An active ingredient is either mixed with or applied as a coating to an inert carrier to form a small, ready-to-use, low-concentrate chemical which normally does not present a drift hazard. Pellets differ from granules only in their precise uniformity, larger size, and shape.

GROUNDWATER-Water source located beneath the soil surface from which springs and well water are drawn (see also Surface Water.)

HABITAT MODIFICATION-Removing food, water, shelter, and other conditions that support pests, or excluding access by pests to the site.

HALF LIFE-The time required for half of something (i.e. pesticide) to undergo a specific process (chemical degradation), so that only one-half of the applied material is still active (i.e. half life of

Chlordane in soil is about 75 years).

HANTAVIRUS-A deadly virus transmitted to humans through contact with rodent feces, urine and saliva resulting in acute respiratory failure.

HARBORAGE-Shelter that provides the basic needs, including a safe place for the pest population.

HAZARD-See Risk.

HERBICIDE-A pesticide used to kill or inhibit plant growth.

HIGH-RISK PERSON-A person who has some condition that may put him or her at risk from exposure to pesticides. Such persons include children, the elderly, pregnant women, newborns, asthmatics, the neurologically impaired, the environmentally ill (EI), and those with multiple chemical sensitivity (MCS).

HOST-Any animal or plant on or in which another lives for nourishment, development, or protection.

IGR, INSECT GROWTH REGULATOR JUVENOID-A pesticide which mimics insect hormones that control molting and the development of insect systems affecting the change from immature to adult (see Juvenile Hormone.)

INERT INGREDIENT-An inactive material without pesticidal activity in a pesticide formulation, but which may be hazardous for some other reason; i.e., petroleum derivatives.

INGREDIENT STATEMENT-A portion of the label on a pesticide container that gives the name and amount of each active ingredient and the total amount of inert ingredients in the formulation.

INHALATION-Taking a substance in through the lungs (breathing in). (See Exposure Route.)

INSECT GROWTH REGULATOR-See IGR.

INSECTICIDE-A pesticide used to manage or prevent damage caused by insects.

INSECTS, INSECTA-A class in the phylum Arthropoda characterized by a body composed of three segments and three pair of legs.

INSPECTION-A process for detecting pests, pest damage, and evidence of pest activity in a managed site. (See Monitoring.)

INTEGRATED PEST MANAGEMENT-See IPM.

IPM-Integrated pest management. The coordinated use of pest and environmental information with available pest management methods to prevent unacceptable levels of pest damage by the most economical means, and with the least possible hazard to people and the environment. IPM includes reducing pests to a tolerable level. Pesticide application is not the primary management method, but is an element of IPM, as are cultural and structural alterations. IPM programs stress communication, monitoring, inspection, and evaluation (keeping and using records).

JUVENILE HORMONE-A hormone produced by an insect that inhibits change or molting. As long as juvenile hormone is present the insect does not develop into an adult, but remains immature.

LABEL-All printed material attached to or on a pesticide container.

LABELING-The pesticide product label and other accompanying materials that contain directions for use that pesticide users are legally required to follow.

LARVA (plural - larvae)-The developmental stage of insects with complete metamorphosis that hatches from the egg. A mature larva becomes a pupa.

LC_{50}-Lethal concentration. The concentration of a pesticide, usually in air or water, that kills 50 percent of a test population of animals. LC_{50} is usually expressed in parts per million (ppm). The lower the LC_{50} value, the more acutely toxic the chemical.

LD_{50}-Lethal dose. The dose or amount of a pesticide that can kill 50 percent of the test population of animals when eaten or absorbed through the skin. LD_{50} is expressed in milligrams of chemical per kilogram of body weight of the test animal (mg/kg). The lower the LD_{50}, the more acutely toxic the pesticide.

LEACHING-The movement of a substance with water downward through soil.

LYME DISEASE-A debilitating disease mainly affecting joints that is transmitted to humans through the bite of ticks, especially the Deer Tick.

METAMORPHOSIS-A change in the shape or form of an animal. Usually used when referring to insect development.

MICROBIAL DEGRADATION-Breakdown of a chemical by microorganisms.

MICROBIAL PESTICIDE-Bacteria, viruses, fungi, and other microorganisms used to manage pests. Also called biorationals.

MICROORGANISM-An organism so small that it can be seen only with the aid of a microscope.

MITICIDE-A pesticide used to kill mites (see Acaricide.)

MODE OF ACTION-The way in which a pesticide exerts a toxic effect on the target plant or animal.

MOLLUSCICIDE-A chemical used to kill snails and slugs.

MONITORING-Ongoing surveillance. Monitoring includes periodic inspection and record-keeping. Monitoring records allow technicians to evaluate pest population suppression, identify infested or non-infested sites, and manage the progress of the pest-management program.

MSDS-Material Safety Data Sheet required by Department of Labor to be provided by manufacturers to those who request information on chemical substances. Included is data on flammability, eye hazards, protective equipment necessary, spill/clean-up instructions, and other hazard information.

NECROSIS-Death of plant or animal tissues which results in the formation of discolored, sunken, or necrotic (dead) areas.

NONTARGET ORGANISM-Any plant or animal other than the intended targets of pesticide application.

NYMPH-The developmental stage of insects with gradual metamorphosis that hatches from the egg. Nymphs become adults.

ORAL TOXICITY-The effect of a pesticide resulting in injury or acute illness when taken by mouth.

ORGANOPHOSPHATES-A large group of pesticides that contain phosphorus and inhibit cholinesterase in animals; i.e., Malathion and Diazinon.

PARASITE-A plant, animal, or microorganism living in, on, or with another living organism for the purpose of obtaining all or part of its food.

PATHOGEN-A disease-causing organism.

PERSONAL PROTECTIVE EQUIPMENT-Devices and clothing intended to protect a person from exposure to pesticides, including items like long-sleeved shirts, long trousers, coveralls, hats, gloves, shoes, respirators, and other safety items as needed.

PEST MANAGEMENT-See IPM.

PEST-An undesirable organism including any insect, rodent, nematode, fungus, weed, or some terrestrial and aquatic plants and animals, virus, bacteria, or micro-organism which the US EPA Administrator declares to be a pest under FIFRA, Section 25(c)(1).

PESTICIDE-A chemical or other agent used to kill, repel, or otherwise manage pests or to protect from a pest.

pH-A measure of acidity/alkalinity of a liquid: acid below pH7; basic or alkaline above pH7 (up to 14).

PHEROMONE-A substance emitted by an animal to influence the behavior of other animals of the same species. Some are synthetically produced for use in insect traps.

PHOTODEGRADATION-Breakdown of chemicals by the action of light.

PHYSICAL CONTROL-Habitat alteration or changing the infested physical structure, such as by caulking holes, cracks, tightening around doors, windows, moisture reduction, ventilation, and other means.

PHYSIOLOGICAL SENSITIVITIES-Human physiological reaction from exposure in the environment to perhaps minute amounts of chemicals that produce an adverse response.

PHYTOTOXICITY-Injury to plants caused by a chemical or other agent.

POINT OF RUNOFF-The point at which a spray starts to run or drip from the surface to which it is applied.

POISON CONTROL CENTER-A local agency, generally a hospital, which has current information on the proper first-aid techniques and antidotes for poisoning emergencies. Such centers are listed in telephone directories (AAPCC Certified Banner Poison Control Center: 1-800-222-1222).

POPULATION-Individuals of the same species. The populations in an area make up a community

(see Ecosystem.)

PORT-Small sealable hole that allows injection of pesticidal material into a wall or other void in a structure.

PRECIPITATE-A solid substance that forms in a liquid and settles to the bottom of a container; a material that no longer remains in suspension.

PREDATOR-An animal that attacks, kills, and feeds on other animals. Examples of predaceous animals are coyotes, hawks, owls, snakes, spiders, lady-bird beetles and other insects.

PROFESSIONAL-One who is trained to conduct an efficient operation and able to make judgments based on training and experience.

PROPELLANT-The inert ingredient in pressurized containers that forces an active ingredient from the container.

PUPA (plural - pupae)-The developmental stage of insects with complete metamorphosis when major changes from larval to adult form occurs.

QUALIFIED APPLICATOR-An applicator who is certified (and licensed in some states) to apply restricted-use pesticides in the state. Qualification may also include training or experience.

RATE OF APPLICATION-The amount of pesticide applied to a plant, animal, unit area, or surface; usually measured per acre, per 1,000 square feet, per linear foot, or per cubic foot.

RE-ENTRY INTERVAL-The length of time following an application of a pesticide during which entry into the treated area is restricted. Also known as Entry Interval.

REGISTERED PESTICIDES-Pesticide products which have been registered by the Environmental Protection Agency for uses listed on the label.

REPELLENT-A compound that keeps insects, rodents, birds, or other pests away from plants, domestic animals, buildings, or other treated areas.

RESIDUAL PESTICIDE-A pesticide that continues to remain effective on a treated surface or area for an extended period following application.

RESIDUE-The pesticide active ingredient or its breakdown products which remain in or on the target after treatment.

RESTRICTED USE PESTICIDE-A pesticide that can be purchased and used only by certified applicators or persons under their direct supervision. A pesticide classified for restricted use under FIFRA, Section 3(d)(1)(C).

RISK-A probability that a given pesticide will have an adverse effect on people or the environment in a given situation.

RMSF-Rocky Mountain Spotted Fever is an acute infectious rickettsial disease transmitted to humans by the American dog tick.

RODENTICIDE-A pesticide used to kill rodents.

RUNOFF-The movement of water and associated materials on the soil surface. Runoff usually proceeds to bodies of surface water.

SANITATION-The practice of removing undesirable substances that support a pest or pest population (for instance, food or water).

SIGNAL WORDS-Required wording which appears on every pesticide label to denote the relative toxicity of the product. Signal words are DANGER-POISON, DANGER, WARNING, or CAUTION.

SITE-Areas of actual pest infestation. Each site should be treated specifically or individually.

SOIL INJECTION-The placement of a pesticide below the surface of the soil, a common application method for termiticides.

SOIL DRENCH-To soak or wet the ground surface with pesticide. Large volumes of pesticides are usually needed to saturate the soil to a sufficient depth.

SOIL INCORPORATION-The mechanical mixing of a pesticide product with soil.

SOLUTION-A mixture of one or more substances in another substance (usually a liquid) in which all the ingredients are dissolved. Example: sugar in water.

SOLVENT-A liquid which will dissolve another substance (solid, liquid, or gas) to form a solution.

SPACE SPRAY-A pesticide which is applied as a fine spray or mist to a confined area.

STOMACH POISON-A pesticide that must be eaten by an animal in order to be effective; it will not kill on contact.

SURFACE WATER-Water on the earth's surface such as rivers, lakes, ponds, and streams. (See Groundwater.)

SUSPENSION-A pesticide mixture consisting of fine particles dispersed or floating in a liquid, usually water or oil. Example: wettable powders in water.

TARGET-Plants, animals, structures, areas, or pests toward which the pesticide or other management method is directed.

TECHNICAL MATERIAL-Pesticide active ingredient in pure form, as it is manufactured by a chemical company. It is combined with inert ingredients or additives in formulations such as wettable powders, dusts, emulsifiable concentrates, or granules.

TOXIC-Poisonous to living organisms.

THRESHOLD-A level of pest density. The number of pests observed, trapped, or counted that can be tolerated without an economic loss or aesthetic injury. Thresholds in pest management may be site specific. For example, different numbers of flies may be tolerated at different sites (warehouse and kitchen would have different thresholds).

TOLERABLE LEVELS OF PESTS-The presence of pests, at certain levels, is tolerable in many situations. Totally eliminating pests in certain areas is sometimes not achievable without major

structural alterations, excessive control measures, unacceptable disruption, or unacceptable cost.

The tolerable level in some situations will be near zero. Urban pest management programs may have lower tolerable levels of pests than rural programs.

TOXICANT-A poisonous substance such as the active ingredient in a pesticide formulation.

TOXICITY-The ability of a pesticide to cause harmful, acute, delayed, or allergic effects. (The degree or extent that a chemical or substance is poisonous.)

TOXIN-A naturally occurring poison produced by plants, animals, or microorganisms. Examples: the poison produced by the black widow spider, the venom produced by snakes, the botulism toxin.

UNCLASSIFIED PESTICIDE-See General-Use Pesticide.

USE-The performance of pesticide-related activities requiring certification including application, mixing, loading, transport, storage, or handling after the manufacturing seal is broken; care and maintenance of application and handling equipment; and disposal of pesticides and their containers in accordance with label requirements. Uses not needing certification are long-distance transport, long-term storage, and ultimate disposal.

VAPOR PRESSURE-The property which causes a chemical to evaporate. The higher the vapor pressure, the more volatile the chemical or the more easily it will evaporate.

VECTOR-A carrier, an animal (such as an insect, nematode, mite) that can carry and transmit a pathogen from one host to another.

VERTEBRATE-Animal characterized by a segmented backbone or spinal column.

VIRUS-Ultramicroscopic parasites composed of proteins. Viruses can only multiply in living tissues, and they cause many animal and plant diseases.

VOID-Space inside walls or other inaccessible space that may harbor pests.

VOLATILITY-The degree to which a substance changes from a liquid or solid state to a gas at ordinary temperatures when exposed to air.

WATER TABLE-The upper level of the water-saturated zone in the ground.

WEST NILE VIRUS-A disease transmitted to humans and other animals by the bite of a mosquito. Birds (notably Corvids) act as a reservoir and may die as a result.

WETTABLE POWDER-A dry pesticide formulation in powder form that forms a suspension when added to water.

ZONE-The management unit, an area of potential pest infestation made up of infested sites. Zones will contain pest food, water, and harborage. A kitchen-bathroom arrangement in motel units might make up a zone. Zones may also be established by eliminating areas with little likelihood of infestation and treating the remainder as a zone. A zone will be an ecosystem.

STRUCTURAL IPM INSPECTION FORM

Date_____ Inspector_____ Assisted by_____

Building_____

Code Numbers for Problems on Form/Map:

1 = Roaches	2 = Flying Insects (flies, moths)	3 = Other Insects	4 = Rodent Sign	5 = Housekeeping
6 = Maintenance	7 = Bird Sign	8 = Ground Squirrels	9 = WDO= s	10 = Other

Abbreviations: PTW = Pressure Treated Wood FWJ = Floor Wall Junction

1. OUTSIDE - Curtilage:
Pests known present.....

Garbage/dumpster conditions.....
General area cleanliness.....
Dead trees/sod debris/termites.....
Pest harborage/debris on ground.....
Pest breeding (water, food, shelter).....
Paving/walk drainage problems.....
Wood too close to structure.....
Plants too close to building.....
General wood control.....
Hazardous trees/limbs.....
Shed/outbuilding problems.....
Rodent burrows/sign/holes.....
Pet/bird feeders/waterers.....
Insect evidence/harborage garden?.....
Vertebrate evidence/holes.....
.....
...

2. FOUNDATION - Exterior
Pests known present.....

A. Foundation:
Building corners square foundations.....
Foundation intact: dirt/wood contact?.....
Wood-concrete-soil contacts/PTW.....
Foundation cracks.....
36 in. clear area around structure (1 in. gravel).....
.....
...

B. Grade
Soil drainage characteristics.....
Grade from structure (6 in/10 ft.).....
Grade and water accumulations.....
.....
...

C. Siding/Building Exterior
Downspout drains splash on siding?.....
Splash blocks perforated pipe.....
Main siding peeling paint/buckling?.....
Water/air conditioner leaks.....
Rusty nails/wood streaking.....
Discolored/decayed wood siding.....
Wood pick test results.....
Wood moisture readings.....
Wood junctions caulked.....
Porch and soffit conditions.....
Tongue & groove flooring caulked.....
Door sweeps/good door closure.....
Metal kickplates on doors.....
Window frame conditions.....
Vents/exhaust/conduits screened.....
Cracks/holes around pipes/wires.....
Outside lights away from doors/on poles; high pressure sodium bulbs; covers clean.....
Trees touching/overhanging structure.....
Plants/plantings/planters/trellises.....
..
Trash/debris accumulations.....
Insect/vertebrate evidence/harborage.....
.....
...

D. Food Establishments
Loading docks/receiving areas clean.....
Garbage area removed from structure.....
Other outside storage/spills.....
Exterior wall/foundation cracks.....
.....
...

E. Structural Roof
Pests known

present.....

Missing shingles/cracks in surface.....
Moss/lichen/algae/fungus on roof.....
Rusty iron nails in roofing.....
Shingles/roof intact.....
Shingle extension 1 ft. eave (12-24-30).....
Gutters clean, not clogged.....
Chimney/vents screened.....
Bird problems in eaves.....
Chimney flashing/construction tight.....
Dormer flashing/construction tight.....
Soffit flashing tight.....
Wires from roof pest-protected.....
Insect evidence/harborage.....
Fascia tight/painted (carpenter bees).....
.....
...

3. INSIDE - Crawlspace
Pests known present.....

Monitor (repair) structure twice a year (spring/fall) for moisture/

damage.....
.
Vents screened/open/in wells.....
Height of crawlspace (18 in.t joists).....
Wood/soil contact.....
Wood pick test results.....
Termite shields installed.....
Leaking pipes.....
Structural wood type.....
Wet areas? Why? Moisture readings.....
Mold/fungus/decay/insect damage.....
Wood debris present.....
Evident floor/wood shrinkage.....
Vapor barrier? Intact?.....
Pest access into structure thru floor.....
Active insect infestations?.....
Vertebrate
Suspended ceilings/light fixtures.....

C. Service/Custodial Rooms
Custodial storage area.....
Wet mops/rags/sour drains.....
sign?.....
Ventilation: 1 sf/150 sf; within 3 ft. of corner.....
Crawlspace access door clear.....

4. INSIDE - Structural
Pests known present.....

A. Basement
Walls dry/moisture readings.....
Storage condition/sanitation.....
Wood moisture in sill area.....
Floor drains clean/screened.....
Sticky trap monitoring.....
Trash collection practices.....
Insect evidence/harborage.....

B. Offices; Classrooms
Reception desk area.....
Exhibit area: general pest risks?.....
Exterior door conditions.....
Offices: neatness/problem areas.....
Eating/storing food at desks.....
Computers/elec equipment problems.....
Insect attracting items in building?.....
Insect evidence/harborage.....
Lunchroom/coffeemaking area.....
Vending machines.....
Trash collection practices.....
Decorative plants.....
General sanitation/lint.....
Cracks/holes in floor.....
Windows/doors:
.....
...
.....
...
.....
...

Ceilings:
.....
...
.....
...

Electrical boxes/equipment.....
Drains cleaned/screened.....

D. Kitchens/Food Establishments
Countertops caulked/intact.....

Exhaust vents.....
Water leaks/pipe sweating/hot water heater.....
Drains clear/good condition.....
Food stored in cans/glass.....
Shelves clean/no shelf paper.....
Refrigerator pan/motor.....
Windows tight/insect presence.....
Condition of walls/grease/moisture.....
Storage 6 in. off floor.....
Dishwasher cleanliness/pests.....
Stove vent clean/screened.....
Stove/refrigerator doors clean.....
Hollow legs on tables/chairs/rails?.....
Equipment elevated on legs.....
Conditions under lowest drawers.....
Trash covered; out every night.....
Dishes kept in water until cleaned.....
Outside trash covered; cans cleaned weekly.....
Insect evidence/harborage.....
Dry storage areas.....
Areas behind false fronts on equipment.....
Loose floor tile/screened drains.....
Regularly emptied trash containers.....
Area around can opener/grease hoods.....
Condition of window frames.....
Employee lockers.....
Air doors/vanes positioned correctly.....
Door sweeps.....

E. Bathrooms
Water leaks at tub/shower/toilet; fungus.....
Floor strength near toilet.....
Water leaks under sink.....
Condition of window frames.....
Blistered ceiling/wall paint.....
Insect evidence/harborage.....

F. Structural/Attic
Sufficient ventilation.....
Insect/pest evidence/harborage.....
Vents screened.....
Temperature.....
Roof/wall junction tight seal.....
Rodent evidence.....
Exposed/chewed wiring.....
Appliance venting.....
Frozen condensation/ice dams.....
Bat presence.....

G. Additional notes

Floors:
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Walls:
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Other:
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EQUIPMENT CHECKLIST - personal protective equipment

- 9 Hard hat
- 9 Insect repellant
- 9 Knee pads
- 9 Gloves, heavy/medical
- 9 Face shield/goggles
- 9 Dust mask/respirator
- 9 Overalls and/or bee suit
- 9 Bee veil
- 9 Smoker and fuel
- 9 Wasp Freeze
- 9 Fly swatter
- 9 .....

TOOLS FOR SITE INSPECTIONS

- 9 Clipboard/grid/paper
- 9 Inspection forms
- 9 Pencil/pen
- 9 Insect keys/info
- 9 Aspirator/collecting vials
- 9 Flashlight/headlamp
- 9 Flashlight batteries
- 9 Hand duster
- 9 Vials w/alcohol
- 9 Polaroid/digital camera
- 9 Belt/leatherman/knife
- 9 15x Hand lens/loupe
- 9 Film/flash
- 9 Caulk
- 9 Lo-line sticky traps
- 9 Screwdriver/phillips/slot
- 9 Crescent/general wrench
- 9 Forceps
- 9 Pocket tape recorder
- 9 Pliers
- 9 .....
- 9 .....
- 9 Masking/filament tape
- 9 Portable vacuum cleaner
- 9 Ladders/rope/carabiner
- 9 Sharp probe (wood awl)
- 9 White coveralls
- 9 Belt pouch for tools
- 9 Extendable mirror
- 9 Tape measure/6 in ruler
- 9 Plastic zip locs
- 9 Digital camera
- 9 Colored sticky labels
- 9 Binoculars
- 9 Moisture meter/thermometer
- 9 Small hand trowel
- 9 Knee/elbow pads
- 9 Spatula
- 9 Rechargeable drill
- 9 Stethoscope
- 9 Optivisor
- 9 Hand mirror
- 9 .....
- 9 .....

ADDITIONAL
COMMENTS.....
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GROUNDS IPM INSPECTION FORM

Site_____ Date_____ Inspector_____ Assisted by_____

PESTS PRESENT

VERTEBRATES	LOCATION	ACTION
INSECTS	LOCATION	ACTION
WEEDS	LOCATION	ACTION

INSECT PHEROMONE MONITORING TRAPS

SPECIES	COUNTS	LOCATION

OTHER OBSERVATIONS – i.e., Plants too Close to Structures, etc.

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Name of Observer:

Date	Time	Finch	Pigeon	GH Owl	Dove	Starling	Woodpkr	Flicker	Kestrel	Observations

COYOTE SIGHTING LOG

Date	Den	Holes	Site number	Observations

DEAD ANIMAL SIGHTING LOG

Date Reported	Animal Type	Location	Reason For Death (Natural Causes, Snap Traps, Pesticide, Herbicide, Predation, etc.)	Reporter/Recorder	Tested for Disease? When, Where, and Results?

FERAL DOG SIGHTING LOG

Date	**Number of Dogs**	**Description**	**Location**	**Observations**

PEST CONCERNS SIGHTING LOG

Date	Animal Type	Location	Pest Concern	Reporter

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VENDORS

AGRIZAP, INC., 4535 McGrath Street, Building B, Ventura, CA 93003. 1-888-332-3728. www.ratzapper.com. Electronic rodent management device.

ARBICO ORGANICS, P.O. Box 8910, Tucson, AZ 85738. 1-800-827-2847. www.arbico-organics.com. Provides low-risk biocontrol organisms (parasites and predators).

BENEFICIAL INSECTARY, 9664 Tanqueray Court, Redding, CA 96003. 1-800-477-3715. www.insectary.com. Provides beneficial critters for managing aphid, whitefly, mites and more.

BIOCONTROL NETWORK, 5116 Williamsburg Road, Brentwood, TN 37027. 1-800-441-2847. www.biconet.com. Provides an extensive list of low-risk pest control critters and products.

BIOQUIP PRODUCTS, INC., 2321 Gladwick Street, Rancho Dominguez, CA 90220. 1-310-667-8800. www.bioquip.com. Equipment, supplies and books for Entomology and related sciences.

GARDENS ALIVE!, 5100 Schenley Place, Lawrenceburg, IN 47025. 1-812-537-8650. www.gardens-alive.com. Informative catalog with a wide selection of many biological-based pest controls, including beneficial predators, parasites, beneficial nematodes, fertilizers and much more.

INSECTS LIMITED, INC., 16950 Westfield Park Road, Westfield, IN 46074. 1-317-896-9300. www.insectslimited.com. Source for insect pheromone traps.

IPM LABORATORIES, Main Street, Locke, NY 13092-0099. 1-315-497-2063. www.ipmlabs.com. This company produces a very informative catalog and newsletter with helpful, expert information on using its many beneficial insects. Provides whitefly egg parasites and predators as well as a number of wasp parasites for aphid control, including the difficult to find *Aphelinus abdominalis* and *Aphidius ervi*. They always carry a quality product.

M&R DURANGO, INC., P.O. Box 886, Bayfield, CO 81122 aka The Good Bug Company, 970-259-3521. www.goodbug.com. Provides *Encarsia Formosa*, thrips predator, spider mite predator, green lacewing and more.

NEEM RESOURCES, THE AHIMSA ALTERNATIVE, INC., 5317 Whiting Avenue, Edina, MN 55439. 1-877-873-6336 or 1-405-538-0280. www.neemresource.com. Provides pure neem oil, karanja oil and other neem products for natural pest management.

PERMA-GUARD, INC., 625 East 2150 South, Bountiful, UT 84010. 1-877-801-2025. www.perma-guard.com. Supplier of diatomaceous earth product and pyrethrin and diatomaceous earth insecticides.

PEST CONTROL SUPPLIES, 1700 Liberty Street, Kansas City, MO 64102. 1-800-821-5689. www.pcspest.com. Termite and rodent control, herbicides, insect traps.

PRESERVATION PRODUCTS UNLIMITED, 6929 Seward Avenue, P.O. Box 29109, Lincoln, NE 68529. 1-800-648-7329.

RESIDEX, 8486-F Tyco Road, Vienna, VA 22182. 1-800-247-8528. www.residex.com. A source for pesticides, Lo-Line sticky monitoring traps, Victor snap traps and more.

RINCON-VITOVA INSECTARIES, INC., P.O. Box 1555, Ventura, CA 93002. 1-800-248-2847. www.rinconvitova.com. Provides a wide variety of pest management supplies and beneficial organisms.

TARGET SPECIALTY PRODUCTS, 15415 Marquardt Avenue, Santa Fe Springs, CA 90670. 1-562-802-2238. www.target-specialty.com. A source for pesticides, Lo-Line sticky monitoring traps, Victor snap traps and more.

UNIVAR USA. 2090 E. University Dr., Ste. 111, Tempe, AZ 85281-4684. 1-480-894-5323. www.univarusa.com. A source for pesticides, Lo-Line sticky monitoring traps, Victor snap traps and more.

VICTOR PEST AND SAFER PEST CONTROL PRODUCTS. 1-800-800-1819. www.victorpest.com. Provides a full line of poison-free and low-risk pest management products. There is a search feature on pests, what they are, what diseases they may carry, and how to prevent infestations.

NOTE:

These suppliers are known to IPMI as providing high-quality products and services. There are hundreds of pest management product suppliers in the U.S. that may also provide high-quality products and services.

- Victor brand snap traps are the oldest manufactured traps, are widely available, and can be easily “fine-tuned” for reliable kills.
- Lo-Line monitoring (sticky) traps for crawling insects are the best designed, reliable products on the market to date.


CASA GRANDE
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PREHISTORIC RUINS
NATIONAL PARK SERVICE
U.S. DEPARTMENT OF INTERIOR